TASMANIAN SCALEFISH FISHERY ASSESSMENT 2018/19

Nils Krueck, Klaas Hartmann and Jeremy Lyle

May 2020

This assessment of the Tasmanian Scalefish Fishery is produced by the Institute for Marine and Antarctic Studies (IMAS) using data downloaded from the Department of Primary Industries, Parks, Water and Environment (DPIPWE) Fisheries Integrated Licensing and Management System (FILMS) database. The information presented here includes all logbook returns for the 2018/19 season.

IMAS Fisheries and Aquaculture
Private Bag 49
Hobart TAS 7001
Australia

Email: nils.krueck@utas.edu.au
Ph: +61 3 6226 8226

Contents

Executive Summary

The Tasmanian Scalefish Fishery is a multi-species fishery that operates in state waters and encompasses a wide variety of species and capture methods. The Scalefish Fishery Management Plan (amended in 2015) provides the legislative framework for the fishery.

Fishery assessment

Since the early 1990s, annual commercial catches of the major species have generally declined. This decline can be explained in part by changed targeting practices and market demand, the introduction of the Scalefish Fishery Management Plan in 1998, and the transfer of the Southern Shark Fishery to the Commonwealth in 2000.

The general decline in commercial catches of Scalefish Fishery species over the last decades was accompanied by a continuous decline in the number of vessels participating and in the number of scalefish fishing licences since 2000. Although catch is thus commonly declining due to declining effort, there is insufficient information or ongoing concern about the status of half of all species assessed in this report. There is also concern regarding the level of latent capacity within the fishery from licence holders who are currently participating either at low levels or not active (only 20–50% of licences are active depending on the type).

Highest commercial catches in 2018/19 were reported for Southern Calamari (107 t), Wrasse (81 t), Whiting (41 t), Australian Salmon (39 t) and Banded Morwong (37 t). Catch and effort information for the recreational fishery, which are available periodically, demonstrate that the recreational catch in recent years represents a significant component of the total harvest (>50%) for some key species of management concern, including Sand Flathead, Striped Trumpeter and Bastard Trumpeter.

Species status

The status of all of the main species was assessed based on information available through previous assessments, new data on catch, effort and species biology for 2018/2019, as well as updated stock assessments by the Fisheries Research and Development Corporation (FRDC) and the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). The outcomes of species assessments are detailed below, noting that IMAS and DPIPWE have initiated an ongoing review of data quality control and assessment, which could cause changes to the FILMS database and stock assessment calculations that are presented in future reports.

Species status was assigned according to the national stock reporting framework (Sustainable, Recovering, Depleting, Depleted or Undefined), which is explained in more detail below (see Figure 1 and Table 1). We note that the stock reporting framework adopted here only defines the stock against the limit reference point of whether it is likely to be recruitment overfished or not. Target reference points (i.e. those that correspond to levels of biomass and fishing pressure that are considered to provide for optimal sustainable harvests) remain to be defined. We further note that Banded Morwong assessments are reported separately. This change from previous reporting reflects differences in the period for setting the annual Total Allowable Catch (TAC) for Banded Morwong (based on quota year) compared with routine assessment reporting for other scalefish species (based on financial year). Octopus, whose catches are reported following the same reporting period as Banded Morwong, are also assessed in an independent report.

Species assessments for 2018/2019

Species/Species group	Preliminary status	May
Australian Salmon *Arripis trutta*	SUSTAINABLE	This species has a long history of exploitation across south-eastern Australian. Low commercial landings in Tasmania in recent years are driven by market demand rather than abundance. The current level of fishing pressure in Tasmania is well below historically sustained levels and thus unlikely to cause the biological stock to become recruitment impaired.
Australian Sardine *Sardinops sagax*	SUSTAINABLE	The fishery is in a developmental phase in Tasmania, with low catches reported to date. The species was classified as not overfished nor subject to overfishing by ABARES for 2018/19. Similarly, all Australian stocks are currently classified as sustainable in the 2018 Status of Australian Fish Stocks. The current level of fishing pressure in Tasmania is low and unlikely to cause the biological stock to become recruitment impaired.
Barracouta *Thyrsites atun*	UNDEFINED	Catches of Barracouta have declined steadily since the mid-2000s due to a decrease in targeted effort as a result of low market demand. Catches and catch rates are not considered indicative of stock status and there is insufficient information to confidently classify the status of the stock.
Bastard Trumpeter *Latridopsis forsteri*	DEPLETED	Trends in commercial and recreational catches suggest record low population levels and that the species is recruitment overfished. The current minimum legal size limit is below the size of maturity. Although commercial catches have remained low for the past decade, fishing pressure may be too high to allow stocks to recover.
Blue Warehou *Seriolella brama*	DEPLETED	This is a predominately Commonwealth-managed species that is classified as overfished in the ABARES Fishery Status Reports 2019. It is classified as depleted in the 2018 Status of Australian Fish Stocks Report. This species is sporadically abundant in Tasmanian waters. Despite a reduction in Total Allowable Catch (TAC) for the Commonwealth fishery to 118 t and the initiation of a stock rebuilding strategy in 2008, there is no evidence of stock recovery.
Tiger Flathead *Platycephalus richardsoni*	SUSTAINABLE	This is a predominately Commonwealth-managed species that is classified as not overfished nor subject to overfishing in the ABARES Fishery Status Reports 2019. It is classified as sustainable in the 2018 Status of Australian Fish Stocks Report. In Tasmania, Tiger Flathead are caught predominately by the commercial sector. Catches fluctuate substantially, but they typically represent a small proportion of Commonwealth trawl landings.
Sand Flathead *Platycephalus bassensis*	DEPLETING	Recreational catches dominate landings of Sand Flathead in Tasmania. Fishery independent surveys suggest relatively low abundances of legal sized fish, particularly in south-eastern Tasmania where populations are subject to heavy fishing pressure. While a recent increase in minimum size limit and reduction in bag limit seems to have reduced catches, the current levels of fishing pressure are high and likely to cause the stock to become recruitment impaired.

Flounder Pleuronectidae family	UNDEFINED	Greenback Flounder (*Rhombosolea tapirina*) constitute the majority of the commercial catch, which remains low due to a widespread ban on overnight gillnetting and limited market demand. Catch and catch rates are considered unreliable estimators of abundance and the status of the stock remains uncertain.
Gould's Squid *Nototodarus gouldi*	SUSTAINABLE	This is a predominately Commonwealth-managed species that is classified as not overfished nor subject to overfishing by ABARES for 2018. Dual-licensed vessels fish in Tasmanian waters, especially in years of peak abundance. The species is characterised by high inter-annual variability in abundance in state waters, and generally low catches in recent years.
Jack Mackerel *Trachurus declivis*	SUSTAINABLE	This is a predominately Commonwealth-managed species that is classified as not overfished nor subject to overfishing by ABARES for 2018. Only minor catches of this species have been taken from Tasmanian waters in recent years due to an operator leaving the fishery. Patterns of catch and effort are unlikely to reflect stock status, but the current low level of fishing pressure in Tasmania is unlikely to cause the stock to become recruitment impaired.
Jackass Morwong *Nemadactylus macropterus*	SUSTAINABLE	This is a Commonwealth-managed species that is classified as not overfished nor subject to overfishing by ABARES for 2018. It is classified as sustainable in the Status of Australian Fish Stocks Report 2018. Commercial catches in Tasmania are low.
Leatherjackets ***Monacanthidae*** family	UNDEFINED	Several undifferentiated species of Leatherjacket are found in coastal waters around Tasmania. Leatherjackets are largely a by-product and not actively targeted due to a lack of market demand. Therefore, catch is not a good indicator of abundance, and there is little biological information to confidently classify the status of Leatherjacket stocks.
Longsnout Boarfish *Pentaceropsis recurvirostris*	UNDEFINED	Boarfish are a by-product species of Banded Morwong fishing with low catches due to the large minimum legal size. There is insufficient information available to confidently classify this stock.
Yelloweye Mullet ***Aldrichetta forsteri***	SUSTAINABLE	Yelloweye Mullet are most abundant in estuarine habitats, where netting is prohibited or restricted, thereby providing a high degree of protection throughout most of their range. Catches are at low levels, but unlikely to reflect abundance. It is overall unlikely that the stock is recruitment impaired or that the current fishing pressure is high enough that the stock might become recruitment impaired in the future.
Snook ***Sphyraena novaehollandiae***	SUSTAINABLE	Current catches of Snook approach historically lowest levels. Catch rates are considered unreliable to estimate abundance due to the species not being actively targeted. Recent biological analyses indicate that the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired.
Eastern School Whiting *Sillago flindersi*	SUSTAINABLE	This is a predominately Commonwealth-managed species that is classified as not overfished nor subject to overfishing by ABARES for 2018. It is classified as sustainable in the 2018 Status of Australian Fish Stocks Report. Tasmanian catches fluctuate due to market demand, but generally represent only a small proportion of the Commonwealth commercial catch.

Southern Calamari *Sepioteuthis australis*	**DEPLETING**	State-wide commercial catches in 2017/18 declined by more than 50% from 2016/17, which is largely due to a decline in catch in the northern areas of the state. Fishing effort also declined, particularly on the North coast, but remained high relative to historic levels. In 2018/19, both catch and effort increased again in all regions. This reveals an increase in CPUE that is consistent with fishery-independent survey results, which showed increased egg laying activity in 2018 compared to 2017. However, total catch in 2018/2019 was notably higher again than the estimated maximum sustainable yield (MSY). In combination with egg survey results for 2019, which indicate reduced spawning activity, there is reason for concern that fishing mortality has been excessive and could cause the stock to become recruitment impaired.
Southern Garfish *Hyporhamphus melanochir*	**DEPLETED**	After strong declines in catches in 2006/07 and 2007/08 coupled with changes in population age structure, management actions appeared to initiate a recovery. However, both catches and catch rates showed significant declines over the last couple of years, which might be explained by recent estimates of consistently high fishing mortality. In consideration of the likely vulnerability of this species to overfishing, even currently low levels of fishing pressure may be too high to allow stocks to recover.
Striped Trumpeter *Latris lineata*	**RECOVERING**	Following evidence of recruitment in the last two years, population status and trends remain unclear. In 2018/19, reference points for low commercial catch, high recreational catch, and a high proportion of recreational catch were triggered. Commercial catches are at a historical low, but total levels of fishing pressure (commercial and recreational combined) could still be too high to allow for recovery, especially since the minimum size limit is below the estimated size at maturity.
Wrasse ***Notolabrus tetricus*** (Bluethroat Wrasse) ***Notolabrus fuciola*** (Purple Wrasse)	**SUSTAINABLE**	Catches, effort and catch rates have remained relatively stable for almost a decade providing little reason for concern that recent fishing mortality is too high. Some uncertainty remains over the size of the catch taken by rock lobster fishers and used for bait.

1. Introduction

The Tasmanian Scalefish Fishery

The Tasmanian Scalefish Fishery is a multi-gear and multi-species fishery. The main gear types include gillnet, hooks and seine nets. Other fishing gears in use include traps, Danish seine, dip nets and spears. Reported harvesting includes a diverse range of scalefish, shark and cephalopod species. A list of both common and scientific names of these species is presented in Appendix 1.

The Scalefish fishery is dynamic with fishers readily adapting and changing their operations in response to changes in fish availability, legal requirements and market opportunities. In consequence, only a small proportion of the fleet has specialised in a single activity or targets a single primary species (Ziegler 2012). For many operators, scalefish represent an adjunct to other activities, such as Rock Lobster fishing.

Management objectives and strategies

The Scalefish Fishery Management Plan [*Fisheries (Scalefish) Rules 1998*] was first introduced in 1998 (DPIF 1998) and reviewed in 2001, 2004, 2009 and 2015. The management plan provides the regulatory framework for the fishery, which covers commercial and recreational components. While the management plan contains the overarching legislation under which the fishery operates, the following objectives, strategies and performance indicators are contained in a policy document currently under review.

Major objectives

- To maintain fish stocks at sustainable levels by restricting the level of fishing effort directed at scalefish, including the amount and types of gear that can be used;
- To optimise yield and/or value per recruit;
- To mitigate any adverse interactions that result from competition between different fishing methods or sectors for access to shared fish stocks and/or fishing grounds;
- To maintain or provide reasonable access to fish stocks for non-commercial fishers;
- To minimise the environmental impact of scalefish fishing methods generally, and particularly in areas of special ecological significance;
- To reduce by-catch of juveniles and non-target species; and
- To implement effective and efficient management.

Primary strategies

- Limit total commercial fishing capacity by restricting the number of licences available to operate in the fishery;
- Define allowable fishing methods and amounts of gear that can be used in the scalefish fishery by both commercial and non-commercial fishers;
- Monitor the performance of the fishery over time, including identification and use of biological reference points (or limits) for key scalefish species;
- Protect fish nursery areas in recognised inshore and estuarine habitats by prohibiting or restricting fishing in these areas;
- Employ measures to reduce the catch and mortality of non-target or undersized fish; and
- Manage developing fisheries under permit conditions.

This report

This report covers assessments of 20 selected taxa, including species of teleosts and cephalods which are exploited by diverse fishing activities around Tasmania that are managed under either Tasmanian or Commonwealth jurisdiction. Formal assessments of species primarily caught under Commonwealth jurisdiction (e.g. Tiger Flathead, Blue Warehou, Jackass Morwong, Ocean Perch, School Whiting, Blue-eye Trevalla, Blue Grenadier, School and Gummy Shark) are undertaken by the Southern and Eastern Scalefish and Shark Fishery Assessment Group (SESSFAG) and summarised in fishery status reports produced by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES; e.g. Patterson et al. 2019).

Data sources

Commercial catch and effort data are collected through compulsory Tasmanian Commercial Catch, Effort and Disposal Returns, and Commonwealth non-trawl (GN01 and GN01A) and Southern Squid-jig Fishery (SSFJ) logbook returns. Unless noted otherwise, catch and effort data reported in this assessment relate to the commercial sector. Catch and effort information for the recreational sector are collected from surveys that are conducted periodically.

Tasmanian General Fishing Returns

The catch and effort logbooks have been modified several times (1995, 1999, 2007, 2010, 2013 and 2015) to report at finer spatial scales and provide greater operational detail. While the offshore fishing blocks are still at the 30nm (1/2 degree) spatial resolution, the logbooks introduced in 2010 have redefined the scale of the coastal blocks (Fig. 1.1). Analysis of catch and effort information reported in FILMS requires data quality control measures, which are detailed in Appendix 2. FILMS data quality control procedures are currently under review to improve the precision of catch and effort information for future assessments.

Commonwealth catch returns

Following the introduction of the Commonwealth non-trawl logbook (GN01 and subsequent versions) in late 1997, dual endorsed Tasmanian and Commonwealth (South East Non-Trawl and Southern Shark) operators generally commenced recording all of their catch and effort data, including fishing in State waters, in the Commonwealth logbooks. In addition, several dual endorsed squid operators reported some or all their state waters fishing activity in the Southern Squid-jig Fishery (SSJF) logbook. As most of these operators did not explicitly indicate whether fishing occurred in State or Commonwealth waters, it has been necessary to incorporate all activity reported from coastal fishing blocks in the analyses. For details of data restrictions and quality control involving Commonwealth logbook data see Appendix 2.

During 2001, dual endorsed fishers were instructed to report all fishing activities under State jurisdiction in the Tasmanian catch and effort logbooks. This should have removed the necessity to include subsequent Commonwealth catch and effort data into analyses, but it has become apparent that there was some confusion amongst fishers about reporting requirements. For example, catches of species such as Striped Trumpeter taken by Commonwealth operators were not routinely reported in the Tasmanian catch returns. Commonwealth logbook data since 2001 have been available for the current assessment and have been checked for possible double reporting (*i.e.* on both the Tasmanian and Commonwealth catch returns) and where this was not the case, the catch and effort database used in this assessment was updated.

Data analysis

For the purposes of this assessment, effort and catch rate analyses are restricted to commercial data provided for the period 1st July 1995 to 30th June 2019.

A fishing year from 1st July to 30th June in the following year has been adopted for annual reporting. Reporting based on financial rather than calendar year better reflects the seasonality of the fisheries for most species, which are characterised by a concentration of catch (and effort) between late spring and early autumn. In addition, it better encompasses the biological processes of recruitment and growth for most species. Unless otherwise stated, data have been analysed at state-wide and regional levels. Five broad assessment regions are used: southeast coast (SEC), east coast (EC), northeast coast including Flinders Island (NEC), northwest coast including King Island (NWC), and west coast (WC) (Fig. 1.1).

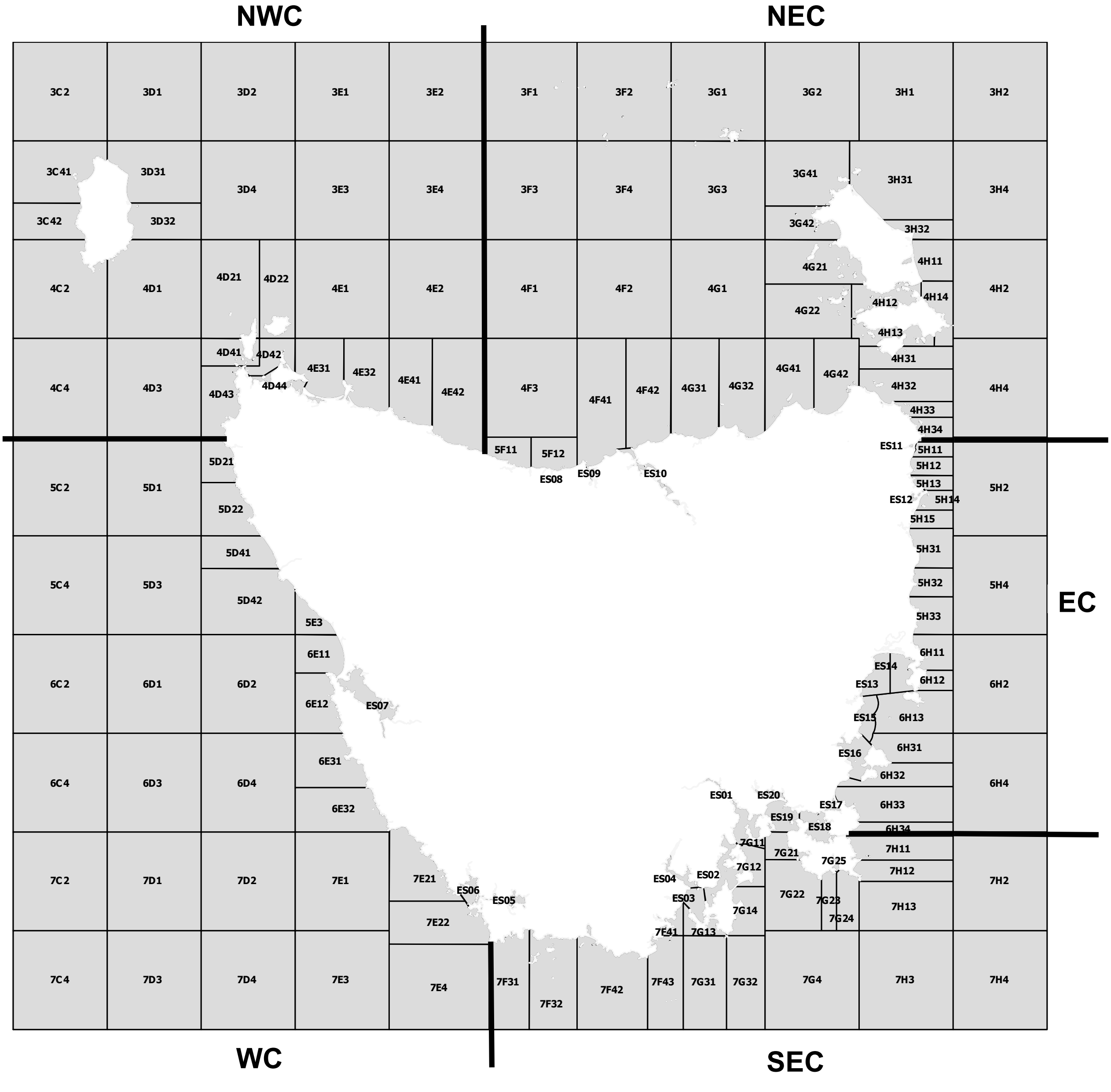


Figure 1.1 Map of Tasmania showing assessment regions and fishing blocks. SEC = southeast coast, EC = east coast, NEC = northeast coast, NWC = northwest coast, and WC = west coast.

There are 14 main fishing methods used in the Tasmanian Scalefish Fishery. Catch and effort by gear types are presented in Figures 3.1 to 3.27. For assessment purposes, effort has been primarily expressed in terms of number of days fished using the specified gear type, irrespective of the amount of gear utilised each day. Although days fished represents a less sensitive measure of effort, it has become apparent that some fishers have misinterpreted reporting requirements for effort. Attempts have been made to reduce this problem by updating the logbook; however, confusion about the new reporting requirements can bias some effort measures. Examining effort in terms of days fished overcomes any uncertainty about the reporting of effort units and provides consistency through time, assuming that there have been no major changes to fishing practices over the duration of the time series (1995-2019).

Since catch rate data are typically log-normally distributed, the geometric rather than arithmetic mean of individual daily catch records has been calculated when generating catch rate statistics. The geometric mean is calculated as the n^th^ root of the product of individual catch rates (y_i):

$$GM_{\bar{y}} = \sqrt[n]{\prod y_i}$$

This is equivalent to computing the arithmetic mean of the natural logarithm of each number, and then taking the exponent:

$$GM_{\bar{y}} = \exp\left[\frac{1}{n}\left(\sum \ln\left(y_n\right)\right)\right]$$

Catch rates calculated using this method may differ slightly from the more simplistic approach of dividing total catch by total effort or using the arithmetic mean. The advantage of calculating the geometric mean is that results are less affected by relatively few, outstandingly high data points, which are characteristic of log-normally distributed data.

Recreational fishery

Information on recreational fisheries in Tasmania is relatively sparse in comparison to commercial data. Detailed analyses of the Tasmanian recreational fishery are available from the National Survey in 2000/01 (Lyle 2005) and state-wide surveys conducted in 2007/08 (Lyle et al. 2009), 2012/13 (Lyle et al. 2014a) and 2017/18 (Lyle et al. 2019). Additional data are provided by targeted surveys of the offshore recreational fishery (Tracey et al. 2013), recreational gillnet fishery (Lyle and Tracey 2012) and fishing practices (Lyle et al. 2014b), along with recreational net licence numbers.

Assessment categories

Species are assessed according to importance and multiple specific reference points for catch and effort data.

Species importance

Catches of more than 90 species are reported under the commercial Scalefish Fishery in Tasmania. Catches vary substantially among species, primarily because of differences in social and economic values. In consequence, some species have a higher priority for stock status assessments than others and only the most important species are assessed in this report. Species importance was assigned by considering a combination of factors, including:

- Whether the species is a target, secondary target or by-product
- The economic importance of the species
- The annual landings of the species (i.e. annual catch > 5 t for 50% of the time between 1995 and present)
- The number of operators targeting the species
- The “conservation” value of the species

According to these criteria, species are classified as either “Key species” or “Minor species”. The remaining species reported in commercial catches, which are not considered in this assessment report, are assumed to face a relatively minor threat from current fishing practices.

Reporting level definitions

Each species in the assessment is associated with one of three levels of reporting: Full, Medium or Minor. Reporting levels are assigned according to data availability for each species or species group. Attributes of the three different reporting categories are detailed in Table 1.1. Table 1.2 summarises information for all species covered in this assessment report, including their importance and level of reporting. Full reporting for all key species and medium reporting for all minor species is aimed for in the long-term.

Table 1.1. Summary of the attribute for the reporting categories.

Attribute	**Reporting level** **Full**	 **Medium**	 **Minor**
Time series estimate of biomass from dynamic models	●		
Time series estimate of total, natural and fishing mortality from dynamic models	●		
Quantitative risk analysis of future harvesting using dynamic models	●		
Time series of age and/or length composition data	●		
Estimates of total, natural and fishing mortality (from catch curves)	●		
Local (TAS) information for growth, mortality, selectivity and maturity	●	●	
Representative time-series of commercial catch	●	●	●
Single biological species or stock	●	●	●
Sporadic age and/or length composition data		●	
Non-local (non-TAS) information for growth, mortality, selectivity and maturity		●	●
Complex of related species		●	●

Table 1.2. Summary of importance and reporting level for all retained species.

Species/Species group	Importance	Reporting level
Banded Morwong[1]	Key	Full
Australian Salmon	Key	Medium
Bastard Trumpeter	Key	Medium
Blue Warehou	Key	Medium
Flathead (Sand and Tiger)	Key	Medium
Southern Calamari	Key	Medium
Southern Garfish	Key	Medium
Striped Trumpeter	Key	Medium
Wrasse	Key	Medium
Barracouta	Minor	Minor
Flounder	Minor	Minor
Gould's Squid	Minor	Minor
Jack Mackerel	Minor	Minor
Jackass Morwong	Minor	Minor
Leatherjacket	Minor	Minor
Longsnout Boarfish	Minor	Minor
Mullet	Minor	Minor
Pike	Minor	Minor
School Whiting	Minor	Minor
Australian Sardine	Developmental	Minor

---

[1] Note that Banded Morwong are assessed in a separate report.

Stock status definitions

In order to assess species in a manner consistent with the national approach (and other jurisdictions), we have adopted the national stock status categories used in the Status of Australian Fish Stocks (SAFS) reporting scheme (Table 1.4 and Fig. 1.2). These categories define the assessed state of the stock in terms of recruitment impairment, which represents a limit reference point. Recruitment impairment occurs when the mature adult population (spawning biomass) is depleted to a level where it no longer has the reproductive capacity to replenish itself. Hence, recruitment-impaired stocks have not necessarily collapsed, but they do have reduced productivity and face an undesirably high level of risk of collapse. Fisheries are ideally also managed towards target reference points, which aim to maximise long-term fisheries productivity. The scheme used here does not assess the fishery against target outcomes.

Table 1.3. Details on the classification of stock status in consideration of biomass (or proxy) and fishing mortality (or proxy). © Australian Government's Fisheries Research and Development Corporation (FRDC) (www.fish.gov.au).

Stock status	Description	Potential implications for management of the stock
Sustainable	Biomass (or proxy) is at a level sufficient to ensure that, on average, future levels of recruitment are adequate (recruitment is not impaired) and for which fishing mortality (or proxy) is adequately controlled to avoid the stock becoming recruitment impaired (overfishing is not occurring).	Appropriate management is in place.
Depleting	Biomass (or proxy) is not yet depleted and recruitment is not yet impaired, but fishing mortality (or proxy) is too high (overfishing is occurring) and moving the stock in the direction of becoming recruitment impaired.	Management is needed to reduce fishing mortality and ensure that the biomass does not become depleted.
Recovering	Biomass (or proxy) is depleted and recruitment is impaired, but management measures are in place to promote stock recovery, and recovery is occurring.	Appropriate management is in place, and there is evidence that the biomass is recovering.
Depleted	Biomass (or proxy) has been reduced through catch and/or non-fishing effects, such that recruitment is impaired. Current management is not adequate to recover the stock, or adequate management measures have been put in place but have not yet resulted in measurable improvements.	Management is needed to recover this stock; if adequate management measures are already in place, more time may be required for them to take effect.
Undefined	Not enough information exists to determine stock status.	Data required to assess stock status are needed.

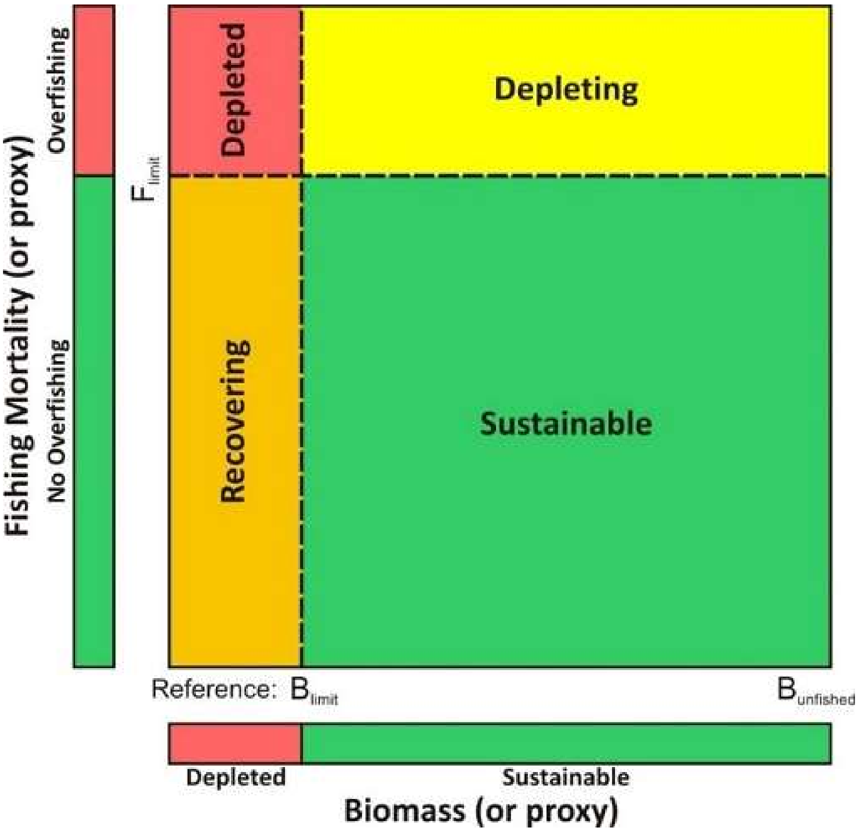


Figure 1.2 Classification of stock status in consideration of biomass (or proxy) and fishing mortality (or proxy). A stock is considered to be "sustainable" if both its biomass and fishing mortality are estimated to be within safe limits ($B > B_{limit}$ and $F < F_{limit}$). If stock biomass is estimated to be within safe limits ($B > B_{limit}$) but fishing mortality is not ($F > F_{limit}$), then stocks are considered to be "Depleting". Stocks whose biomass is estimated to fall below critical limits ($B < B_{limit}$), are classified as either "Depleted" (if fishing mortality $F > F_{limit}$) or "Recovering (if $F < F_{limit}$). © Australian Government's Fisheries Research and Development Corporation. See Table 1.4 above for more detailed information.

Performance indicators and reference points definitions

The determination of stock status is based on the consideration of model outputs (for species with full reporting) and commercial catch and effort data, which are assessed by calculating fishery performance indicators and comparing them with reference points. For the current assessment, as in previous years, we present performance indicators and reference points recommended in recent assessment reports as alternatives to those originally proposed in the Scalefish Fishery Management Plan policy document (DPIF 1998).

Standard performance indicators are fish biomass and fishing mortality. For medium and minor reporting, proxies (commercial catch and CPUE) are used instead as there are insufficient data to calculate biomass or fishing mortality. Catch and CPUE data are then compared to a reference period (1995/96[2] to 2006/07 unless stated otherwise) for each species. The reference points for more generic and full reporting are species-specific while the reference points for medium and minor reporting are applicable for all species.

Table 1.4 Summary of the performance indicators and reference points for each reporting standard. See also Table 1.4 and Fig. 1.2 above.

Reporting	Performance indicators	Reference points
Full	Fishing mortality	• Level of catch to avoid the stock remaining or becoming recruitment impaired • Appropriate spatial distribution of catch
	Biomass	• High probability of staying above a certain level of spawning biomass
		• High probability of staying above a certain CPUE
Medium	Fishing mortality	• Catch > 3rd highest catch value from the reference period
		• Catch < 3rd lowest catch value from the reference period
		• Catch variation from the previous year above the greatest inter-annual increase from the reference period
		• Catch variation from the previous year above the greatest inter-annual decrease from the reference period
		• Latest recreational catch estimate > recreational catch estimate from the reference period
		• Proportion of recreational catch to total catch > previous proportion estimate
	Biomass	• CPUE< 3rd lowest CPUE value from the reference period
		• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period
Minor	Fishing mortality	• Catch > 3rd highest catch value from the reference period
		• Catch < 3rd lowest catch value from the reference period
		• Latest recreational catch estimate > recreational catch estimate from the reference period
		• Proportion of recreational catch to total catch > previous proportion estimate
	Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period

---

[2] 1995/96 to 2006/07 was selected as the reference period, corresponding to the first twelve years since the introduction of daily catch and effort reporting in the Tasmanian General Fishing Returns.

Other measures are also taken into consideration in the determination of stock status, including changes in biological characteristics of the stock, indicators of stock stress, as well as any significant external factors related to fishing activities. Indicators of stock stress include significant changes in the size or age composition of fish in commercial catches, high numbers of undersized fish and high numbers of unhealthy fish.

We note that the assessment of Banded Morwong (*Cheilodactylus spectabilis*) has been conducted in a separate report (Stacy et al. 2019). This change from assessment reports prior to 2017/18 reflects differences in the timetable for setting the annual total allowable catch for Banded Morwong (based on quota year) compared with routine assessment reporting for other scalefish species (based on financial year).

We also note that shark net and bottom longline catch and effort have been excluded from this report because the methods relate specifically to the School and Gummy Shark fishery, which is managed by the Commonwealth.

Uncertainties and implications for management

While considerable attention has been directed at ensuring comparability of commercial data over time (refer Appendix 2), it is acknowledged that some recent administrative changes relating to the reporting of catches may have, nonetheless, influenced observed catch and effort trends.

Other uncertainties that arise in this assessment relate to limitations in catch and effort data; mainly in terms of the level of detail provided and the lack of independent verification. The Commercial Catch, Effort and Disposal logbook (formerly the General Fishing Return) was designed to accommodate a diverse range of fishing activities and compromises have been necessary. Consequently, data reporting is on a daily rather than operational (set or shot) basis.

In the past, some fishers have experienced problems in correctly interpreting or complying with reporting requirements, especially in terms of effort information reporting. The introduction of new logbooks during the 2007/08 season has helped to clarify reporting, but there is an ongoing need to educate fishers. Further, the lack of catch verification remains an issue.

Catch and effort are influenced by a combination of factors including market-demand, changes in resource availability, as well as responses to changing management arrangements. The latter adds further uncertainty regarding the underlying causes of any observed trends in catch and effort. There is, therefore, a need to take account of industry perceptions and information when interpreting fishery dependent information.

Limited information about the recreational fishery remains a major source of uncertainty and is especially significant in the scalefish assessment given that recreational catches of some species appear to equal or exceed commercial catches. Recreational fisher surveys conducted in 2000/01, 2007/08, 2012/13 and 2017/18 provide critical information about this sector and are considered in this assessment report.

Fish mortality due to disease, predation and fishery interactions with Australian and New Zealand fur seals is largely unknown and represents another source of uncertainty. Seals can cause substantial mortality to some of the fish species assessed in this report. Seals can also cause gear damage and influence fisher behaviour, all of which are factors that impact catches and catch rates. Seal interaction issues tend to be predominantly caused by individual ‘rogue’ seals, which learn to target particular fisheries or fishing methods (e.g. gillnetting), while the typical diet of seals includes mainly pelagic fish species (Goldsworthy et al. 2003).

Ecological Risk Assessment

The following assessments of species status incorporate an evaluation of the potential ecological risks posed by the Tasmanian Scalefish Fishery. Two recognised Ecological Risk Assessment (ERA) frameworks were used in this process: (1) a qualitative approach suited to fisheries with limited data, which is closely aligned with the standard risk assessment approach utilised in occupational health and safety; (2) a semi-quantitative approach that is suited to fisheries for which data relating to catch, discards, post release survival and technical aspects of the fishery are available. Risk analysis considers the source of risk, the possible consequences of the risk and how likely it is that the consequences will occur. Consequences and likelihood are assessed against specific objectives, which differ according to the component of the risk assessment. Consequence and likelihood are combined to produce an estimated level of risk associated with any specific hazardous event under consideration. The ERA was conducted once in 2012/13, capturing a snapshot risk profile of the fishery. Full details are provided in Bell et al. (2016).

2. General fishing trends

Commercial fishing licences

The number of Scalefish Fishery licences has gradually declined from more than 450 in 2001 to 260 in 2019, mainly driven by a substantial reduction (>75%) in the number of Scalefish C licences issued (see Table 2.1). Up until 2008, about half of all Scalefish Fishery licences were active. In the current reporting year (2019), 43% of all Scalefish licences were active.

In addition to Scalefish Fishery licences A, B and C, separate fishing licences allow the use of beach seine (a total of 50 licences in two categories, A and B), small mesh gillnet (10 licences), purse seine (9 licences) and Danish seine nets (7 licences). Fishers holding a rock lobster licence (but without Scalefish A or B licence) are also allowed to take scalefish species albeit with a limited amount of fishing gear.

Table 2.1 Numbers of Scalefish Fishery licences (total and active) by type (A, B or C) since 2001. Licence years run from 1 March to the last day of February.

Licence Numbers	**Expiry Year**																		
Licence Type	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Scalefish A	70	68	70	70	70	66	66	66	66	65	65	65	65	65	63	63	63	63	63
Scalefish B	165	165	163	165	165	162	161	160	159	159	157	158	155	153	151	149	147	148	146
Scalefish C	222	203	191	178	161	143	132	126	116	103	89	84	81	73	71	69	65	59	51
Total	457	436	424	413	396	371	359	352	341	327	311	307	301	291	285	281	275	270	260
Active Licences																			
Scalefish A	46	44	50	45	42	37	41	43	35	31	31	35	27	34	33	34	36	36	34
Scalefish B	99	99	104	106	108	95	100	104	84	82	82	76	77	66	70	66	72	71	69
Scalefish C	68	60	61	50	44	33	35	33	21	16	17	16	13	16	17	11	10	9	10
Total	213	203	215	201	194	165	176	180	140	129	130	127	117	116	120	111	118	116	113

Commercial catch trends

General production

Total annual commercial catches have generally declined (Fig. 2.1). Scalefish production of the main species (including all species assessed in this report and Banded Morwong) shows a decline from more than 1,000 t in the late 1990s to less than 400 t in 2018/19. Historic peaks in catch of >1,700 t were observed between 2008 and 2013, largely due to exceptionally high catches of Jack Mackerel and Gould's Squid. The combined commercial catch of assessed species in 2018/19 was lower than in the three previous years, but consistent with previous declines to about 400 t in 2013/14 and 2014/15. From 2009/10 onwards, annually assessed species have matched total scalefish production very closely (Fig. 2.1; see Appendix 3 for more detailed information on scalefish production).

When assessing inter-annual trends within the fishery, it is important to recognise that some species occur periodically in Tasmanian waters and thus availability can differ markedly between years. Therefore, variability does not necessarily reflect changes in stock status. Species in this category include Blue Warehou, Barracouta and Gould's Squid. In contrast, Banded Morwong, Striped Trumpeter, Bastard Trumpeter, Longsnout Boarfish, Southern Calamari and Wrasse are examples of more 'resident' species, with variability in catches then reflecting a possible combination of changes in stock status, management interventions and market demand.

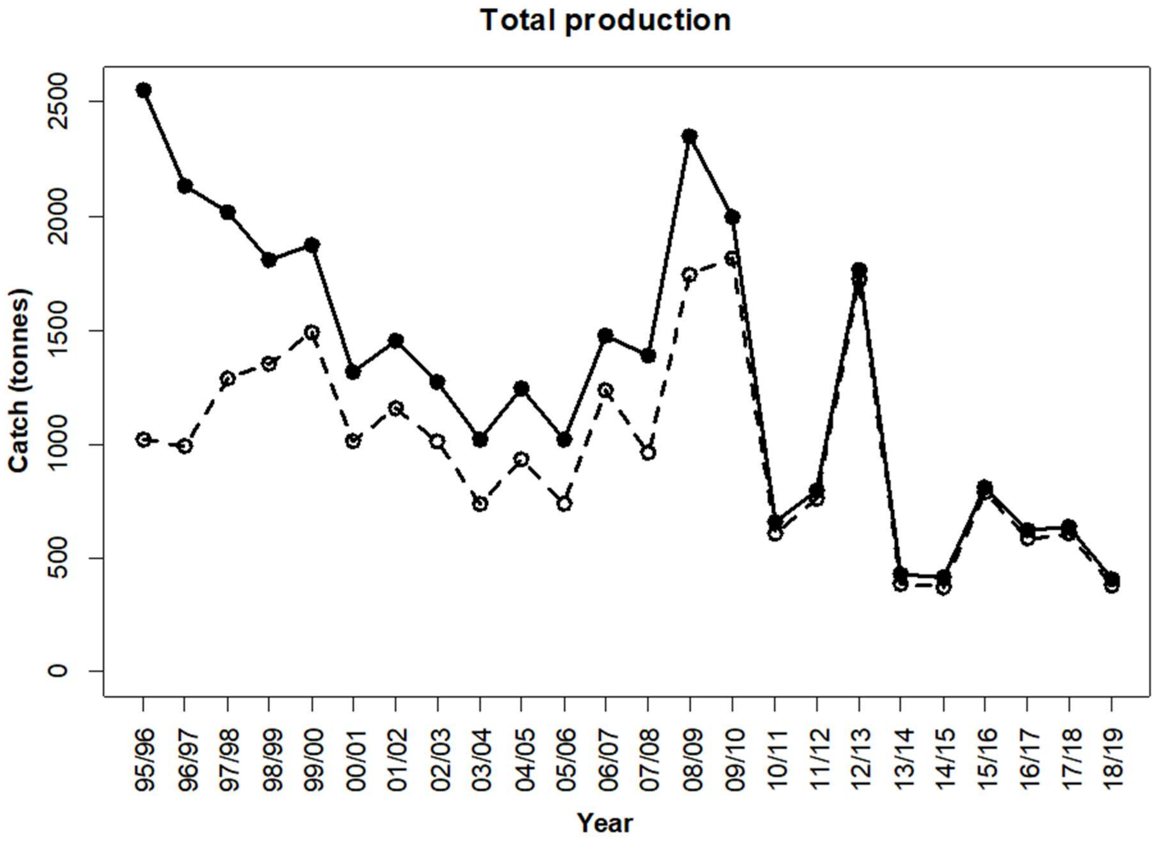


Figure 2.1 Time series of total annual catches reported for all scalefish species (solid symbols and line) as well as assessed scalefish species (hollow symbols and dashed line). See trends for individual species assessed in this report in continued figure 2.1 below.

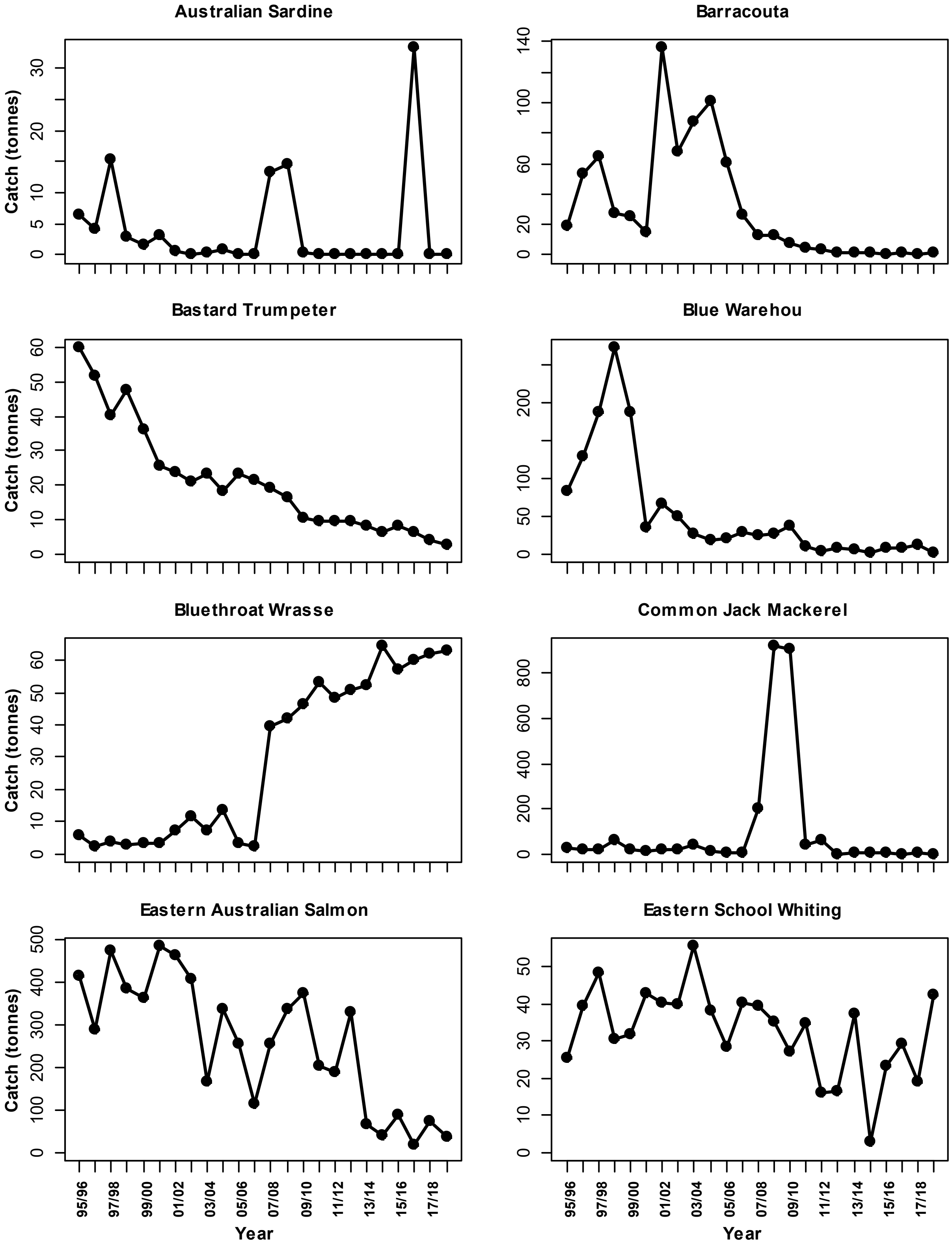


Figure 2.1 Continued.

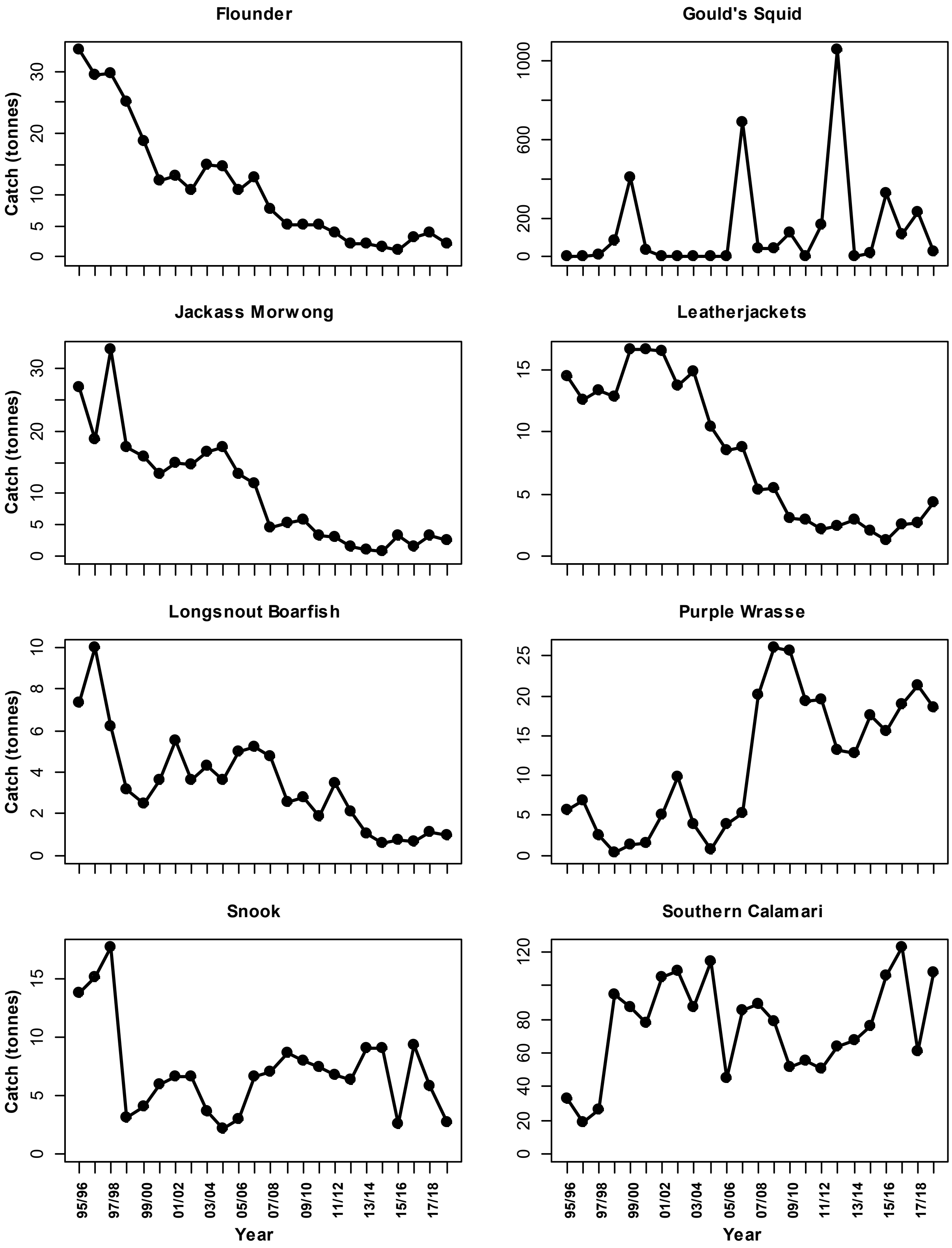


Figure 2.1 Continued.

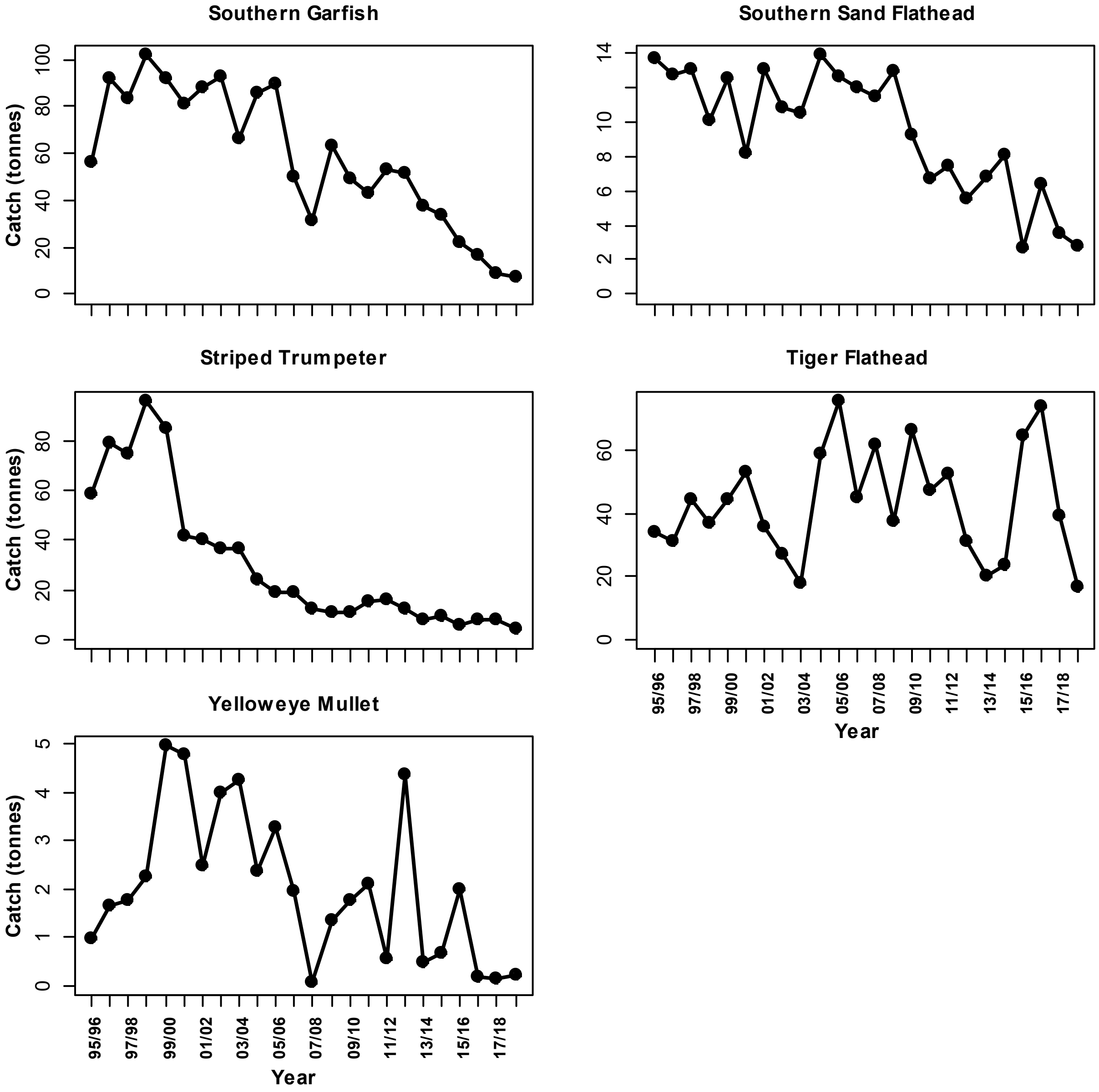


Figure 2.1 Continued.

Estuarine production

Estuarine production (as a subset of the whole fishery) from selected monitored estuaries totalled 75.6 t in 2018/19, an increase of 35 t compared to the previous year and mainly due to an increase in the catch of Eastern School Whiting (Table 2.2). Catches came mainly from the southern estuaries, primarily the Derwent River (ES01), but also from Frederick Henry Bay (ES19) and Blackman Bay (ES17), as well as from Macquarie Harbour in the west (ES07), and the Tamar River (ES10) in the north of the state. Eastern School Whiting, Southern Calamari and Eastern Australian Salmon were the main species captured. Port Davey (ES06) and Mersey River (ES08) are restricted to handline fishing, which accounts for the minimal catches in recent years. Georges Bay (ES12) and Ansons Bay (ES11) have been closed to commercial fishing since 2004 and 2009, respectively.

Table 2.2 Total commercial catches (t) in selected estuaries around Tasmania (a) by fishing year and (b) by species with a reported catch >100 kg in 2018/19.

a) By fishing year	ES01	ES06	ES07	ES08	ES09	ES10	ES11	ES12	ES17	ES18	ES19	ES20	Total
1995/96	17.39	0.67	4.43		0.41	10.75		0.43	2.92	26.44	14.12	3.22	80.78
1996/97	16.71	0.35	2.63		0.56	15.01		0.92	6.12	12.29	6.98	1.78	63.35
1997/98	14.28	0.16	1.41	<0.05	0.63	15.62		2.48	11.47	20.79	13.47	1.35	81.66
1998/99	14.21		1.38		0.90	19.60		1.59	10.04	36.50	23.19	4.87	112.28
1999/00	4.73		0.98		0.45	14.15	0.18	2.56	18.90	28.51	10.23	2.77	83.46
2000/01	16.10		0.25		0.13	12.70	0.05	1.17	15.46	27.93	27.33	1.88	103.00
2001/02	13.88		2.23		0.19	73.82		1.19	8.86	64.06	32.33	2.00	198.56
2002/03	28.13		8.02		0.16	27.64	0.55	0.81	14.55	35.23	23.00	1.57	139.66
2003/04	40.05		6.06		1.00	25.12			5.17	59.52	21.83	0.81	159.56
2004/05	25.99		4.93		1.76	34.47		<0.05	9.46	25.87	23.14	0.66	126.28
2005/06	2.19	0.07	23.16		0.95	33.15	1.29		6.64	14.18	9.67	0.84	92.14
2006/07	30.97	0.25	9.93		2.00	23.60	0.17		8.72	20.01	19.74	1.36	116.75
2007/08	31.87	<0.05	3.16			15.26		<0.05	12.31	26.94	12.11	0.87	102.52
2008/09	32.22		1.14		0.18	20.90		<0.05	8.38	15.75	10.45	2.07	91.09
2009/10	26.91		0.72		0.46	15.22	<0.05	<0.05	3.93	15.57	4.39	2.07	69.27
2010/11	27.84	0.11	0.44		0.60	10.25			5.65	5.82	13.71	1.69	66.11
2011/12	13.88		0.28			8.39			4.95	6.88	6.70	1.89	42.97
2012/13	12.19	0.07	0.13		<0.05	12.22	0.20		6.72	13.27	3.11	0.85	48.76
2013/14	32.28		1.06		0.29	9.69			2.97	6.74	8.75	1.09	62.87
2014/15	1.76	<0.05	<0.05		0.40	8.90		0.10	3.25	8.51	0.87	0.72	24.51
2015/16	17.51				0.82	10.34		0.13	3.10	5.11	3.81	0.58	41.40
2016/17	26.24		0.05		0.17	12.63			2.77	4.13	4.61	2.36	52.96
2017/18	16.07		0.78			8.79			1.94	6.59	3.81	3.03	41.01
2018/19	31.70		12.50			7.64			5.63	1.73	13.56	2.89	75.64

ES	Description
ES01	Derwent River
ES06	Port Davey
ES07	Macquarie Harbour
ES08	Mersey River
ES09	Port Sorell
ES10	Tamar River
ES11	Ansons Bay
ES12	Georges Bay
ES17	Blackman Bay
ES18	Norfolk Bay
ES19	Frederick Henry Bay
ES20	Pitt Water

Table 2.2 cont.

b) By species	Sientific name	ES01	ES06	ES07	ES08	ES09	ES10	ES11	ES12	ES17	ES18	ES19	ES20	Total
Eastern School Whiting	Sillago flindersi	31.680										9.750		41.430
Atlantic Salmon (Farmed)	Salmo salar			10.935										10.935
Southern Calamari	Sepioteuthis australis						1.868			1.444	0.612	3.100	0.009	7.033
Eastern Australian Salmon	Arripis trutta						2.062			3.060			1.700	6.822
Greenback Flounder	Rhombosolea tapirina	0.001		0.653			0.051			0.010	0.151	0.085	1.145	2.095
Bluethroat Wrasse	Notolabrus tetricus						1.140			0.025		0.171		1.336
Leatherjackets	Monacanthidae						0.104			1.030	0.002	0.030		1.166
Maori Octopus	Macroctopus maorum										0.886	0.005		0.891
Southern Garfish	Hyporhamphus melanochir						0.684				0.031	0.131	0.032	0.878
Rainbow Trout (Farmed)	Oncorhynchus mykiss			0.700										0.700
Barracouta	Thyrsites atun			0.210			0.176							0.386
Blue Warehou	Seriolella brama						0.320							0.320
Snook	Sphyraena novaehollandiae						0.250							0.250
Herring Cale	Olisthops cyanomelas						0.243							0.243
Purple Wrasse	Notolabrus fucicola						0.020			0.020		0.200		0.240
King George Whiting	Sillaginodes punctatus						0.127							0.127
Yelloweye Mullet	Aldrichetta forsteri						0.120							0.120
Total	Total	31.695		12.498			7.637			5.631	1.726	13.564	2.887	75.638

Recreational fishery

Catch and effort

Surveys of the recreational fishery conducted in 2000/01, 2007/08, 2012/13 and 2017/18 provide snapshots of the Tasmanian recreational fishery (Henry and Lyle 2003, Lyle 2005, Lyle et al. 2009, Lyle and Tracey 2012, Lyle et al. 2014a, Lyle et al. 2019). In addition, there have been targeted surveys of recreational gillnetting in 1996–98 and 2010 (Lyle 1999, Lyle and Tracey 2012) and offshore boat fishing in 2011/12 (Tracey et al. 2013) and in 2018/19 (results not available in time for this assessment). The most recent recreational fishing survey in the 2017/18 season indicates an overall participation rate of 24%, representing 106,000 Tasmanian residents aged 5 years or older who fished at least once (Lyle et al. 2019). The five most important recreational species by estimated total weight were Sand Flathead, (184 t), Australian Salmon (36 t), Southern Calamari (31 t), Striped Trumpeter (29 t) and Gould's Squid (23.7 t). Recreational landings represent an overall increasing component of the total annual harvest, firstly averaging half of the total catch (recreational and commercial combined) across assessed species in 2012/13 and reaching an average of 54% in 2017/2018 (Table 2.3). Species for which the estimated recreational harvest exceeded commercial catches include Sand Flathead (98% of the total catch), Mullet (94%), Gurnard/Ocean Perch (82%), Cod (81%), Barracouta (75%), Silver Trevally and Jackass Morwong (72%), Striped Trumpeter (67%), Leatherjackets (65%) and Blue Mackerel (64%). In contrast, the commercial sector appeared to dominate catches of Southern Garfish and Gould's Squid (recreational harvest estimated at 4% for both species), Blue Warehou and Banded Morwong (6% recreational for both), as well as Jack Mackerel, Australian Salmon and Southern Calamari (30-35% recreational).

One notable change in the recreational fishery is a greater than threefold increase in the landings of Southern Calamari since 2000/01, such that in the 2012/13 survey the recreational harvest of about 64 t equalled that of the commercial sector (Table 2.3). However, in 2017/18, the estimated recreational harvest dropped back to 31 t, representing 34% of the combined commercial and recreational catch in that year.

Another concerning trend was the significant recreational catch of Blue Warehou in 2012/13, which exceeded the Tasmanian commercial catch and estimates of Commonwealth commercial catches at that time. Blue Warehou has been classified as overfished/depleted in national stock status reports (Woodhams et al. 2013, Flood et al. 2014, Patterson et al. 2019) and is subject to a stock rebuilding strategy at the Commonwealth level. However, in the 2017/18 survey, the estimated recreational harvest of Blue Warehou was less than 1 tonne (6% of the total catch).

Other species of conservation concern include Southern Garfish, Bastard Trumpeter, Sand Flathead and Striped Trumpeter. For most of these species, estimated recreational harvest has either remained at a level comparable to previous assessments or declined. Striped Trumpeter is a notable exception with the estimated recreational harvest almost twice as high in 2017/18 than in 2012/13 (29 t compared to 15 t), which is similar to harvest levels more than 10 years ago.

Table 2.3 Estimated recreational harvest (numbers, weight and percentage) for key scalefish species taken by Tasmanian residents. Percentages are relative to the total estimated weight (recreational plus commercial catch) represented by recreational harvest (Lyle et al. 2014a). Note: the survey periods do not correspond with fishing years; with 2000/01 representing the period May 2000 to Apr 2001, 2007/08 representing the period Dec 2007 to Nov 2008, and 2012/13 representing the period Nov 2012 to Oct 2013.*estimated from the 2011/12 offshore recreational fishing (Tracey et al. 2013); **estimated from the 2010 recreational gillnetting survey (Lyle and Tracey 2012).

Species	**2000/01**			**2007/08**			**2012/13**			**2017/18**		
	Numbers	**Tonnes**	**% Total**	**Numbers**	**Tonnes**	**% Total**	**Numbers**	**Tonnes**	**% Total**	**Numbers**	**Tonnes**	**% Total**
Atlantic Salmon	-	-	-	-	-	-	-	-	-	7835	-	-
Australian Salmon	300,456	105	17.8	110,312	48.1	13.8	144,712	63.7	19	80608	35.5	31.7
Banded Morwong	-	-	-	-	-	-	-	-	-	1522	2	6.1
Barracouta	24,320	46.9	75.7	11,577	10.8	43.8	32,954	31	96.6	6902	2.8	75.3
Bastard Trumpeter	29,130	37	58.5	27,527**	27.3**	72.2	7,573	7.5	43.4	3451	3.4	44.3
Black Bream	34,336	22	100	13,134	11.4	100	19,153	16.7	-	9135	-	-
Blue Mackerel	-	-	-	-	-	-	-	-	-	2338	0.9	64.4
Blue Warehou	16,359	14.6	28.6	8,723	7	20.8	10,757	15.4	63.6	526	0.8	5.6
Cod	65,115	30.6	88.4	14,263	8.2	76.7	10,464	6.1	73.5	8801	3.9	81.4
Flathead	1,236,675	322	83.5	1,066,293	293	80	924,932	235.9	85.5	728,317	200	-
Sand flathead	-	-	-	-	-	-	-	-	-	700,305	184.3	98.1
Tiger Flathead	-	-	-	-	-	-	-	-	-	28012	16	28.2
Flounder	50,582	15.2	59.1	32,436	10.1	56.3	23,238	7.2	77.4	12272	3.8	49.4
Gould’s Squid	9,903	5	11.1	73,236	36.6	44.4	42,853	21.4	2	47467	23.7	4.3
Gurnard/ Ocean perch	-	-	-	-	-	-	-	-	-	21409	8.4	82.4
Jack Mackerel	15,770	3.2	26.8	5,216	1	0.4	30,907	5.2	96.3	4862	0.9	30.4
Jackass Morwong	27,041	31.9	70	9,979	6.8	64.2	23,732	16.1	88.5	12387	8.4	71.9
King George Whiting	-	-	-	-	-	-	-	-	-	14207	7.2	-
Leatherjackets	18,706	8.2	33	7,619	2.6	38	5,389	1.8	41.9	7493	4.9	65.4
Mullet	111,025	30	68.6	24,152	6.6	73.3	26,265	7.1	47.3	9441	4.6	93.9
Pike (Snook)	-	-	-	-	-	-	-	-	-	9404	-	-
Sharks & rays	-	-	-	-	-	-	-	-	-	8888	-	-
Silver Trevally	16,812	4.7	74.6	10,636	4.2	67.9	4,826	1.9	40.4	11091	8.5	72.3
Southern Calamari	29,473	17.7	18.8	40,525	44.6	30.3	57,728	63.5	51.3	41498	31.4	34.1
Southern Garfish	15,669	1.9	2.3	14,568	2	3.7	15,260	2	3.8	2605	0.3	3.5
Striped Trumpeter	13,450	29.6	37.4	7,274*	31.9*	61.7	3,476	15.2	59.1	6360	29.1	67.4
Whiting	7,480	0.8	1.9	14,992	3.4	8.7	9,412	2.1	5.5	85921	-	-
Wrasse	23,083	13.6	13.3	11,640	10.3	13.1	7,223	6.4	8.9	7531	-	-

Recreational gillnet fishery

The use of recreational nets in Tasmania has been subject to licensing since 1995 with fishers able to licence up to two graball nets (gillnets) prior to 2002, along with one mullet net and a beach seine. From November 2002 the number of graball nets that could be licensed was reduced to one per person. The number of recreational net licences issued rose rapidly from around 8,900 in 1995 to over 11,000 in 1999/2000 before licence numbers stabilised between 8,000 to 9,000 for several years. Licence numbers climbed again to around 10,000 in 2007/08 before trending downward to 7,266 in 2018/19 (Table 2.4). It is possible that the reduction in licence numbers since 2009/10 occurred in response to the introduction of maximum soak times for gillnets in 2009. Night netting, which was a common and popular practice amongst recreational fishers (Lyle 2000), was banned for recreational fishers (with the exception of Macquarie Harbour) in late 2004. While this appeared to have little discernible impact on licence numbers, a targeted survey of recreational gillnetting in 2010 revealed a concomitant reduction in overall gillnet effort (effort in 2010 was about 60% of the level in 1997 despite there being 40% more gillnet licence-holders, Lyle and Tracey 2012). Furthermore, only 73% of recreational licences were used during 2010 (Lyle and Tracey 2012).

The 2010 survey revealed that almost 65% of the gillnet catch (by number) was kept (Lyle and Tracey 2012). Bastard Trumpeter and Blue Warehou combined represented 45% of the total retained catch, Atlantic salmon contributed a further 10%. Australian Salmon, Jackass Morwong, Mullet and Wrasse were of lower importance. Wrasse was most significant as by-catch. Recreational gillnet catches of Bastard Trumpeter, Mullet, Jackass Morwong, Leatherjacket and Cod were higher compared to commercial catches, while Blue Warehou catches of the two sectors were similar. Recreational gillnet catch rates have fallen from an average of >6 fish retained per net set in 1997 to just over 4 fish per set throughout the past decade. While variability in the abundance of target species has contributed to this trend (especially for Blue Warehou), changes in fishing practices (including no night netting, shorter average set durations, reduction in the length of mullet nets, larger minimum size limits for some species influencing release/discarding rates, etc.) have also been contributing factors.

Table 2.4 The number of recreational gillnet licences issued by licensing year since 1995/96. na = not applicable.

Licence type	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06
Graball 1	5615	6290	6685	6709	7477	7401	6960	7695	7313	7408	8054
Graball 2	2612	2678	2683	2426	2652	2515	1841	na	na	na	na
Mullet Net	656	684	738	739	879	845	608	754	753	754	816
Total	**8883**	**9652**	**10106**	**9874**	**11008**	**10761**	**9409**	**8449**	**8066**	**8162**	**8870**

Licence type	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17
Graball 1	8677	9185	9172	8960	8162	8248	7995	7765	7887	7070	7092
Graball 2	na	na	na	na	na	na	na	na	na	na	na
Mullet Net	877	995	1080	922	886	888	890	841	855	789	793
Total	**9554**	**10180**	**10252**	**9882**	**9048**	**9136**	**8885**	**8606**	**8742**	**7859**	**7885**

Licence type	17/18	18/19
Graball 1	6670	6540
Graball 2	na	na
Mullet Net	806	726
Total	**7476**	**7266**

3. Commercial fishing gear

General effort trends

Following the introduction of the new management arrangements in November 1998, beach seine, purse seine, gillnet and hand-line effort declined, whereas dropline, squid-jig and dip-net effort increased sharply. A range of factors, including availability of target species and market developments, have had an influence on effort levels, but the most notable direct impacts were initiated by management changes. Specifically, there was a decline in the effort of fishing methods for which gear allocations or access became more regulated (beach seine, purse seine and gillnets), which caused an initial shift to or increase in effort for less regulated methods (hooks, jigs and dip nets; i.e. gear that was generally available to most licence-holders).

Since the early 2000s, effort for most fishing methods has declined, exceptions being handline, which has remained relatively stable, and automatic squid-jig, which has peaked sporadically with the variable abundance of Gould's Squid in Tasmanian waters. For example, catches of Gould's Squid were at a record high level in 2012/13 whereas little fishing was reported for the automatic jig fishery in Tasmanian waters between 2013/14 and 2014/15. This change might be attributed in part to the saturation of local markets from the large catches in 2012/13 as well as interannual variation in availability.

Notable increases in total effort (days fished) from 2017/18 to 2018/19 were recorded only for squid jig and spear fishing (both used to target Southern Calamari). In contrast, notable decreases in total effort (days fished) from 2016/17 to 2018/19 were evident for automatic jig, beach seine, dropline, dip net and hand collection (see Figures 3.1–3.27 for details).

There is the potential for future effort increases due to the levels of latent capacity from licence-holders who are currently inactive or participating at low levels. The 2004 review of the Tasmanian Scalefish Fishery management plan attempted to address this issue through strategies including non-transferability of C-class licences.

The following section presents an overview of the catch composition as well as trends in overall catch, numbers of vessels and effort for each fishing method.

Automatic squid-jig

Automatic squid-jig users target exclusively Gould's Squid, and have practically no by-catch.

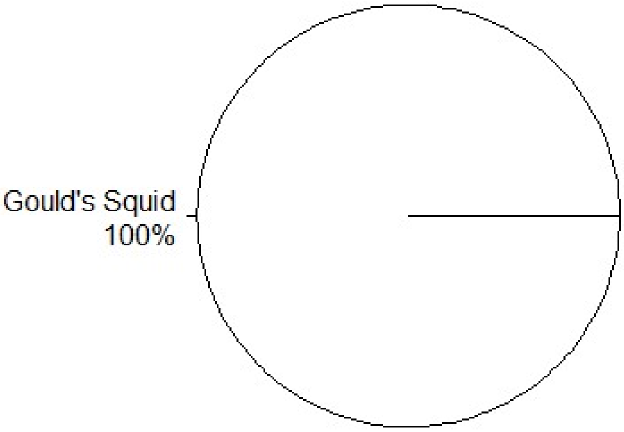


Figure 3.1 Automatic squid jig catch composition for 2018/19.

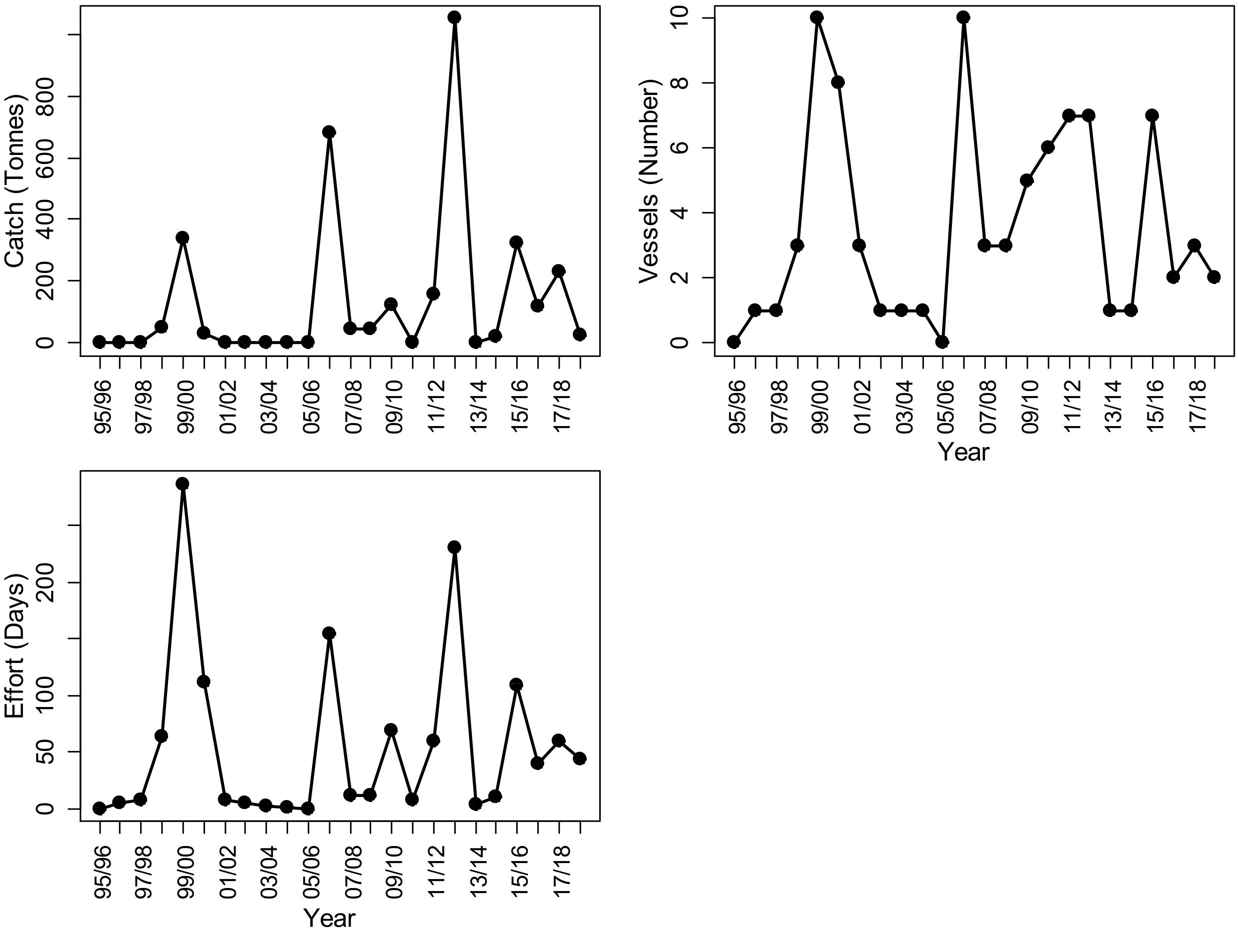


Figure 3.2 Overall catch, number of vessels using the gear, and effort (in vessel days) for automatic squid-jig.

Beach seine

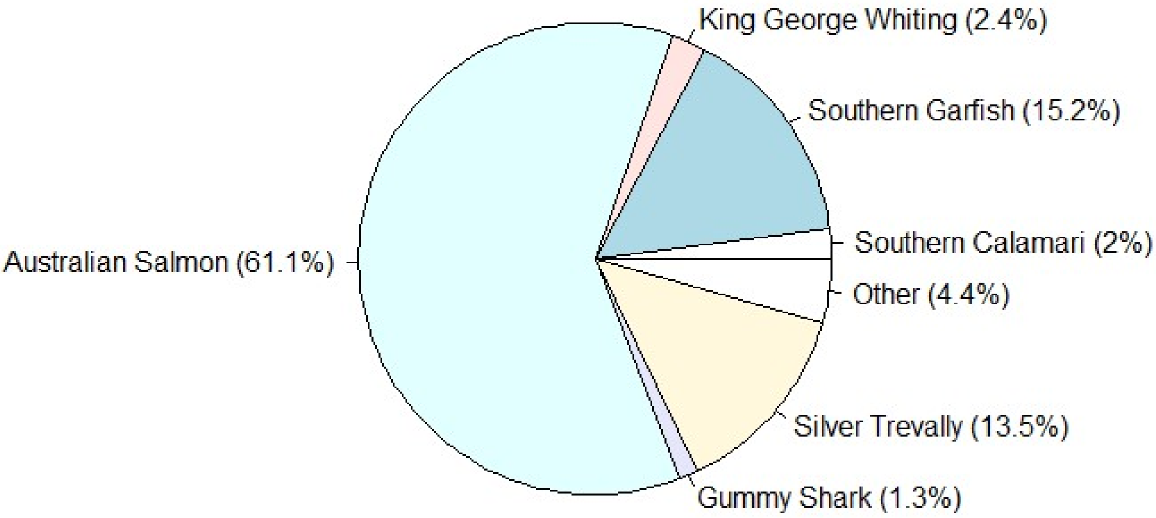


Figure 3.3 Beach seine catch composition for 2018/19.

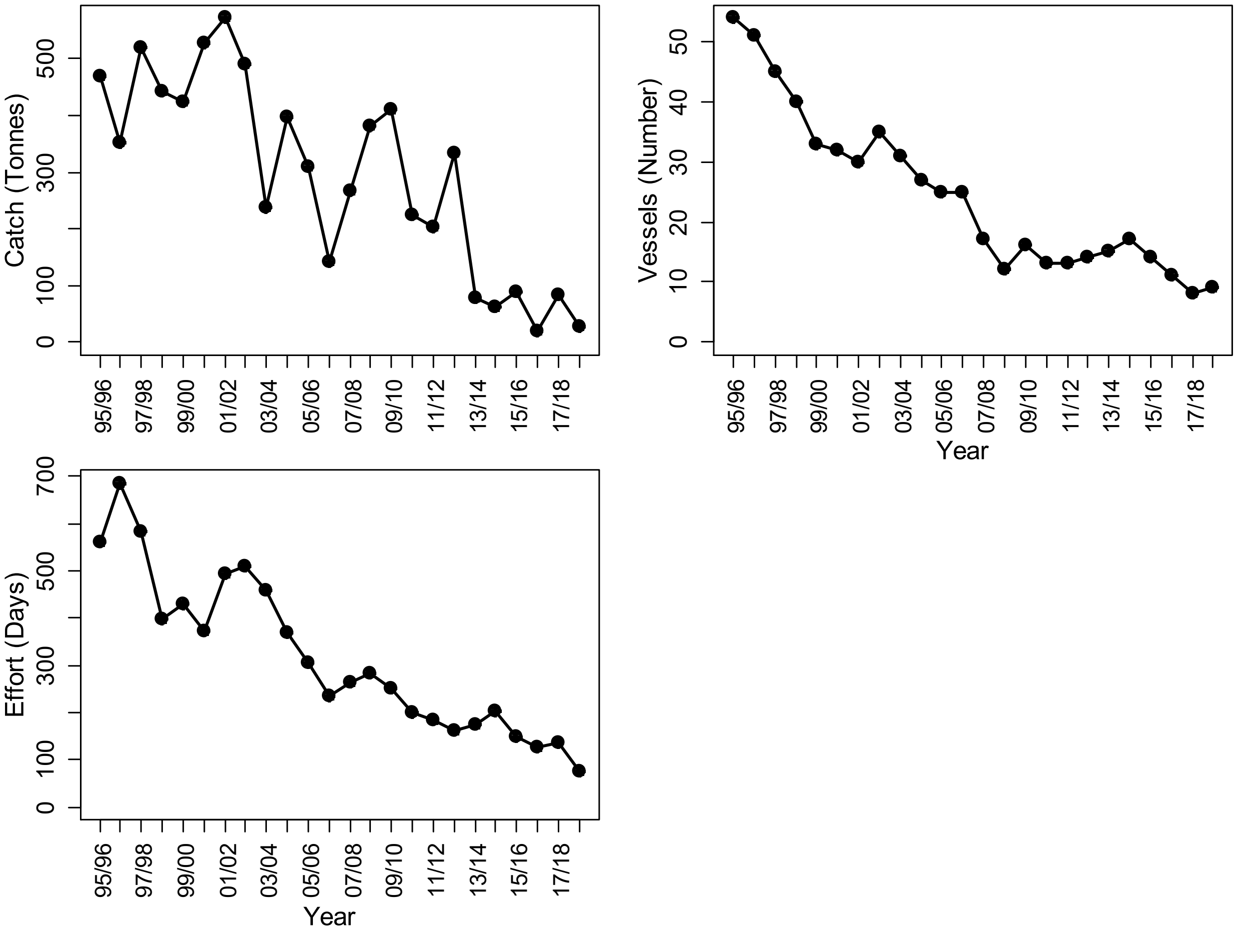


Figure 3.4 Overall catch, number of vessels using the gear, and effort (in vessel days) for beach seine.

Drop-line

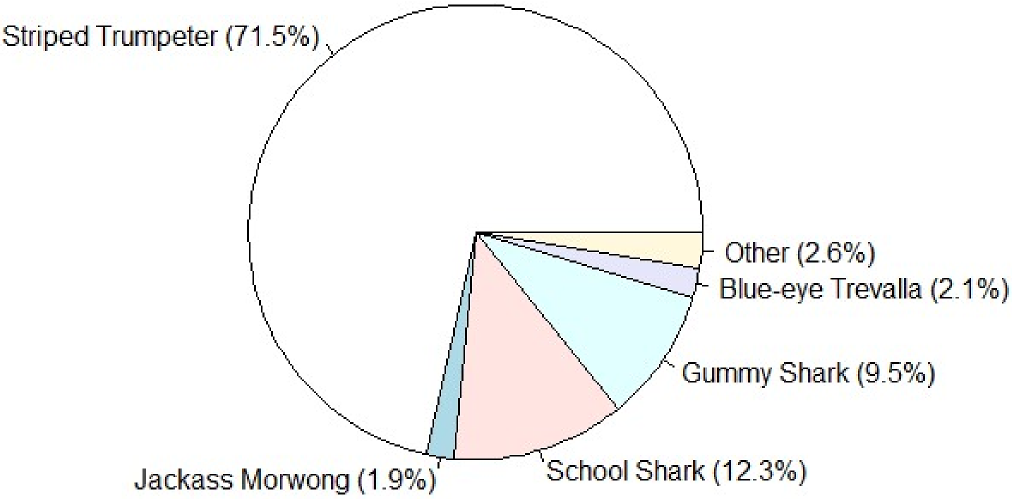


Figure 3.5 Dropline catch composition for 2018/19.

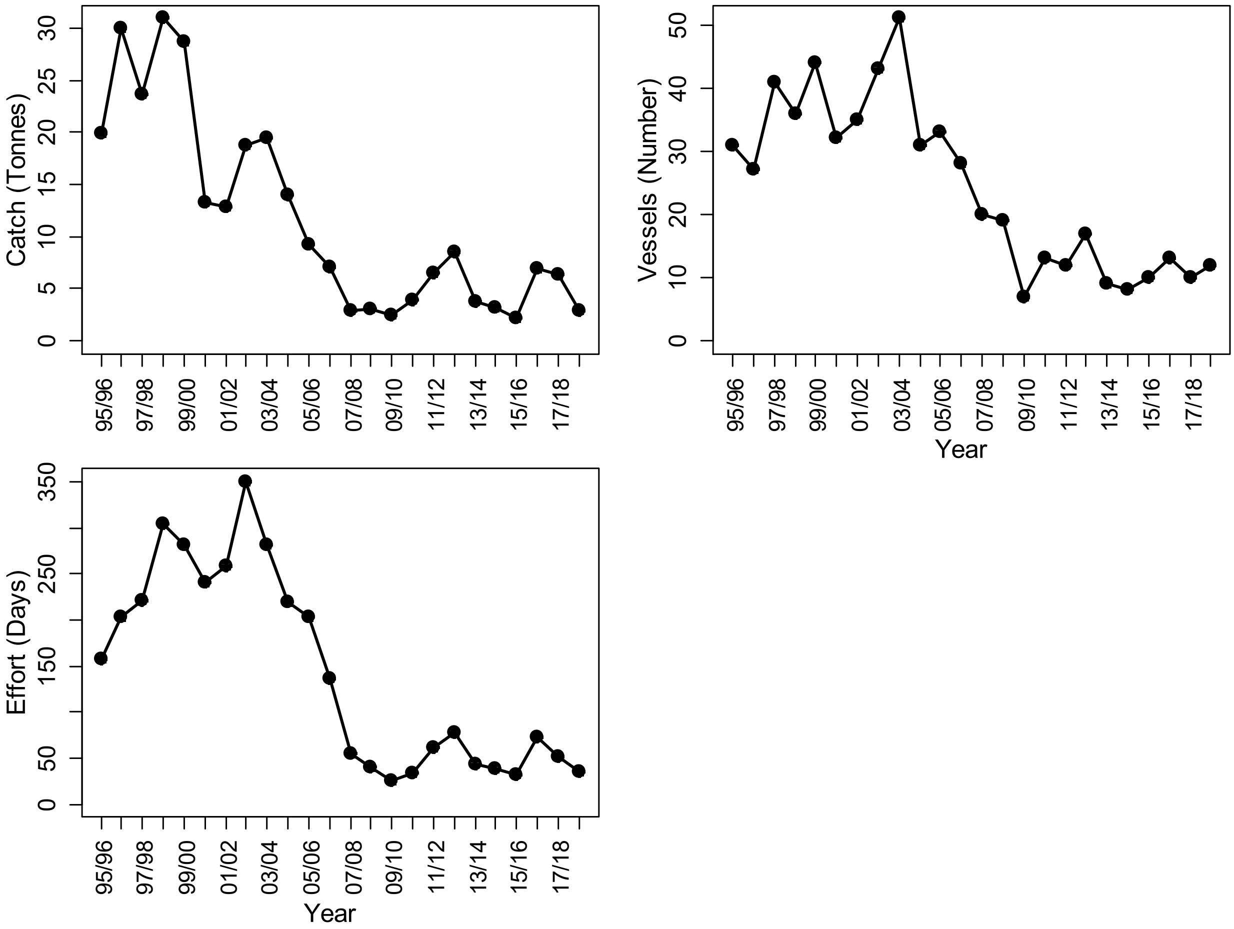


Figure 3.6 Overall catch, number of vessels using the gear, and effort (in vessel days) for dropline.

Dip-net

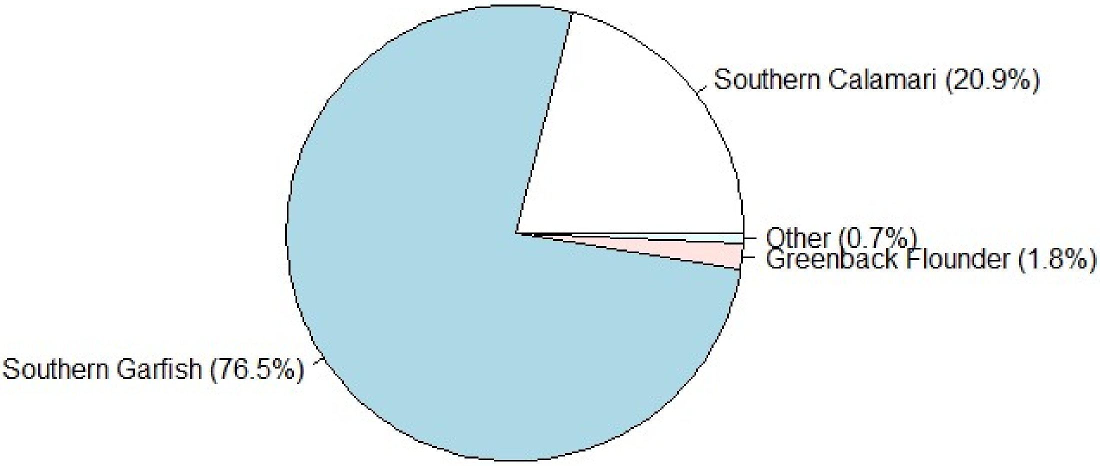


Figure 3.7 Dip-net catch composition for 2018/19.

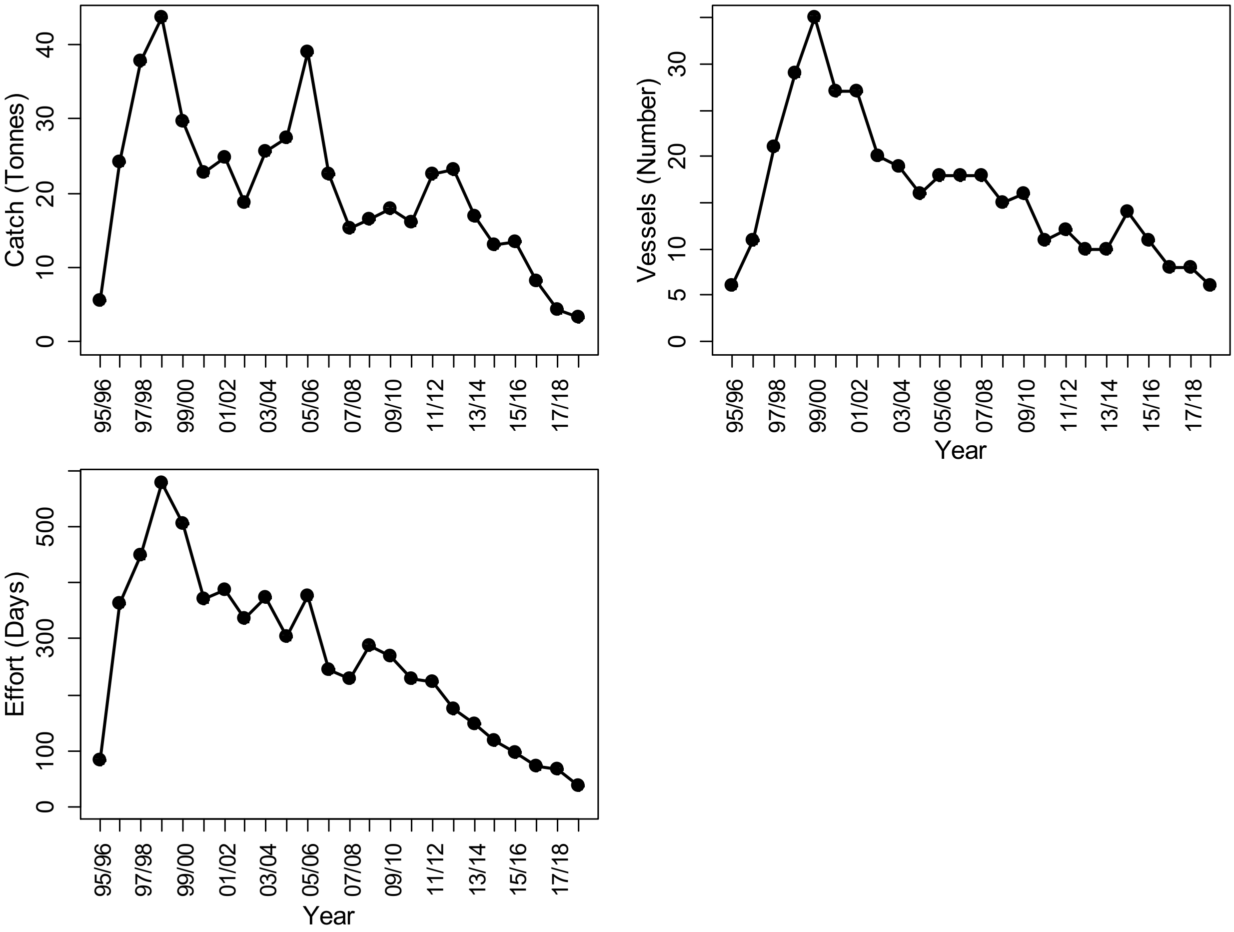


Figure 3.8 Overall catch, number of vessels using the gear, and effort (in vessel days) for dipnet.

Danish seine

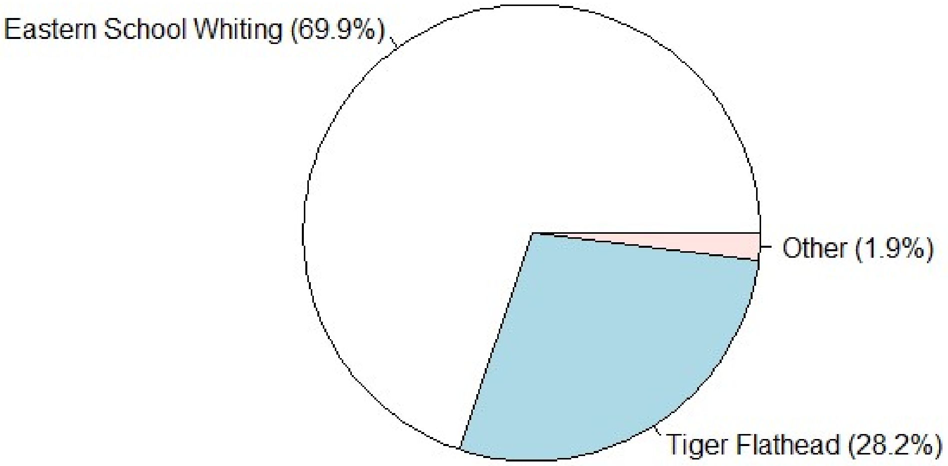


Figure 3.9 Danish seine catch composition for 2018/19.

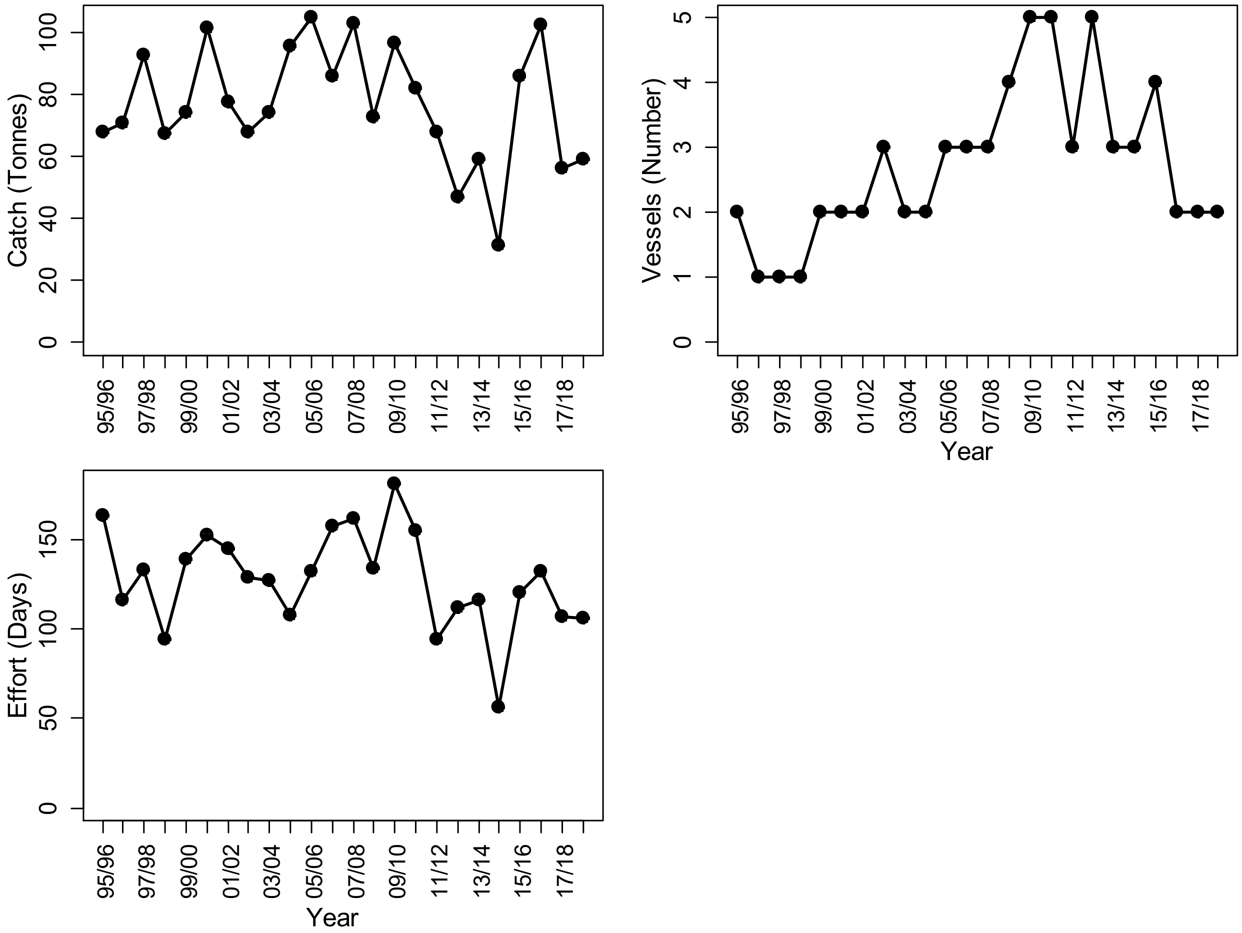


Figure 3.10 Overall catch, number of vessels using the gear, and effort (in vessel days) for Danish seine.

Fish trap

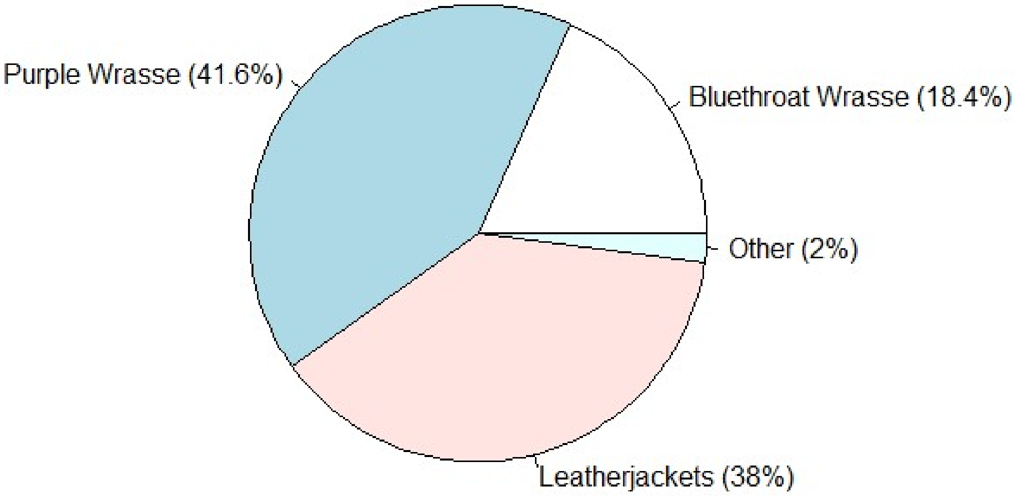


Figure 3.11 Fish trap catch composition for 2018/19.

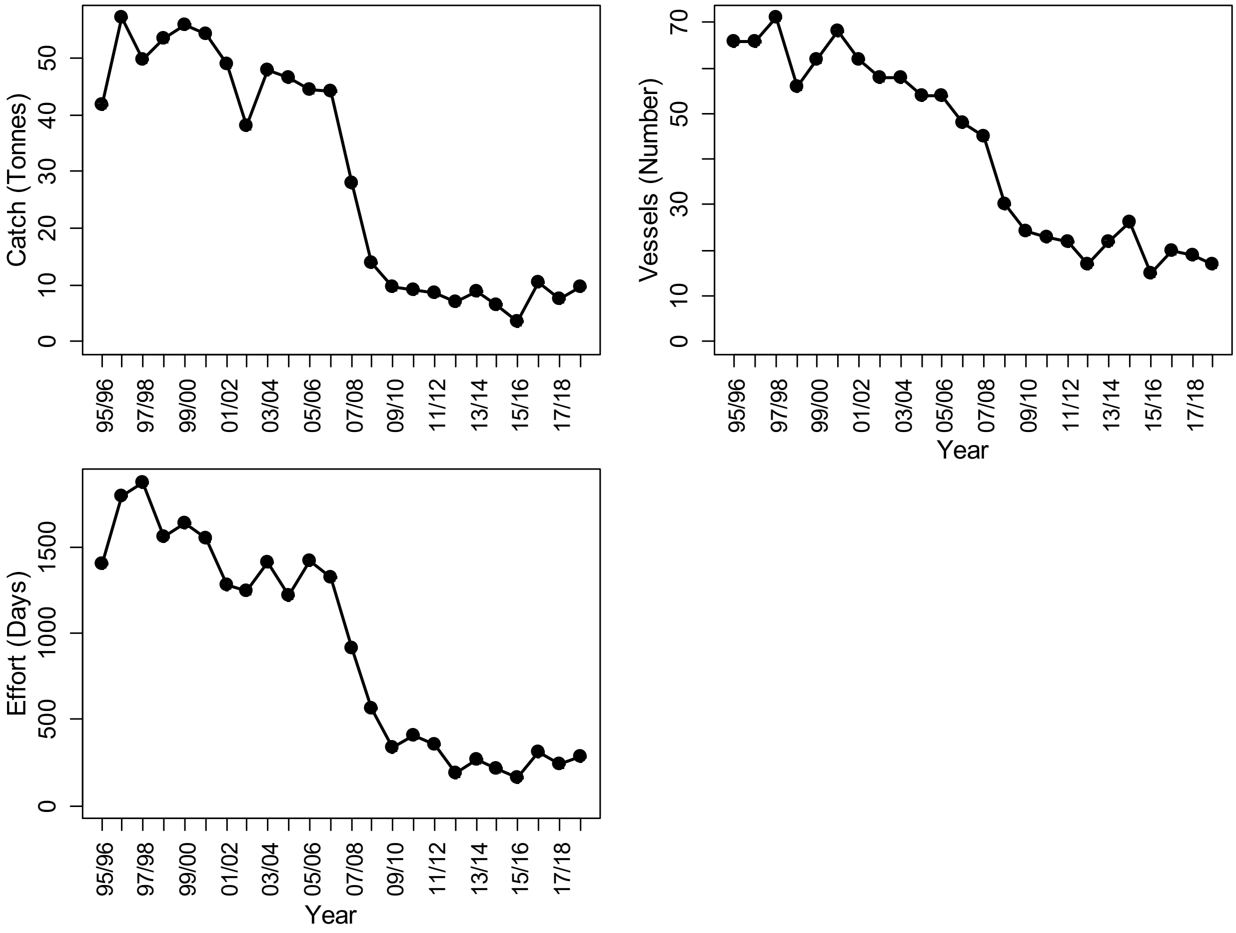


Figure 3.12 Overall catch, number of vessels using the gear, and effort (in vessel days) for fish trap.

Gillnet

Gillnets in this analysis include both traditional gillnets (~110 mm mesh size) and 'Banded Morwong' nets (~140 mm mesh size).

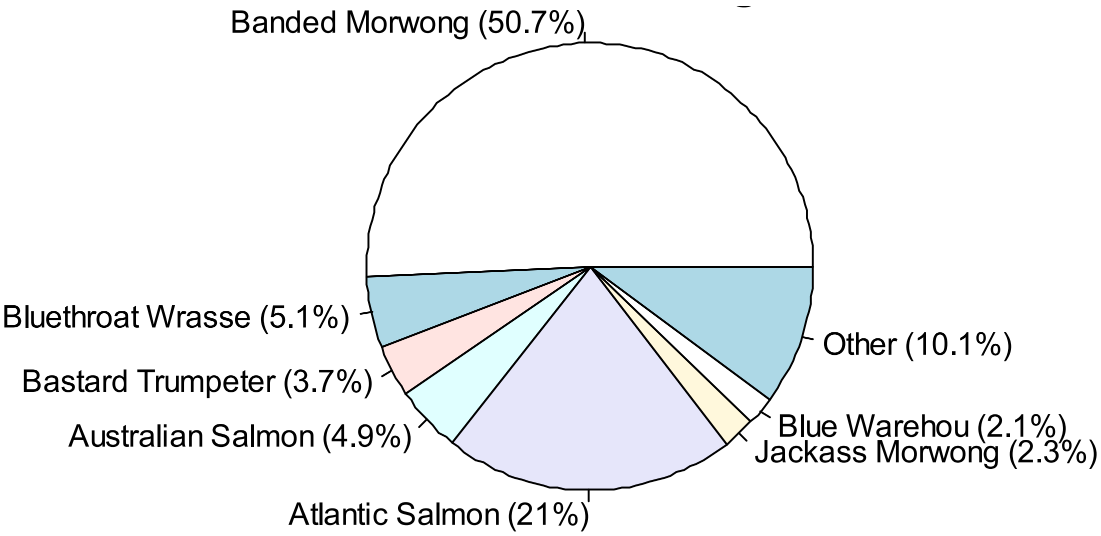


Figure 3.13 Gillnet catch composition for 2018/19, including released Banded Morwong.

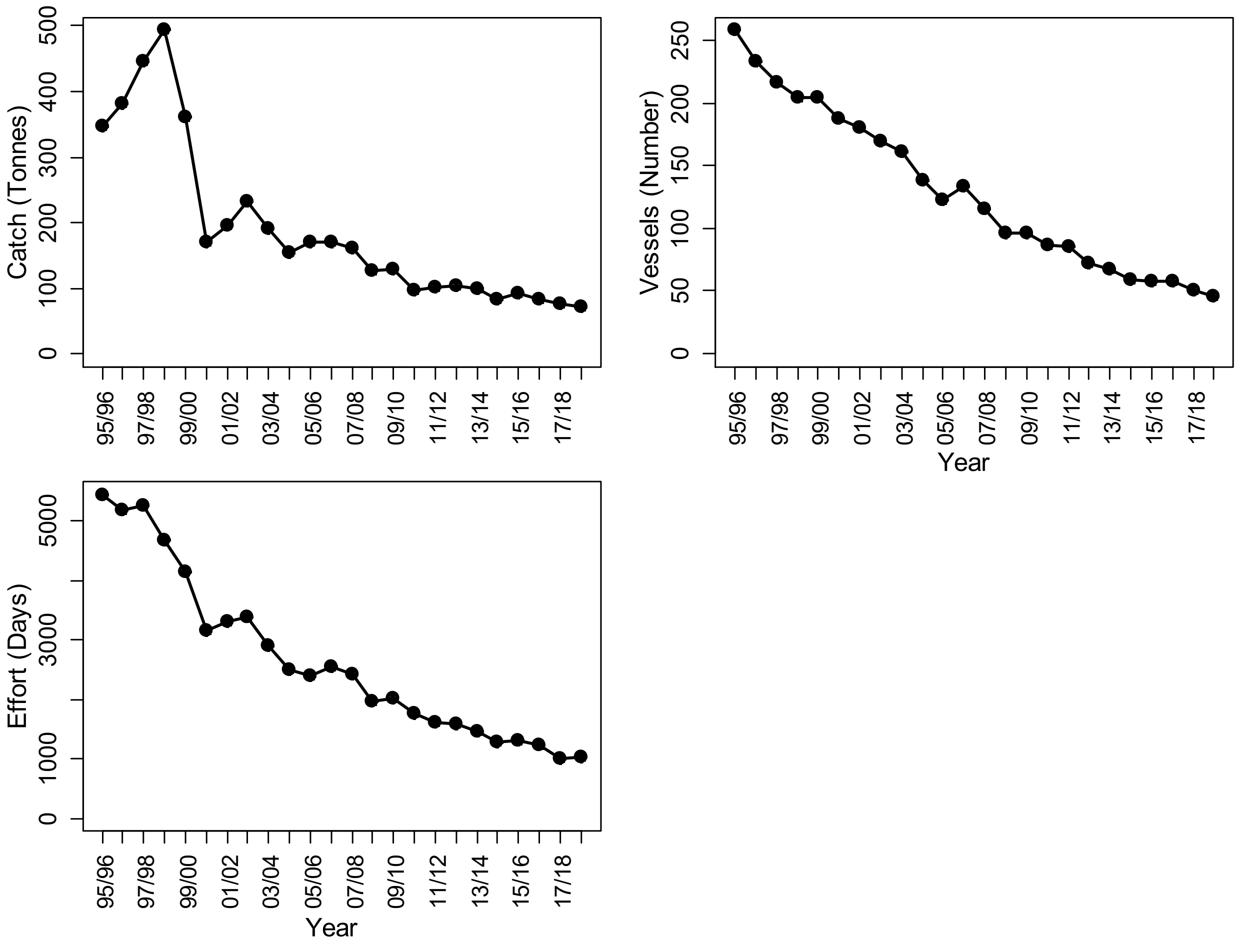


Figure 3.14 Overall catch, number of vessels using the gear, and effort (in vessel days) for gillnet.

Hand collection

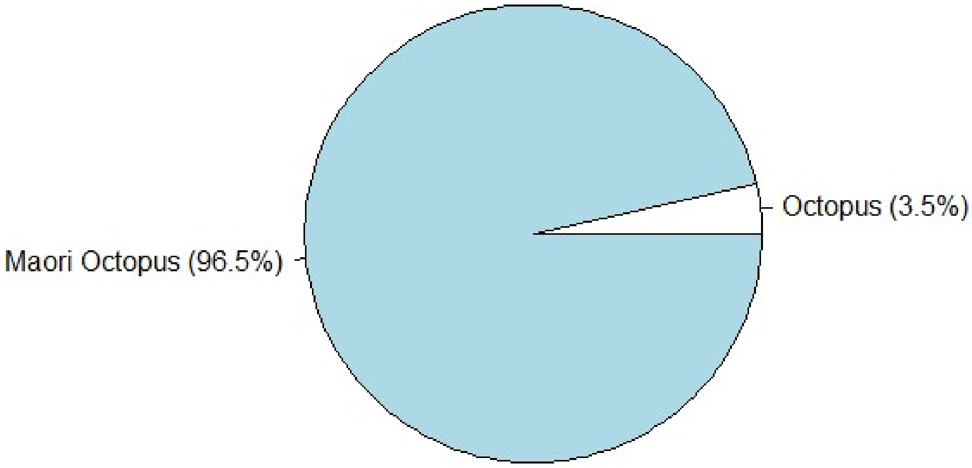


Figure 3.15 Hand collection catch composition for 2018/19.

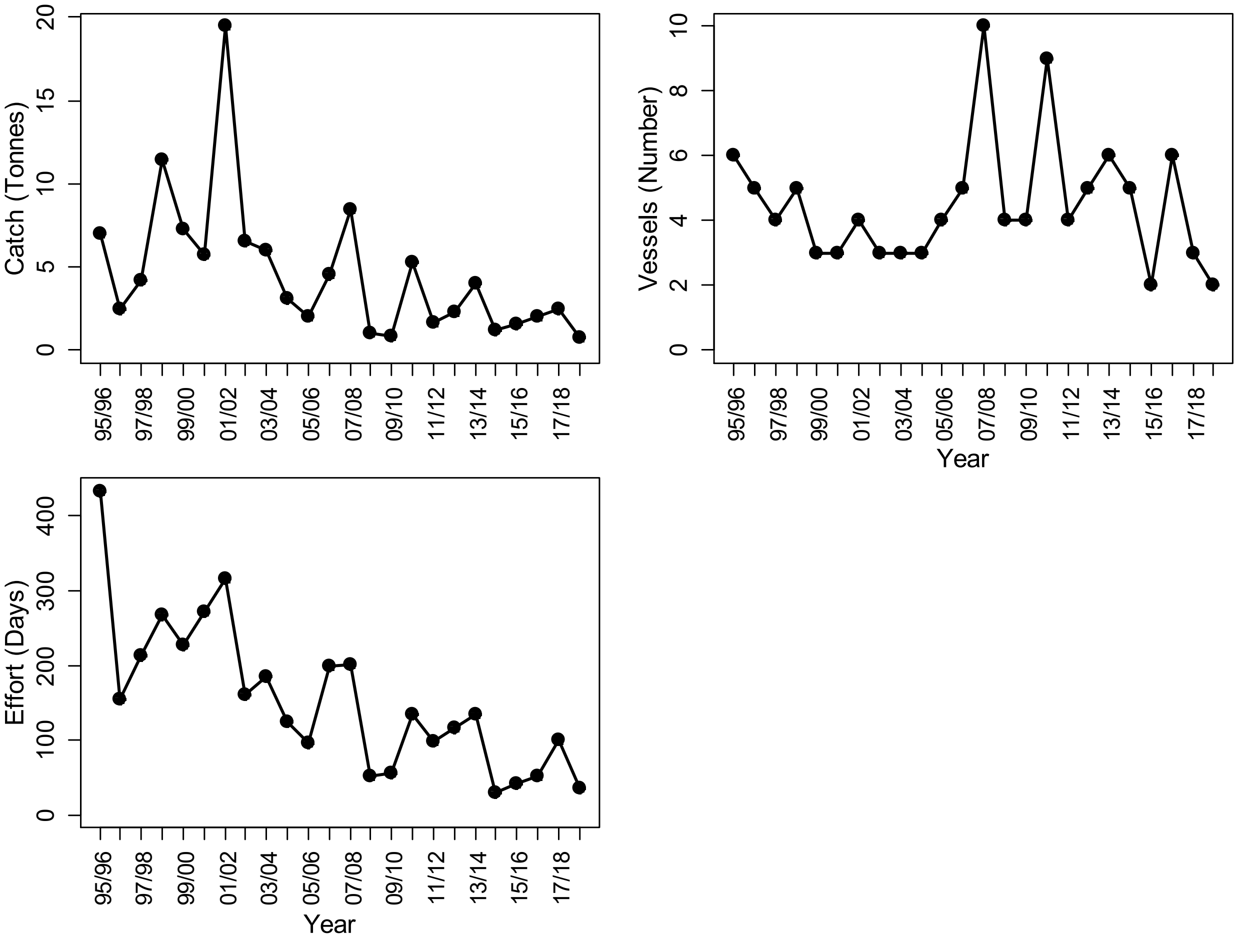


Figure 3.16 Overall catch, number of vessels using the gear, and effort (in vessel days) for hand collection.

Handline

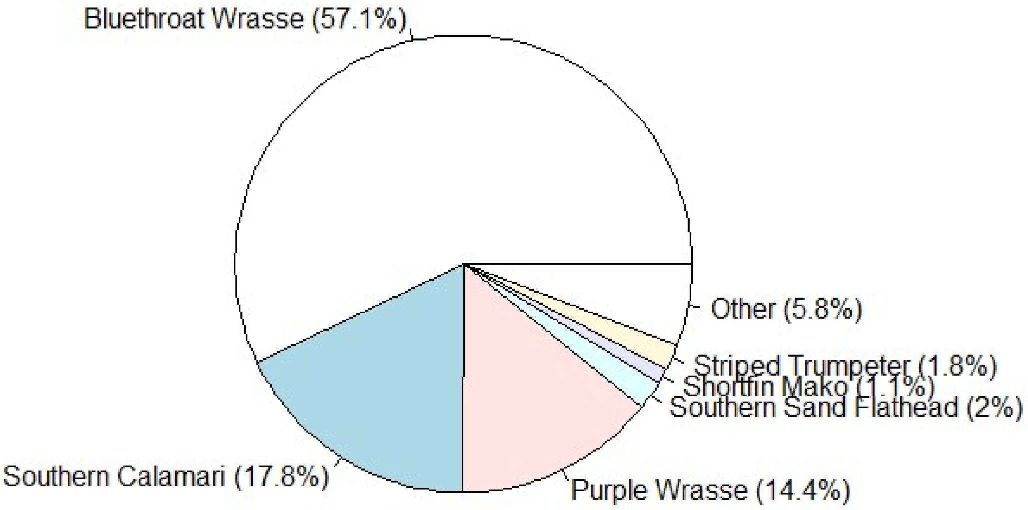


Figure 3.17 Handline catch composition for 2018/19.

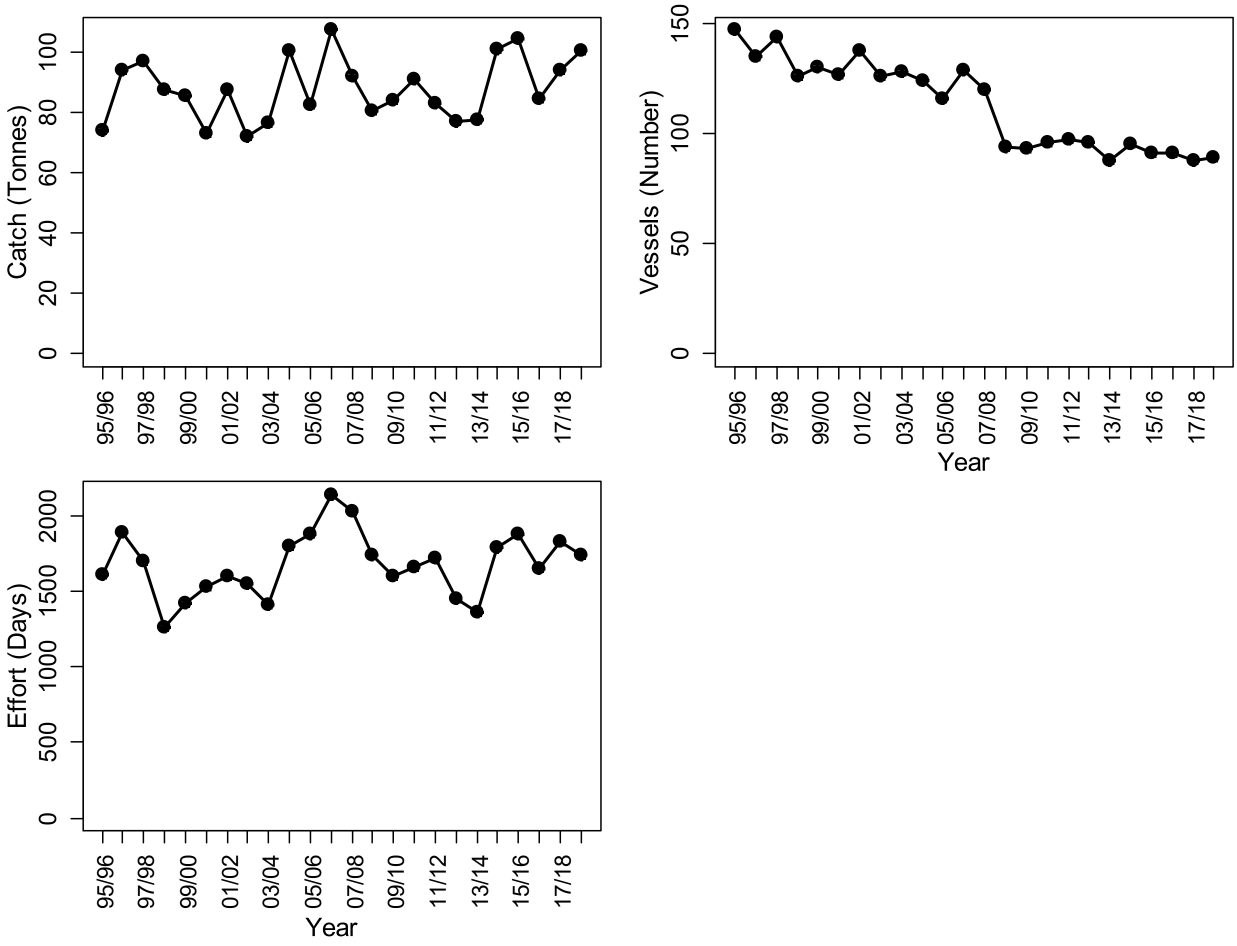


Figure 3.18 Overall catch, number of vessels using the gear, and effort (in vessel days) for handline.

Small mesh net

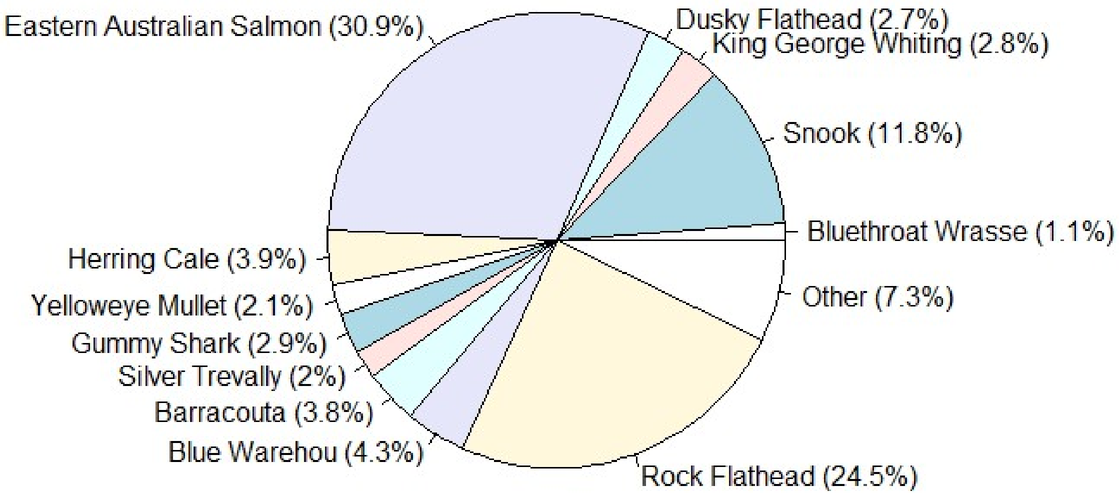


Figure 3.19 Small mesh net catch composition for 2018/19.

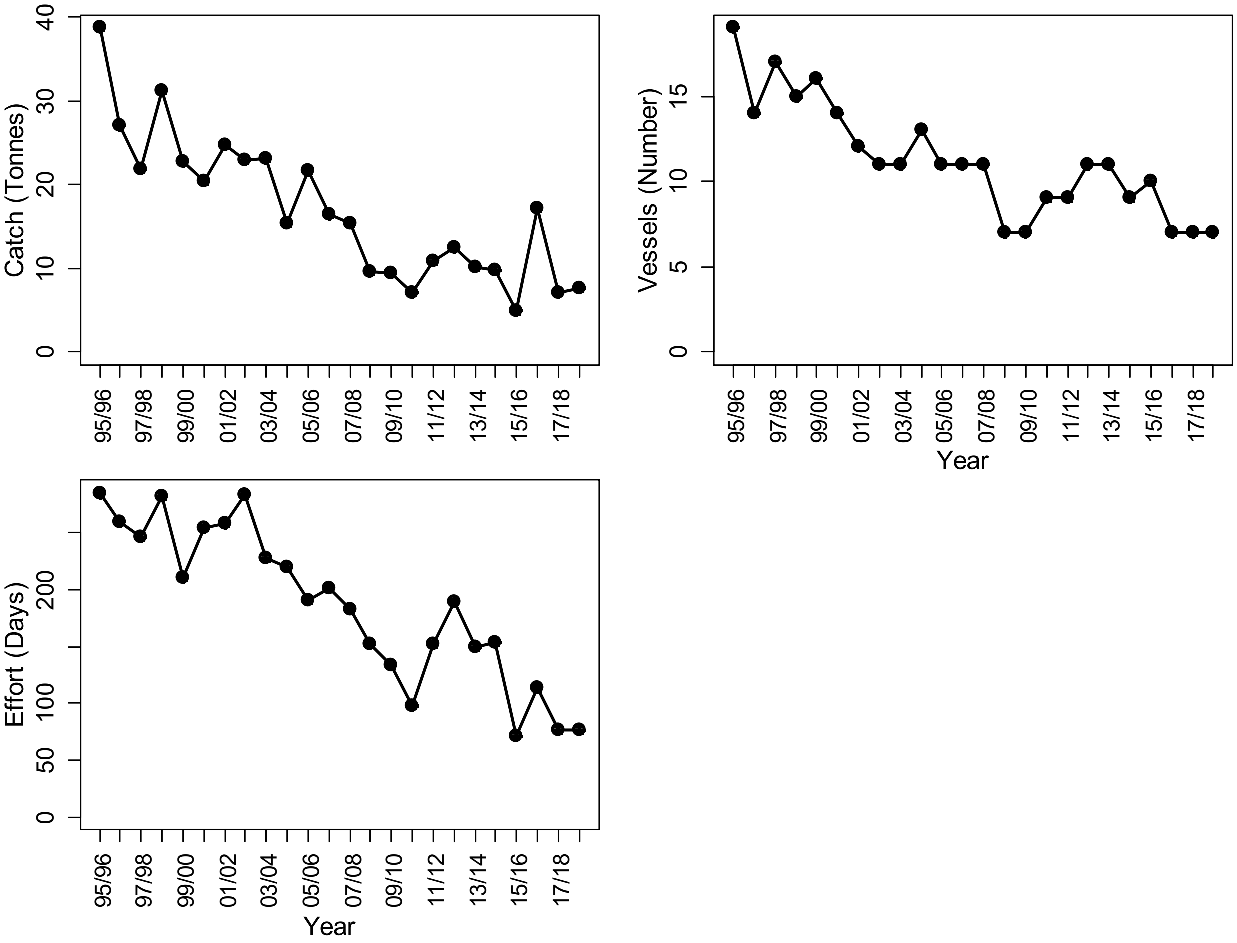


Figure 3.20 Overall catch, number of vessels using the gear, and effort (in vessel days) for small mesh net.

Purse seine

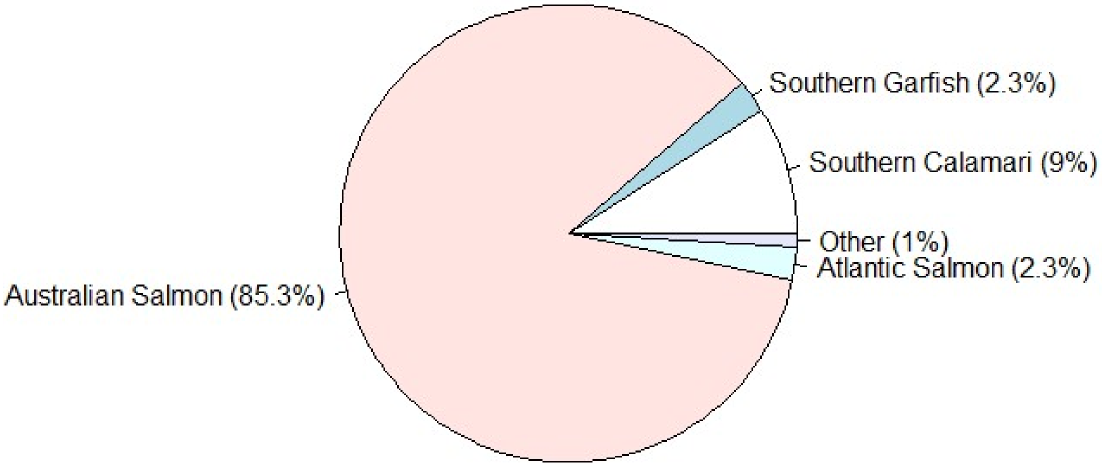


Figure 3.21 Purse seine catch composition for 2018/19.

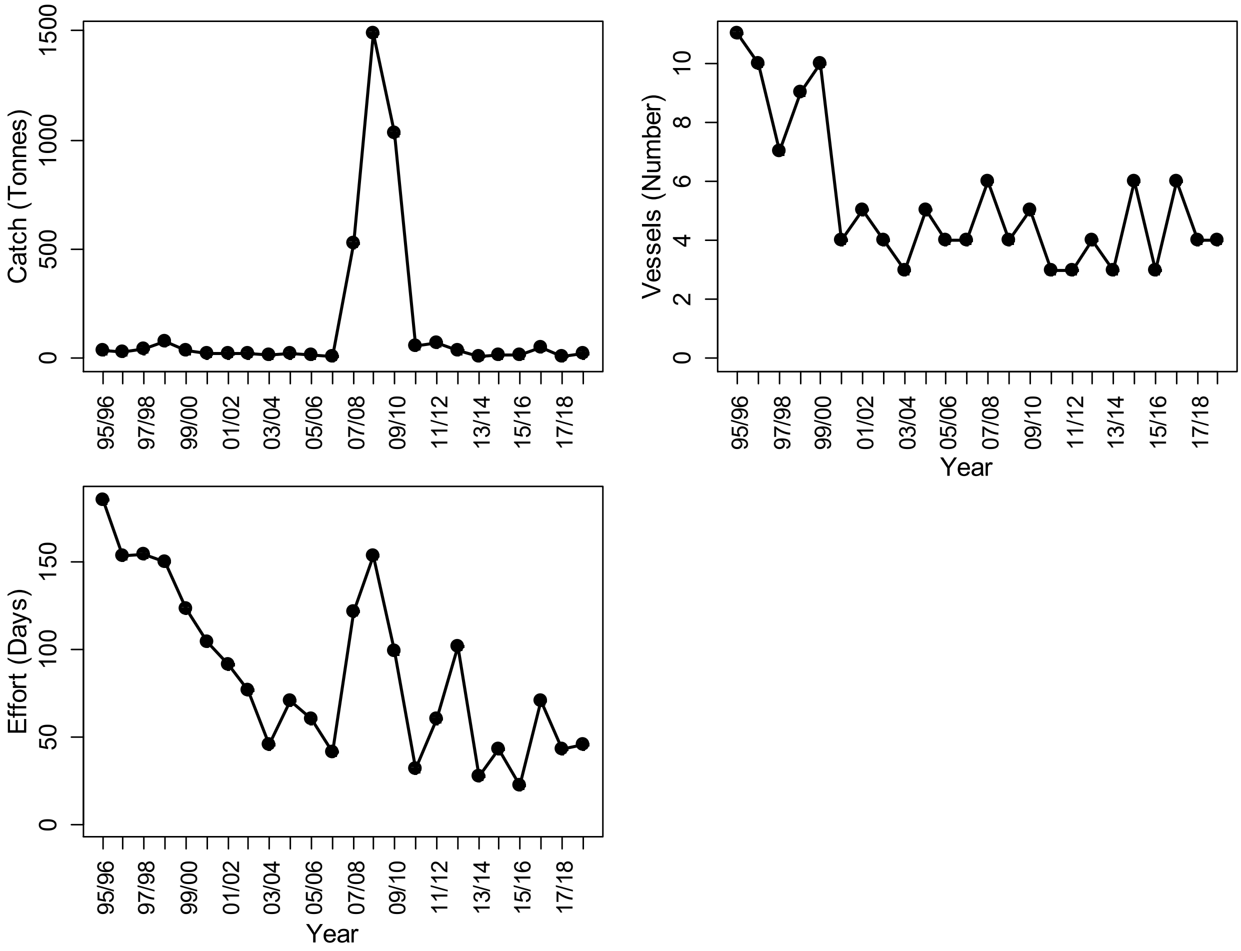


Figure 3.22 Overall catch, number of vessels using the gear, and effort (in vessel days) for purse seine.

Squid jig

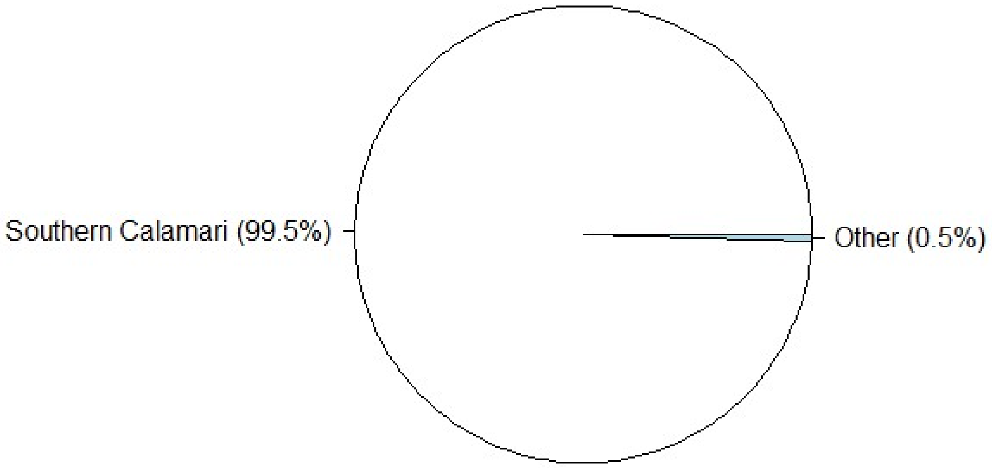


Figure 3.23 Squid jig catch composition for 2018/19.

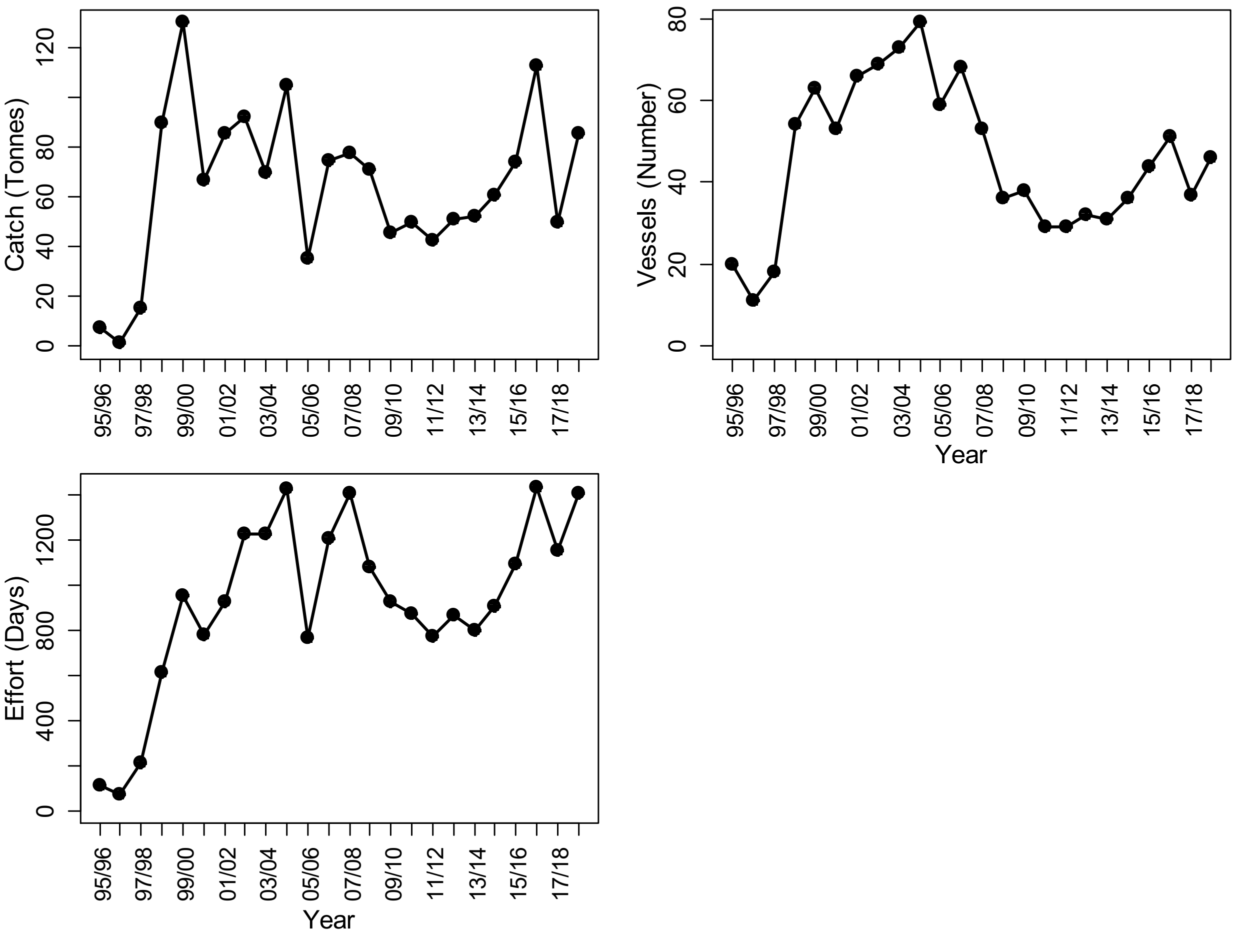


Figure 3.24 Overall catch, number of vessels using the gear, and effort (in vessel days) for squid jig.

Spear

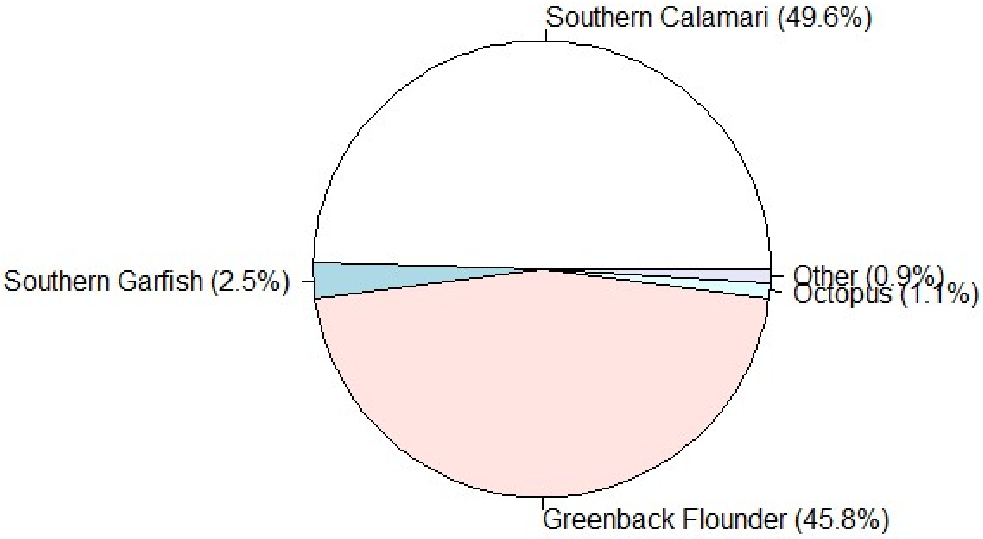


Figure 3.25 Spear catch composition for 2018/19.

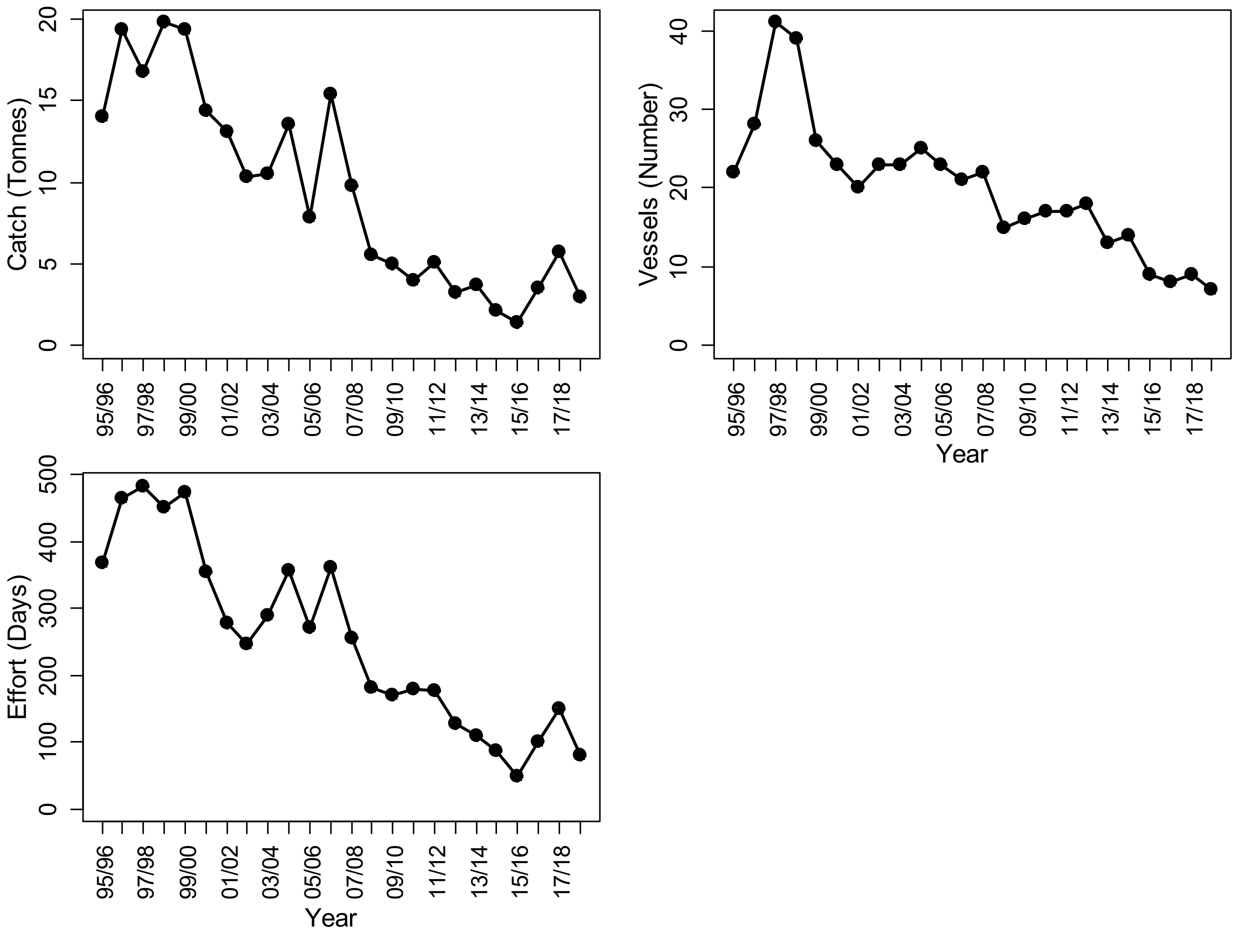


Figure 3.26 Overall catch, number of vessels using the gear, and effort (in vessel days) for spear.

Trolling

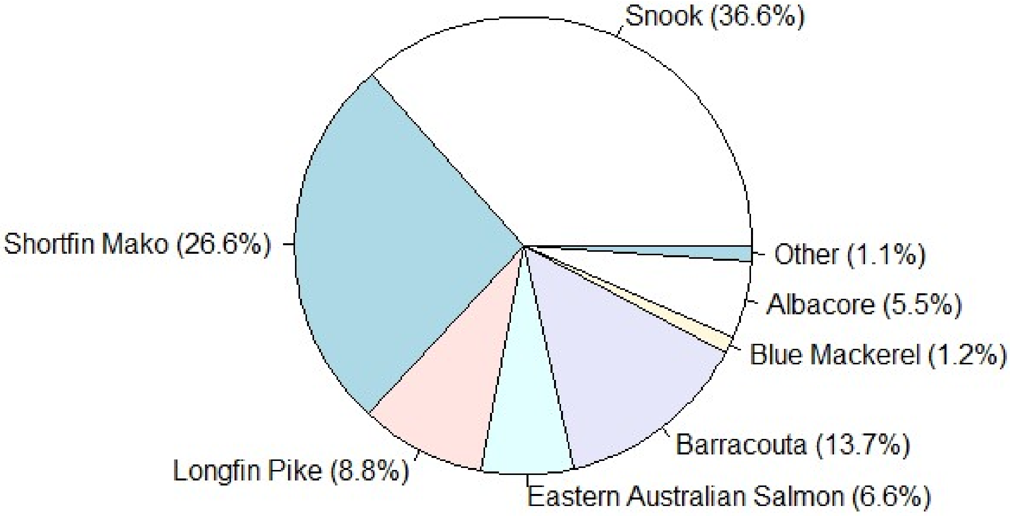


Figure 3.27 Trolling catch composition for 2018/19.

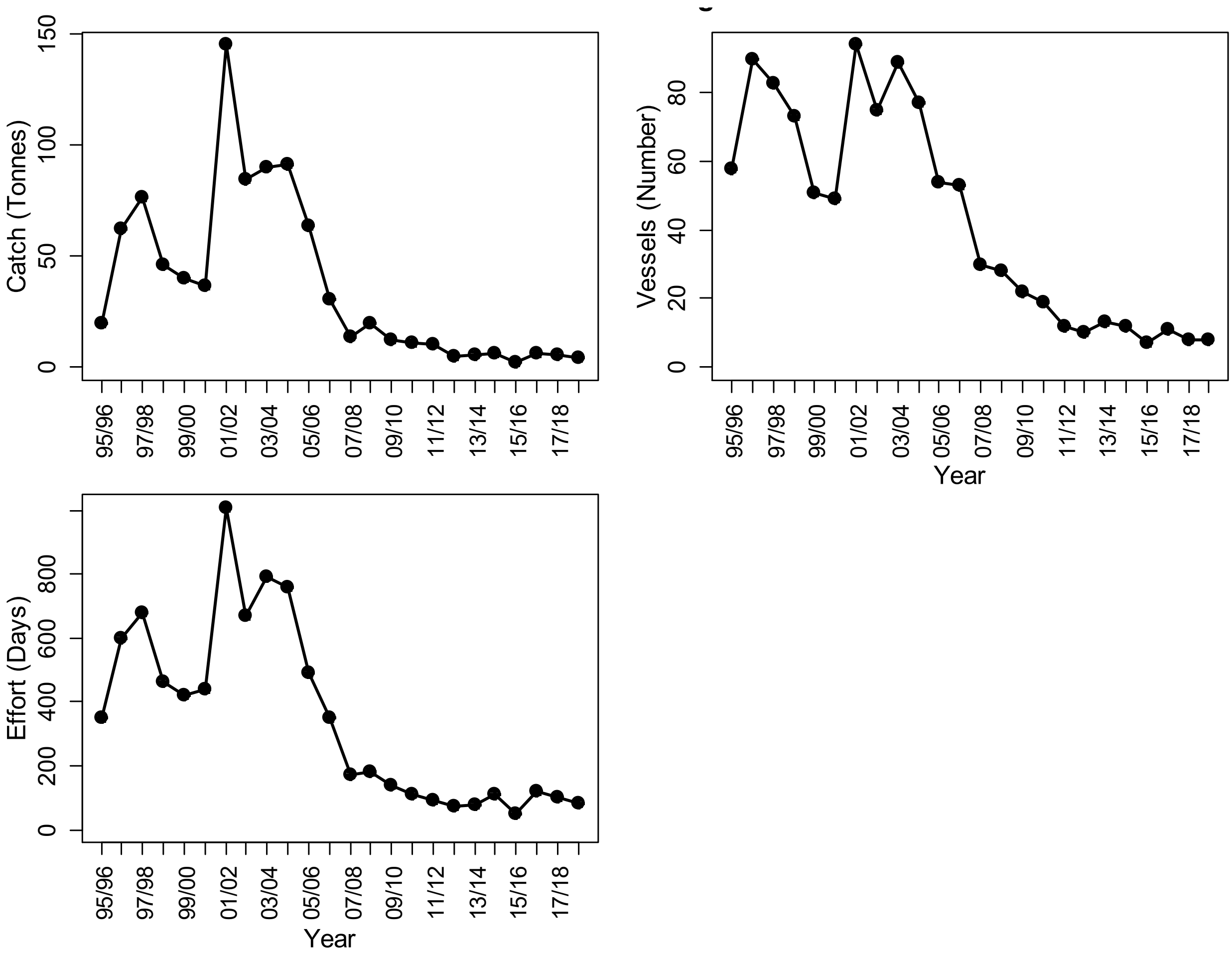
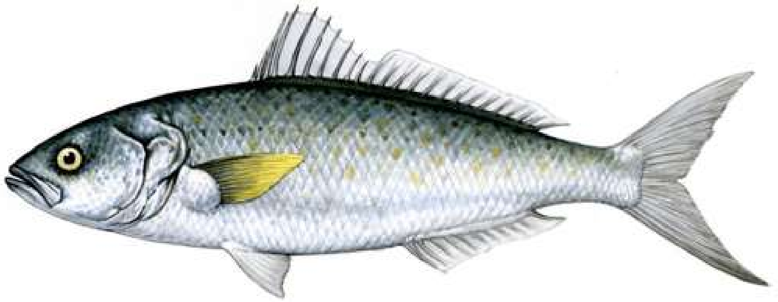


Figure 3.28 Overall catch, number of vessels using the gear, and effort (in vessel days) for trolling.

4. Eastern Australian Salmon

Arripis trutta

STOCK STATUS	**SUSTAINABLE**
This species has a long history of exploitation across south-eastern Australian. Low commercial landings in Tasmania in recent years are driven by market demand rather than abundance. The current level of fishing pressure in Tasmania is below historically sustained levels and thus unlikely to cause the biological stock to become recruitment impaired.	
IMPORTANCE	Key
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends



Arripis trutta
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Open water. Down to 30 m depth.	Edgar (2008)
Distribution	• From Victoria to Queensland (Brisbane) and around Tasmania.	Edgar (2008)
Diet	• Fish (pelagic predominantly).	Stewart et al. (2011)
Movement and stock structure	• One single well-mixed stock along southeast Australia • Travel great distances between the different States. • Increased population mixing occurs with both increasing age and decreasing latitude.	Stewart et al. (2011)
Natural mortality	• *M* between 0.35 and 0.50.	Stewart et al. (2011)
Maximum age	• Maximum sampled is 12 years but potentially up to 26 years.	Stewart et al. (2011)
Growth	• Maximum length: 89.0 cm. • Maximum weight: 9.4 kg • Growth described by von Bertalanffy growth function $L = L_\infty(1 - e^{-k(t-t_0)})$ where *L* is the fork length (cm), *t* is the age (years), L_∞ is the average maximum length for the species, *k* is a constant and t_0 is the (theoretical) age where length equals zero.	Edgar (2008) Frimodt (1995) Stewart et al. (2011)

<table>
<tr><td></td><td>Parameter estimates are:
<table><tr><th>Sex</th><th>L_∞</th><th>k</th><th>$t_{0\infty}$</th></tr><tr><td>Females</td><td>65.0</td><td>0.24</td><td>-0.15</td></tr><tr><td>Males</td><td>61.3</td><td>0.27</td><td>-0.13</td></tr></table></td><td></td></tr>
<tr><td>Maturity</td><td>• Size-at-50% maturity: 42.13 cm
• Age at 50% maturity: 2.19 years</td><td>Stewart et al. (2011)</td></tr>
<tr><td>Spawning</td><td>• From October to March, off New South Wales.
• The relationship between batch fecundity and fork length is exponential with $F = 14581e^{0.0659\,L}$, where F is the fecundity (in number of eggs) and L is the fork length (cm).
• The relationship between batch fecundity and age is exponential with $F = 96604e^{0.227\,A}$, where F is the fecundity (in number of eggs) and A is the age (in years).</td><td>Stewart et al. (2011)</td></tr>
<tr><td>Early life history</td><td>• Eggs, larvae and juveniles drift and migrate from spawning grounds to Tasmania and Victorian waters during autumn and winter.
• Juveniles (4–6 cm fork length) appear in shallow Tasmanian waters between January and September.</td><td>Kailola et al. (1993)</td></tr>
<tr><td>Gillnet post release survival</td><td>• Low: 20–62% depending on soak duration</td><td>Lyle et al. (2014b)</td></tr>
</table>

Background

There are two species of Australian Salmon inhabiting Tasmanian waters: *Arripis trutta* (Eastern Australian Salmon) and *Arripis truttaceus* (Western Australian Salmon). Eastern Australian Salmon constitutes approximately 94% of Tasmanian commercial catches.

Australian Salmon have a long history of exploitation in Tasmania, with large-scale commercial fishing occurring since at least 1958 (Stewart et al. 2011). There are two distinct sectors in the commercial fishery: (1) a small number of large vessels specifically equipped to capture and store large quantities of Australian Salmon, and (2) a large number of small vessels which target the species on an opportunistic basis or take them as by-product. A single company operating up to three vessels has typically accounted for more than 80% of Australian Salmon landings.

Most commercially caught Australian Salmon are frozen whole and sold as rock lobster bait, with production levels linked to the demand for bait. Some Australian Salmon are sold fresh for human consumption.

Australian Salmon is the second most important species for recreational fishers (Lyle 2005, Lyle et al. 2009, Lyle et al. 2014b, Lyle et al. 2019), who target this species mainly by using line fishing methods.

FISHING METHODS	Mainly beach seine, also purse seine and gillnet. Line for recreational.
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence, Beach seine licence). • Species licence (Australian Salmon licence) – 8 issued, 1 commonly used. • Spatial and temporal area closures for Australian Salmon licence. **Output control:** • Trip limit of 500 kg for operators with Scalefish licences but no Australian Salmon licence. • Possession limit of 30 and bag limit of 15 individuals for recreational fishers. • Minimum size (200 mm TL). • Total commercial catch trigger of 435 t.
MAIN MARKET	Local and interstate.

Current assessment

Catch, effort and CPUE

Following a large catch in 2012/13 (331 t), landings for the last few years have been low with only 36 t landed in 2018/19 (Fig. 4.1A). The low catch in recent years has been due to a dramatic decline in the landings by beach seine fishers that have historically landed most of the catch (Fig. 4.1A). The majority of the catch in 2018/19 was also taken using beach seine. Catches in 2018/19 came from the north coast, and from east and south-east coasts (Fig. 4.2). Both effort and catch rates remain low compared historic peaks (Fig. 4.1B and 4.1C). However, catch rates are influenced by the skewed nature of catches with a small number of extremely large catches potentially masking the characteristics of many typically small catches. In addition, catch rate is not a particularly sensitive indicator of stock condition for schooling species, such as Australian Salmon, especially if search time is not considered.

Ecological Risk Assessment

In the 2012/13 ecological risk assessment (ERA) of the Tasmanian scalefish fishery, beach seining for Australian Salmon was considered a very low risk activity. Beach seining was also considered a low risk activity with regards to non-retained bycatch species, which are usually released alive and ‘herded’ not ‘meshed/gilled’ (Bell et al. 2016). Given the low beach seining catch and effort since 2012/13, there is no evidence to suggest this level of risk has increased.

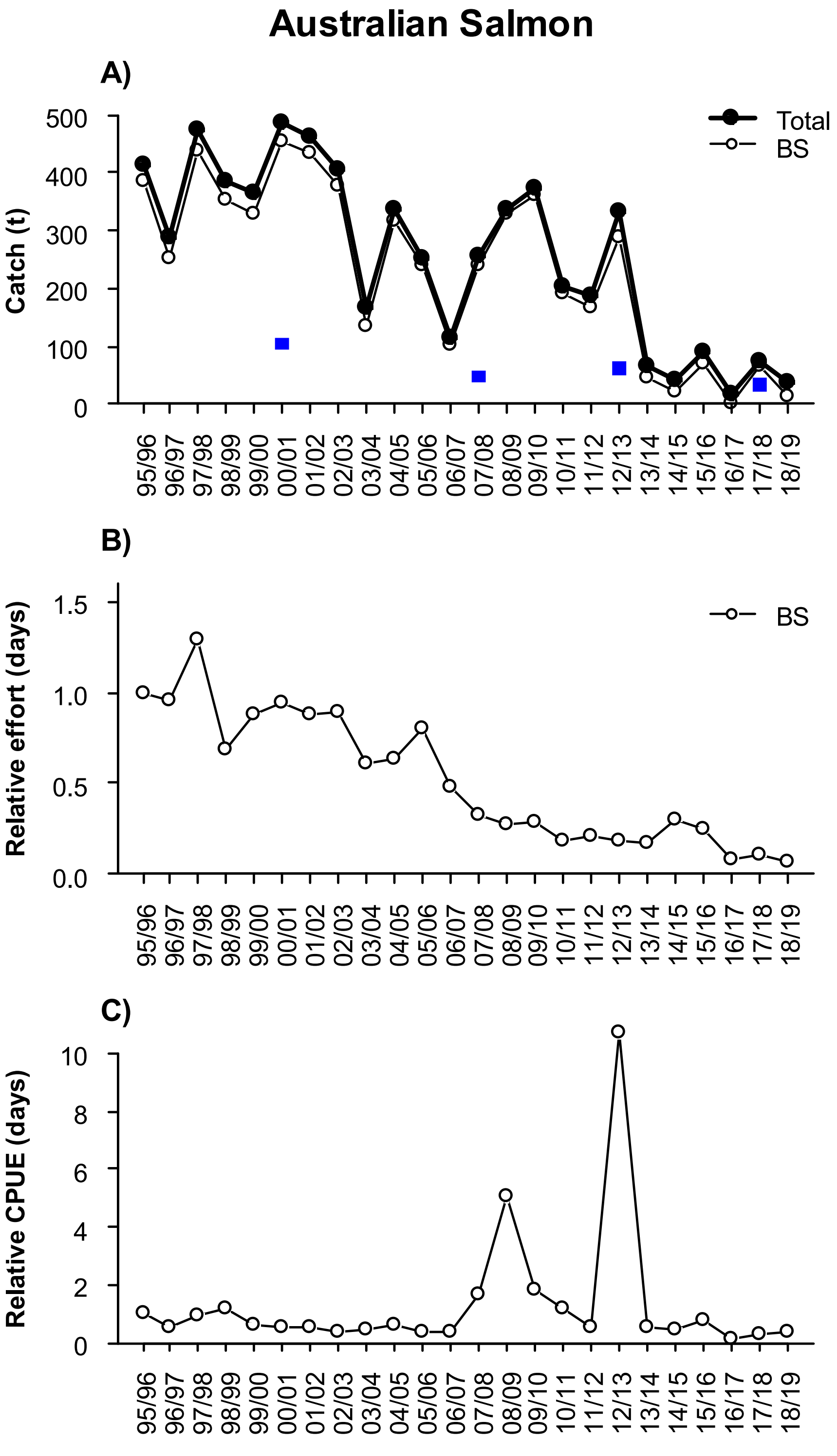


Figure 4.1 A) Annual commercial catch (t) by gear, and best estimates of recreational catches (blue squares). B) Commercial effort by method based on days fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. BS=beach seine.

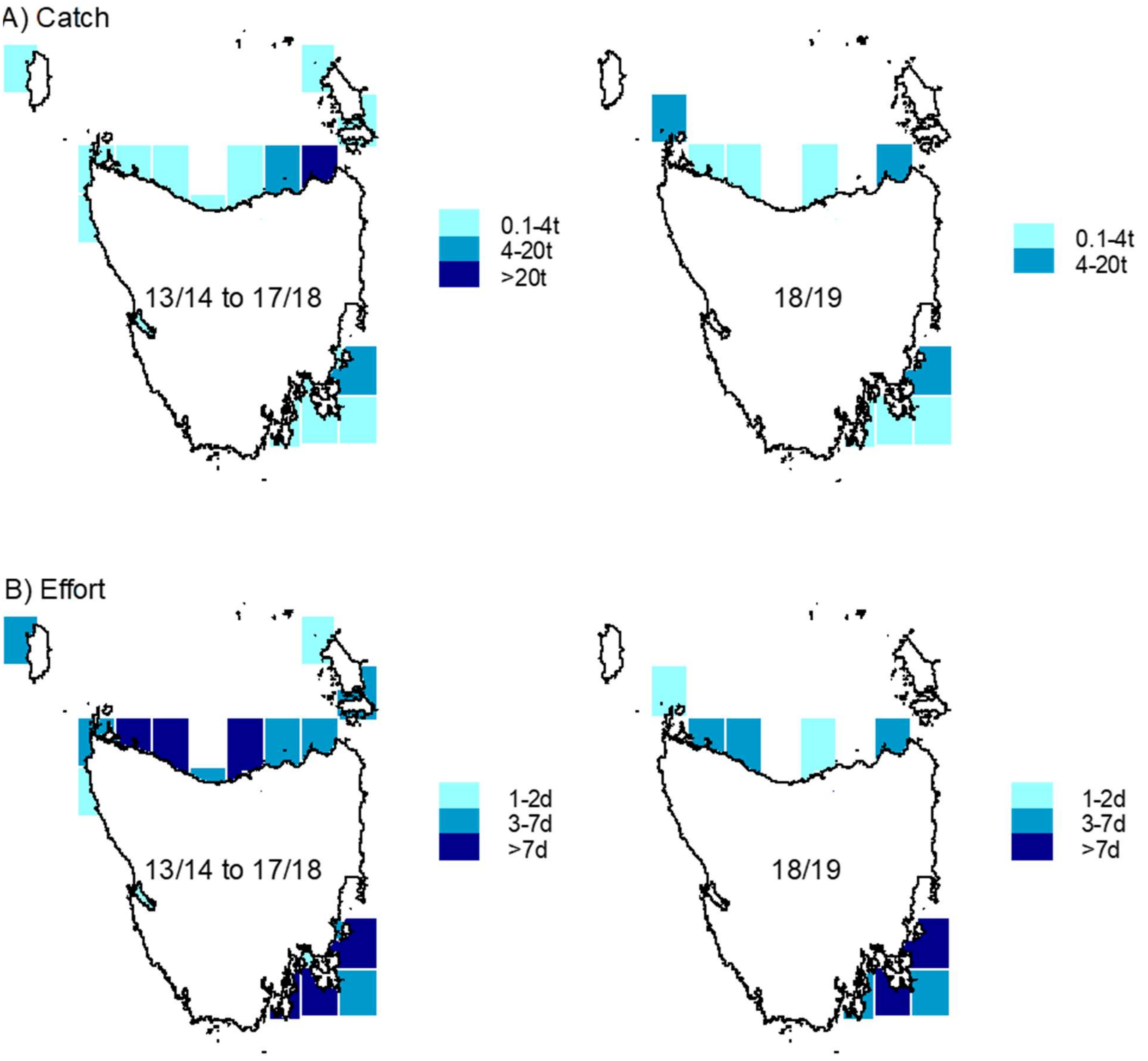


Figure 4.2 (A) Annual Australian Salmon catches (t) and (B) effort (days) for beach seine, gillnet, small mesh net and purse seine fishing methods by fishing block averaged over the last five seasons (left) and during 2018/19 (right).

Reference points

Given that beach seine catch rates are not a sensitive indicator of stock status due to the schooling behaviour of the species, the biomass performance indicators (based on CPUE and CPUE trends) were not calculated for Australian Salmon.

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Total commercial catch >435 t	No	
	• Catch > 3rd highest catch value from the reference period (462.1 t)	No	
	• Catch < 3rd lowest catch value from the reference period (254.2 t)	Yes	↓ 215.5 t (84.8%)
	• Catch variation from the previous year above the greatest inter-annual increase from the reference period (188.7 t)	No	
	• Catch variation from the previous year above the greatest inter-annual decrease from the reference period (240.0 t)	No	
	• Latest recreational catch estimate > recreational catch estimate from the reference period (105.2 t)	No	
	• Proportion of recreational catch to total catch > previous proportion estimate (19% in 2012/13)	Yes	Latest estimate (2017/18) 31.7%

Stock status	**SUSTAINABLE**

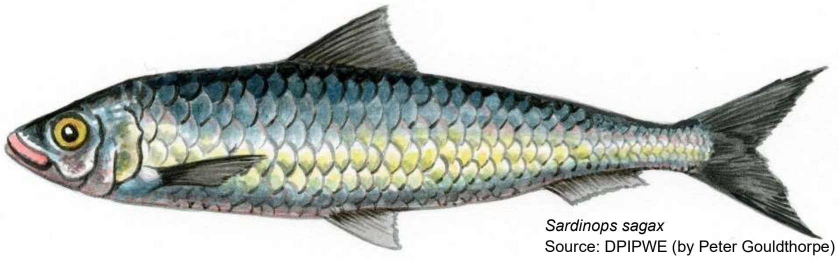
Although the third lowest catch reference point was breached as a result of the low landings in 2018/19, annual production of Australian Salmon is strongly linked to the fishing practices of a single beach seine operator who is responsible for the overwhelming majority of landings. Historically low catch is, thus, more likely to reflect low market demand than changes in abundance.

Eastern Australian Salmon represent a single, well-mixed stock along southeast Australia. There appears to have been little change in the size and age composition of this species while monitored in commercial catches in NSW from the 1970s up to 2008/09 with the eastern Australian biological stock classified as sustainable in the SAFS 2018 report (Stewart et al. 2018). Noting that the Tasmanian fishery catches mostly sub-adults and that the combined commercial and recreational catch in Tasmania is currently well below historical levels, it is unlikely that current fishing pressure will cause the biological stock of Eastern Australian Salmon in Tasmania to become recruitment impaired.

5. Australian Sardine

Sardinops sagax

STOCK STATUS	**SUSTAINABLE**
The fishery is in a developmental phase in Tasmania, with low catches reported to date. The species was classified as not overfished nor subject to overfishing by ABARES for 2018/19. Similarly, all Australian stocks are currently classified as sustainable in the 2018 Status of Australian Fish Stocks report. The current level of fishing pressure in Tasmania is unlikely to cause the biological stock to become recruitment impaired.	
IMPORTANCE	Minor
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends



Sardinops sagax
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameter	Estimates	Source
Habitat	• Lower reaches of estuaries to continental shelf waters.	Paxton and Hanley (1989)
Distribution	• Found throughout southern Australia from Queensland (Rockhampton) to Western Australia (Shark Bay) and northern Tasmania.	Izzo et al. (2017)
Diet	• Phytoplankton and planktonic crustaceans.	Stewart et al. (2011)
Movement and stock structure	• Four separate biological stocks are considered present in Australian waters: south-west coast of Western Australia, Great Australian Bight–Spencer Gulf, Bass Strait–Port Phillip Bay (including Tasmania and likely southern New South Wales) and eastern Australia. Four stocks were considered in the 2016 Status of Australian Fish Stocks reporting (Eastern Australia, Western Australia west coast, Western Australia south coast and Southern Australia). The Tasmanian fishery is likely to be part of the Bass Strait-Port Phillip Bay stock.	Izzo et al. (2017) Ward et al. (2017)
Natural mortality	• *M* of 0.43 calculated for stock on south coast of Western Australia. • Mean *M* estimated as 0.52 for populations of the west coast of the United States.	Fletcher (1995) Zwolinski et al. (2013)

<table>
<tr><td>Maximum age</td><td>• 8 years</td><td>Stewart et al. (2010)</td></tr>
<tr><td>Growth</td><td>• Maximum length: 23.0 cm
• Maximum weight: 0.14 kg
• Growth described by von Bertalanffy growth function $L = L_\infty\left(1 - e^{-k(t-t_0)}\right)$
where L is the fork length (mm), t is the age (years), L_∞ is the average maximum length for the species, k is a constant and t_0 is the (theoretical) age where length equals zero.
Parameter estimates are:
<table>
<tr><th>Sex</th><th>L_∞</th><th>K</th><th>$t_{0\infty}$</th></tr>
<tr><td>Combined</td><td>236.1</td><td>0.37</td><td>-0.28</td></tr>
</table>
</td><td>Neira et al. (1999)
Stewart et al. (2010)</td></tr>
<tr><td>Maturity</td><td>• Size-at-50% maturity: 14.5 cm
• Age at 50% maturity: 1–2 years</td><td>Stewart et al. (2010)
Ward and Grammer (2016)</td></tr>
<tr><td>Spawning</td><td>• Main spawning area for the eastern Australian stock occurs off southern Queensland and northern NSW during late winter and early spring. Spawning has also been recorded to occur between Tasmania and southern Victoria during summer.
• The relationship between batch fecundity and weight is linear with $F = -12042 + 452.69W$, where F is the fecundity (in number of eggs) and W is the female weight (g).</td><td>Ward et al. (2015)
Lo et al. (2005)</td></tr>
<tr><td>Early life history</td><td>• Juveniles (4–6 cm fork length) have been recorded in Port Phillip Bay, Victoria, between February and May, and within bays elsewhere in south-eastern Australia in winter through to summer months.</td><td>Hoedt and Dimmlich (1995)
Neira et al. (1999)</td></tr>
<tr><td>Post release survival</td><td>• Unknown, but likely low.</td><td></td></tr>
</table>

Background

Australian Sardine is a species with a history of commercial exploitation in mainland state and Commonwealth waters, but which has rarely been caught in Tasmanian state waters. The majority of the total Australian Sardine catch is derived from mainland state waters.

The fishery for Australian sardine in Tasmania is likely based on the Bass Strait–Port Phillip Bay stock. There is evidence to suggest that the species may be present in large quantities in Tasmanian waters in some years. Ichthyoplankton surveys conducted during 2014 suggested that a spawning biomass of approximately 10,962 t was present off northern Tasmania and in Bass Strait during summer (Ward et al. 2015). It was also noted that the actual spawning area was likely to be larger than surveyed (possibly extending further into Bass Strait and off northern Tasmania), implying that the estimate may be negatively biased. To ensure sustainable exploitation, Smith et al. (2015a) recommended a harvest rate of 24–27% for Australian Sardine. However, given uncertainty in the biomass estimate and considering that very little is known about the dynamics of the sardine stocks off south-eastern Australia, a more conservative harvest rate of around 20% has been proposed. Applying a harvest rate of 20% to the 2014 biomass estimate suggests that the stock (some of which occurs outside of Tasmanian waters) could support catches in the range of 1,600–3,000 tonnes per year. However, the south-eastern Australian stock is likely to be shared with the fishery operating in Victoria (annual catches > 1,500 t in recent years), and accordingly, collaborative management will be needed.

In 2015, the Tasmanian Government released a framework to support a developmental fishing program for Australian Sardine (DPIPWE 2015). Managed as a developmental fishery, a total annual catch limit of 600 tonnes was applied to the large-scale sector (with a maximum of 300 tonnes to be taken from Bass Strait and 300 tonnes from the east coast) and a maximum of 50 tonnes applied to the small-scale sector. Two large-scale and two small-scale developmental permits were issued initially, but the framework expired in 2018. There are currently no active permits to take sardines.

Australian Sardine is not a significant recreational species in Tasmania (Lyle et al. 2019).

FISHING METHODS	Mainly purse seine, also beach seine.
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence, beach seine licence and purse seine licence). • Developmental Australian Sardine permit. **Output control:** • A trip limit of 10 kg of Australian Sardine for general Scalefish Licence holders. • Spatial restrictions. • Possession limit of 100 and bag limit of 50 individuals for recreational fishers (all baitfish species combined).
MAIN MARKET	Local and interstate

Current assessment

Biological characteristics

In 2017, a sampling program was implemented to obtain baseline biological information, including size and age composition of the catch and insights into spawning dynamics (in both space and time) of Australian Sardine in Tasmanian waters. A total of 201 fish were sampled (including 152 individuals from the north-east and 49 individuals from the north coast) during January and February 2017 with approximately 20–50 fish sampled from each commercial purse seine catch landed.

Size composition

Sampled fish ranged from 125 mm to 216 mm fork length and had a modal length of 160 mm (Fig. 5.1). Samples from the north coast were on average larger than those caught for the north-east (206 ± 1 mm vs. 162 ± 1 mm, respectively). Differences in mean length structure between males and females were not pronounced, but females dominated the larger length classes (Fig. 5.1).

Age composition

In the absence of a validated ageing protocol for the species in Tasmanian waters, ages of sampled individuals were estimated using the linear otolith weight-age relationship of Stewart et al. (2010) that is applied to ageing this species in NSW:

$$\text{Age (years)} = 1.95 \times \text{average otolith weight (mg)} + 0.43$$

The resulting age frequency histogram from the fishery-dependent samples revealed that ages ranged from 2–6 years with a modal age of 3 years (Fig. 5.1). This is largely consistent with observations of the stock elsewhere across its distribution. For example, Stewart et al. (2010) observed an age range of 0–5 years off the coast of NSW with the majority of individuals being between 1 and 4 years old.

A large overlap in age structure was evident between males and females, however, as with length, there were proportionally more females in the older age classes (Fig. 5.1).

Catch, effort and CPUE

The 2018/19 total commercial catch of Australian Sardine in Tasmanian waters was only 6 kg (Fig. 5.2). Historically, this species has constituted a minor and sporadic component of the Tasmania scalefish fishery with peak catches of 15.4 t recorded in 1997/98, 14.5 t in 2008/09 and 33.3 t in 2016/17, which were interspersed among years of little or no catch. The earlier peak catches largely reflect incidental take of Australian Sardine by fishers targeting other small pelagic fishes (e.g. redbait). Targeted fishing for the species under the developmental fishery permit commenced in 2016/17 with fishing activity over the last five years based around the north coast, primarily the northeast coast (Fig. 5.3). Notable catches of Australian Sardine have been reported for purse seine. In the current season, a few kilograms of incidental catch were reported.

Ecological Risk Assessment

In the 2012/13 ecological risk assessment (ERA) of the Tasmanian scalefish fishery, purse seining was considered a negligible risk activity to Australian Sardine due to the small quantities taken by the fishery (Bell et al. 2016). Since 2012/13 there has been minimal catch of Australian Sardine, and the risk is still considered negligible at currently low levels of fishing activity. If catches were to increase markedly in the future, the risks would need to be reassessed including the potential for interactions with marine mammals.

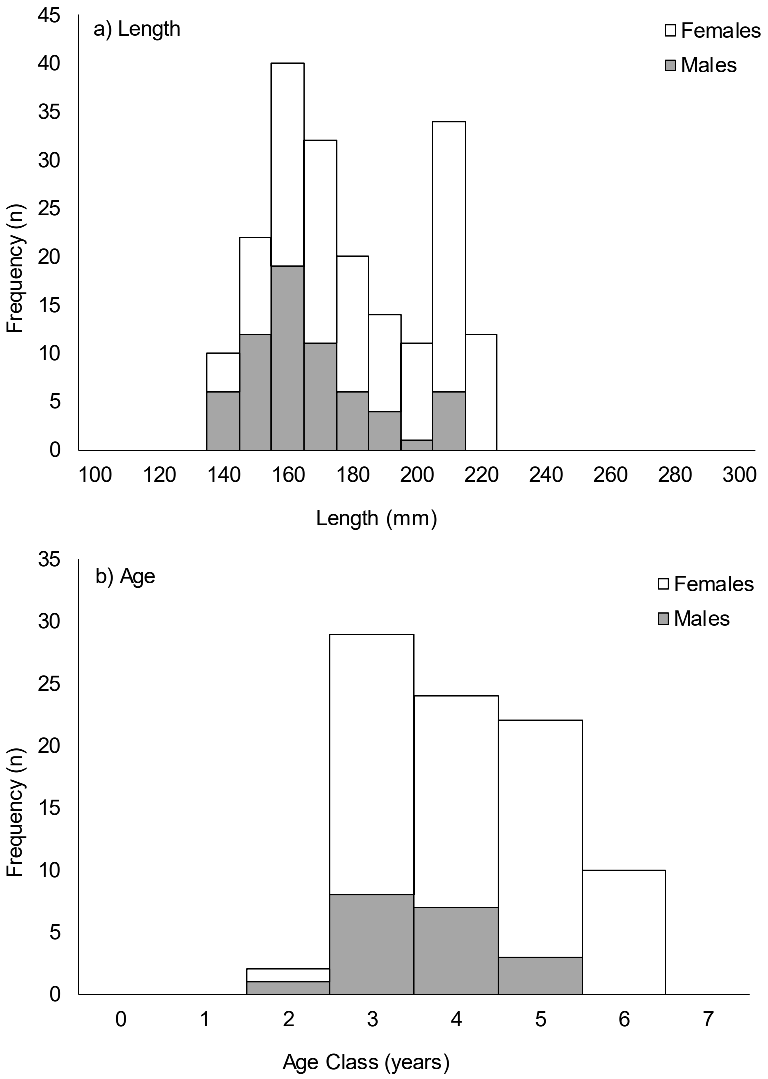


Figure 5.1 Length (top) and age (bottom) frequency histograms for Australian Sardine sampled from the commercial purse seine catch in 2017.

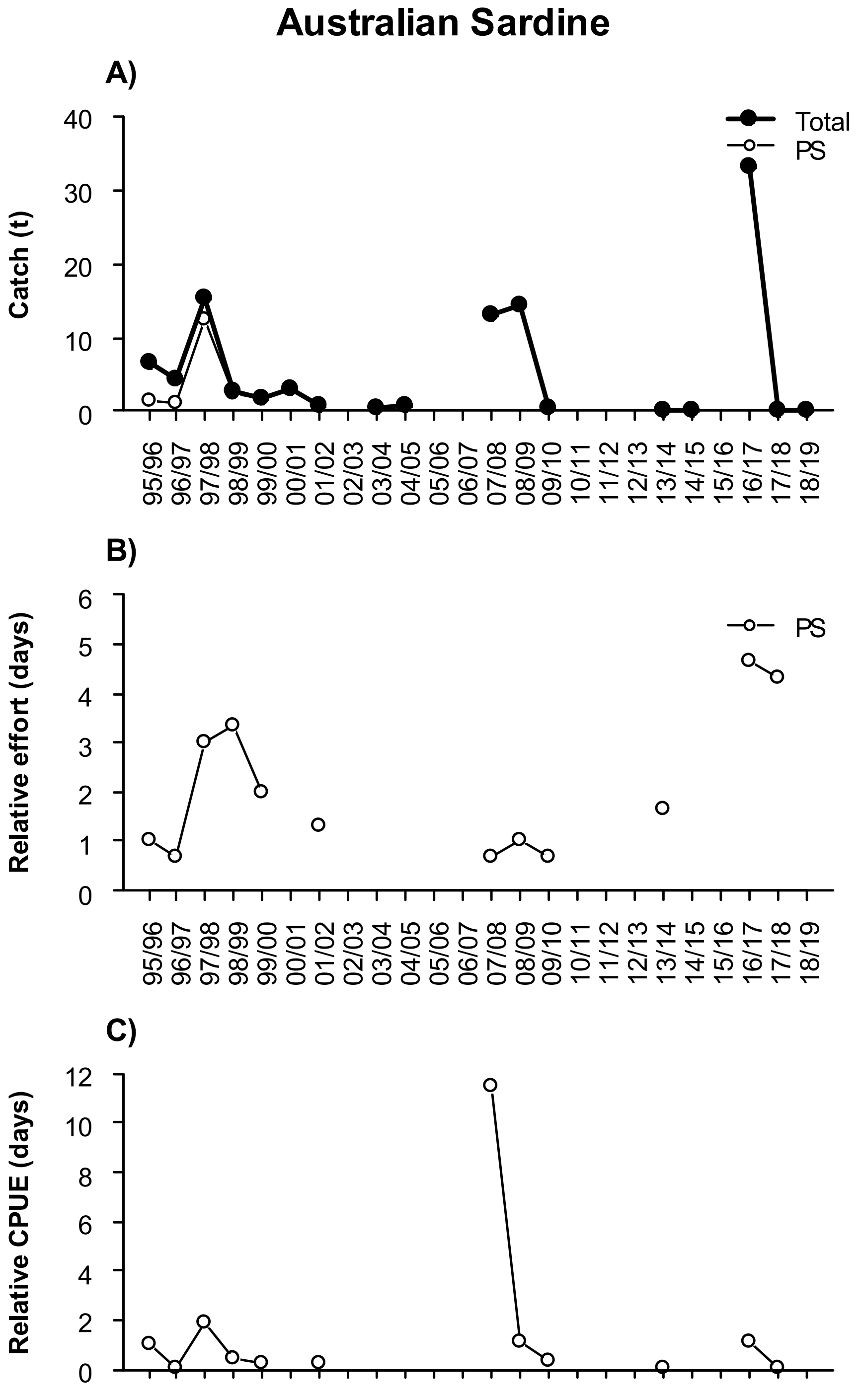


Figure 5.2 A) Annual commercial catch (t) by gear, and best estimates of recreational catches (blue squares). B) Commercial effort by method based on day fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. BS=beach seine.

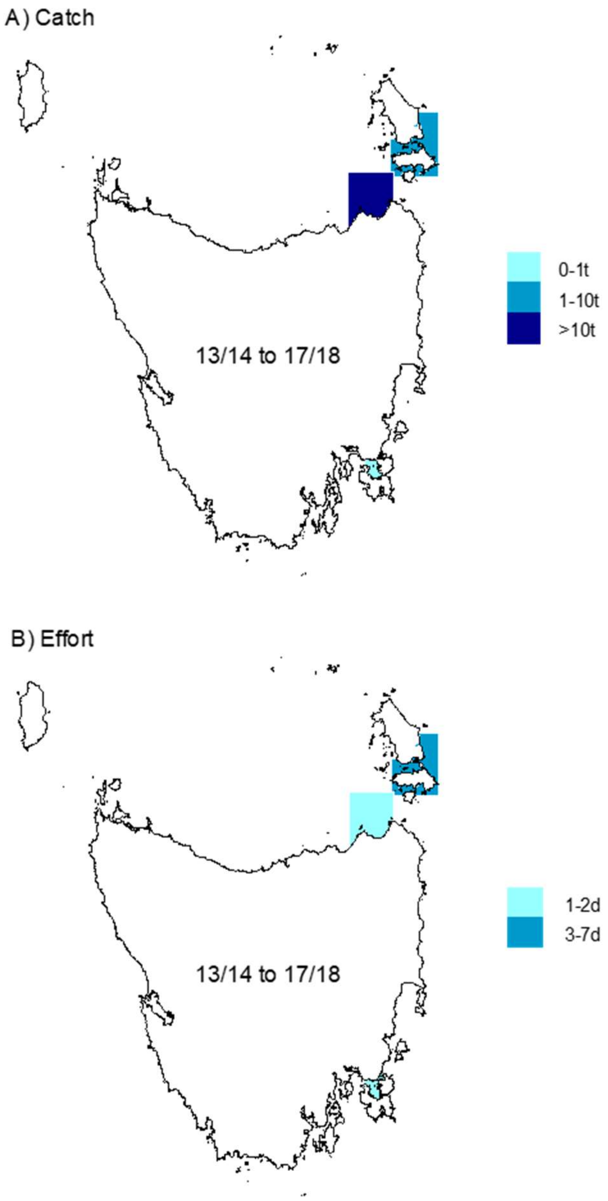


Figure 5.3 (A) Australian Sardine catches (t) and (B) effort (days) for beach seine and purse seine by fishing block averaged from 2013/14 to 2017/18. With no active permits in the current season, catch in 2018/19 was negligible.

Reference points

As this fishery is a developmental and currently inactive fishery in Tasmanian waters, a full suite of reference points is yet to be established. The development phase reference points (see management methods above) were not breached in 2018/19.

Stock status	**SUSTAINABLE**

Overall, catches of Australian Sardine in Tasmanian waters reflect only a minor proportion of the Bass Strait–Port Phillip Bay stock with surveys conducted in 2014 indicating a spawning biomass of approximately 10,962 t off northern Tasmania.

Since 2008, Australian Sardine populations in the Commonwealth Small Pelagic fishery have been considered to be not overfished nor subject to overfishing (Patterson et al. 2019), and all four Australian stocks considered during the 2018 Status of Australian Fish Stocks assessments (Eastern Australia, South-Eastern Australia, South-Western Australia and Southern Australia) were classified as sustainable (Ward et al. 2017). Given that current levels of effort are unlikely to result in recruitment overfishing, this ranking has been applied to the Tasmanian fishery.

6. Barracouta

Thyrsites atun

STOCK STATUS	UNDEFINED
Catches of Barracouta have declined steadily since the mid-2000s due to a decrease in targeted effort as a result of a lack of market demand. Catches and catch rates are not considered indicative of stock status and there is insufficient information to confidently classify the stock.	
IMPORTANCE	Minor
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends

Thyrsites atun
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Open water and coastal bays. Down to 550 m depth.	Edgar (2008) Kailola et al. (1993)
Distribution	• From midwestern Australia to southern Queensland, and around Tasmania. Also widely distributed in the southern hemisphere in temperate latitudes.	Edgar (2008)
Diet	• Pelagic crustaceans, cephalopods, fishes (e.g. anchovy and Jack Mackerel).	Nakamura and Parin (1993)
Movement and stock structure	• Schooling fish. • Some stocks undertake annual migrations lasting 6–9 months and covering several hundreds of km. • Also moves through the water column from 200 m depth to the surface. • At least 5 stocks: 3 in south-eastern waters, 1 in South Australia and 1 in Western Australia.	Paul (2000) Kailola et al. (1993) Blackburn and Gartner (1954)
Natural mortality	• $M = 0.3$	Hurst et al. (2012)
Maximum age	• At least 10 years, potentially up to 15 years.	Kailola et al. (1993) Hurst et al. (2012)
Growth	• Maximum length: 1.4 m • Maximum weight: 6 kg • Growth described by von Bertalanffy growth function $L = L_\infty\left(1 - e^{-k(t-t_0)}\right)$	Edgar (2008) Nakamura and Parin (1993)

<table>
<tr><td></td><td>where L is the fork length (cm), t is the age (years), L_∞ is the average maximum length for the species, k is a constant and t_0 is the (theoretical) age where length equals zero.
Parameter estimates are:
<table>
<tr><th>Sex</th><th>L_∞</th><th>k</th><th>$t_{0\infty}$</th></tr>
<tr><td>Combined</td><td>91</td><td>0.42</td><td>-0.25</td></tr>
</table>
Length-weight relationship was estimated at $W = 0.1064\ L^{2.2385}$ for females and males combined where W is weight (g) and L is the fork length (cm).</td><td>Grant et al. (1978)
Blackburn (1960)</td></tr>
<tr><td>Maturity</td><td>Sexual maturity at about 50–60 cm FL and about 2–3 years of age.</td><td>Hurst et al. (2012)</td></tr>
<tr><td>Spawning</td><td>October to March in Tasmania.</td><td>Kailola et al. (1993)</td></tr>
<tr><td>Early life history</td><td>Little data. Eggs are pelagic and juveniles inhabit sheltered waters of southern bays and estuaries.</td><td>Kailola et al. (1993)
Hurst et al. (2012)</td></tr>
<tr><td>Gillnet post release survival</td><td>NA</td><td></td></tr>
</table>

Background

Barracouta were the subject of a large commercial trolling fishery in Tasmania in the 1960s and 1970s when catches ranged from 600–1,600 t (Kailola et al. 1993). Demand for Barracouta, however, declined in the mid-1970s and there is now little commercial fishing for the species. Barracouta abundance also fluctuates greatly in State waters annually.

FISHING METHODS	Mostly troll and handline.
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence). **Output control:** • Possession limit of 30 and bag limit of 15 individuals for recreational fishers.
MAIN MARKET	Local

Current assessment

Catch, effort and CPUE

Total commercial catches peaked in the early 2000s with maximum of 136 t, but gradually declined from 101 t in 2004/05 to a historical low of 0.4 t in 2015/16 (Fig. 6.1A). Commercial catches in 2018/19 were 1.1 t. Trolling and handline are the main fishing methods used to target Barracouta. Catches and fishing effort were traditionally concentrated off southern Tasmania (Emery et al. 2017). However, over the last few fishing seasons, fishing effort has been concentrated off the north coast (Fig. 6.2).

After the peak in the early 2000s, effort declined and, since 2007/08, has stabilised at a low level (Fig. 6.1B). Catch rates have been relatively stable over the most recent fishing years (Fig. 6.1C). However, it is likely that fishers utilising fishing gears historically used to target Barracouta are now targeting other species and, in consequence, catch-based statistics are unlikely to be a reliable indicator of abundance.

Barracouta are targeted and taken as by-product by the recreational sector. Catches were estimated at 46.9 t in 2000/01 (Lyle 2005), 10.8 t in 2007/08 (Lyle et al. 2009), 31 t in 2012/13 (Lyle et al. 2014b) and 2.8 t in 2017/2018.Therefore, recreational catch generally and sometimes considerably exceed the commercial harvest (Fig. 6.1A).

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian scalefish fishery, trolling was considered a negligible risk activity with regard to Barracouta, by-product species, non-retained species and the general environment (Bell et al. 2016). Since 2012/13, there has been minimal catch of Barracouta and the risk is still considered negligible.

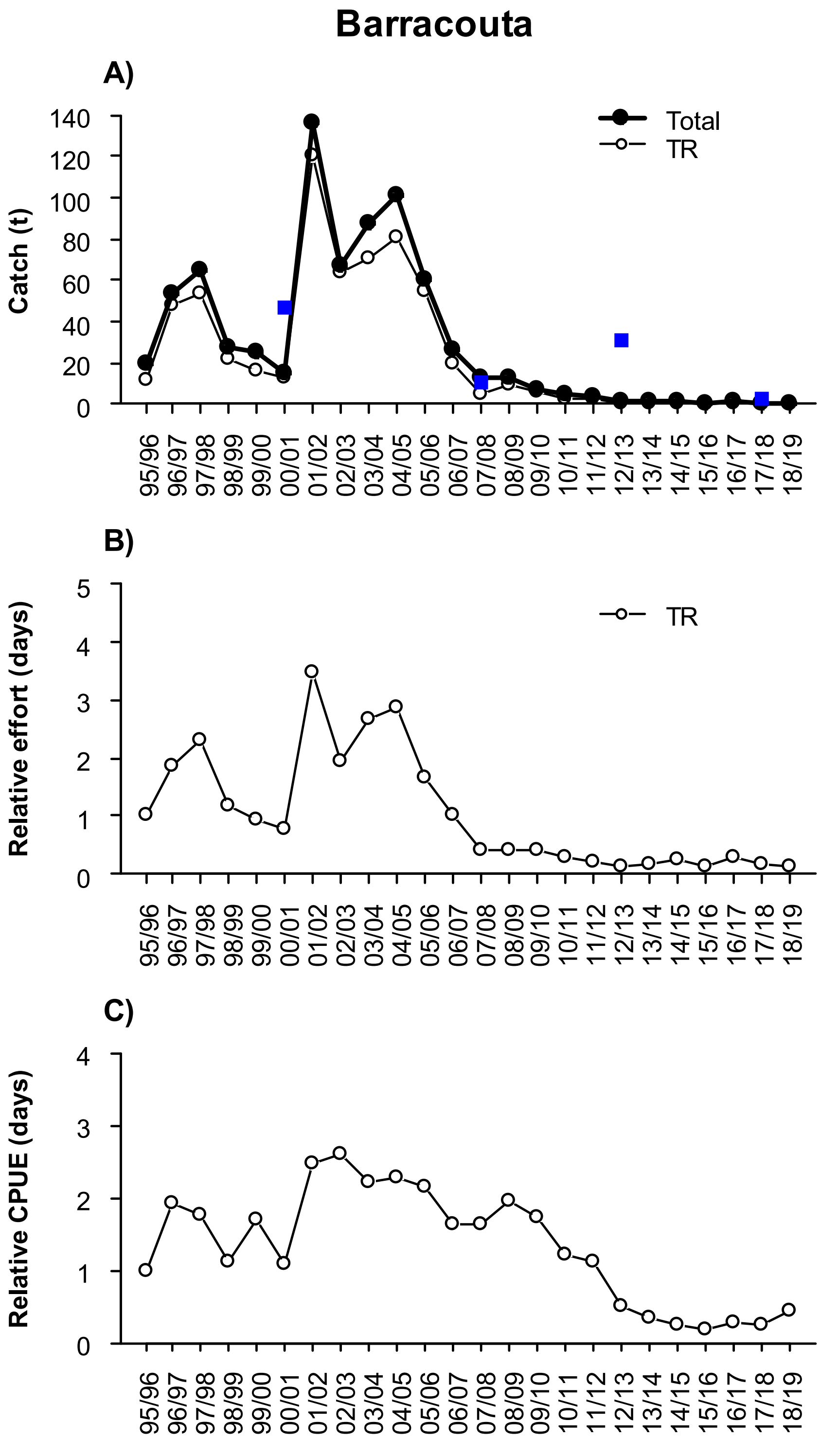
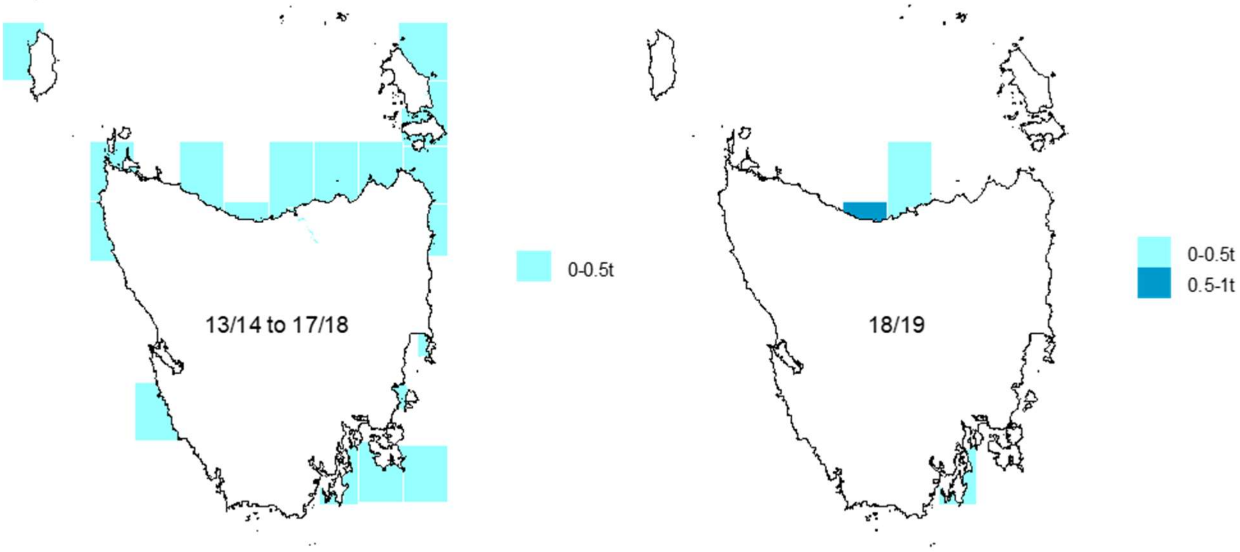


Figure 6.1 A) Annual commercial catch (t) by gear and best estimates of recreational catches (blue squares). B) Commercial effort by method based on day fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. TR=troll.

A) Catch



B) Effort

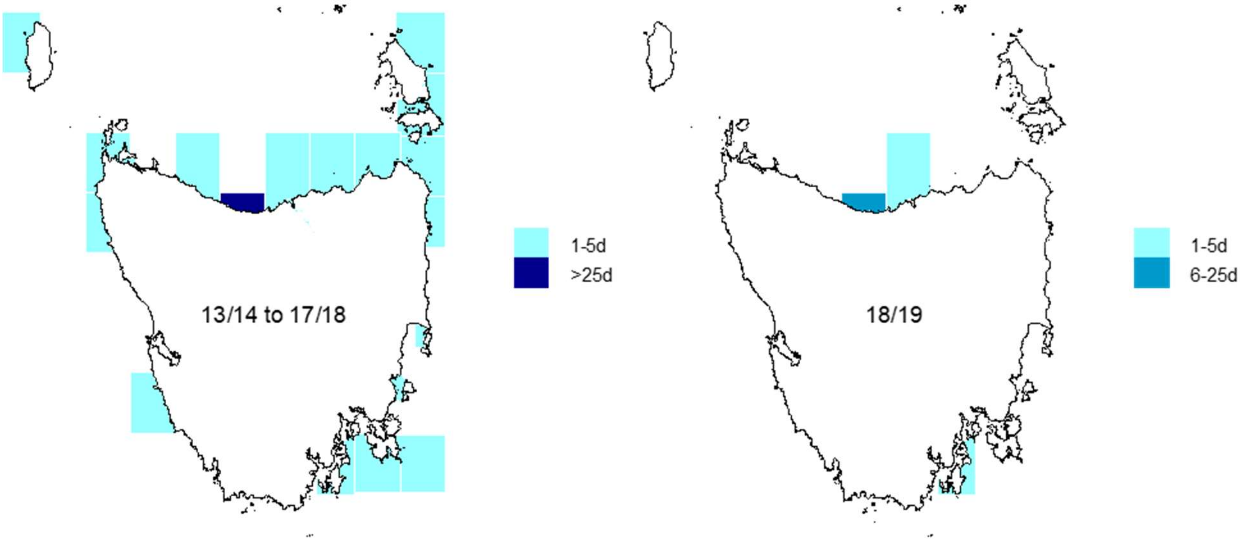


Figure 6.2 (A) Barracouta catches (t) and (B) effort (days) for troll and hand-line fishing methods by fishing blocks averaged from 2013/14 to 2017/18 (left) and during 2018/19 (right).

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (87.5 t)	No	
	• Catch < 3rd lowest catch value from the reference period (25.0 t)	Yes	↓ 23.9 t (95.5%)
	• Latest recreational catch estimate > recreational catch estimate from the reference period (46.9 t)	No	
	• Proportion of recreational catch to total catch > previous proportion estimate (96.6% in 2012/13)	No	
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0091)	No	

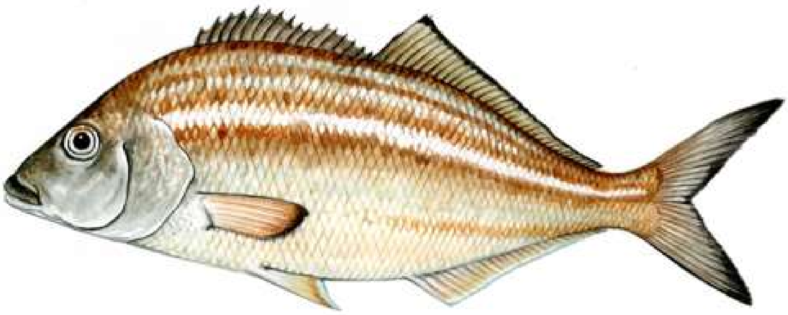
Stock status	**UNDEFINED**

Historically, the population of Barracouta has undergone large fluctuations in size and availability, possibly linked to recruit variability and environmental factors. Catches of Barracouta in Tasmanian waters have been declining steadily since the mid-2000s due to a decrease in targeted effort as a result of a lack of market opportunities. The increase in recreational catch proportion mainly reflects the sharp fall in commercial landings rather than increased targeting by recreational fishers. Discards of Barracouta in the South East Trawl Fishery sector of the Southern and Eastern Scalefish and Shark Fishery (SESSF) have previously estimated to be around 12% of the total discarded non-quota catch (Knuckey 2006), equating to roughly 1,356–1,920 t annually. The fate of such discards is unknown. While this situation suggests that Barracouta may be locally abundant within the SESSF, a lack of targeted commercial catches complicates consideration of catch rates in Tasmania as a proxy of stock status. As such, there is insufficient information to confidently classify this stock.

7. Bastard Trumpeter

Latridopsis forsteri

STOCK STATUS	**DEPLETED**
Trends in commercial and recreational catches suggest record low population levels and that the species is recruitment overfished. The current minimum legal size limit is below the size of maturity. Although commercial catches have been low for the past decade, fishing pressure may be too high to allow stocks to recover.	
IMPORTANCE	Key
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends



Latridopsis forsteri
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Exposed reefs and sandy bottom down to 160 m depth.	May and Maxwell (1986) Edgar (2008)
Distribution	• Sydney (New South Wales) to southern South Australia, Tasmania, southern New Zealand.	Edgar (2008)
Diet	• Small fish, invertebrates.	Edgar (1997)
Movement and stock structure	• Schooling fish, usually in small numbers. Large individuals occur in deeper waters. • Juveniles tend to remain associated with areas of reef for periods of time. • No information on the stock structure.	Edgar et al. (2004) Gomon et al. (2008)
Natural mortality	• Undetermined.	
Maximum age	• Up to 20 years.	Murphy and Lyle (1999)
Growth	• Maximum length: 65 cm • Maximum weight: 4 kg • Growth described by von Bertalanffy growth function $L = L_\infty\left(1 - e^{-k(t-t_0)}\right)$	Edgar (2008) Gomon et al. (2008)

<table>
<tr><td></td><td>where <i>L</i> is the fork length (cm), <i>t</i> is the age (years), L_∞ is the average maximum length for the species, <i>k</i> is a constant and t_0 is the (theoretical) age where length equals zero.
Parameter estimates are:
<table>
<tr><th><i>Sex</i></th><th>L_∞</th><th><i>k</i></th><th>$t_{0\infty}$</th></tr>
<tr><td>Combined</td><td>59.4</td><td>0.144</td><td>-2.9</td></tr>
</table>
</td><td>Murphy and Lyle (1999)</td></tr>
<tr><td>Maturity</td><td>• Sexual maturity at sizes > 45 cm and ages > 4 years.</td><td>Murphy and Lyle (1999)</td></tr>
<tr><td>Spawning</td><td>• Believed to spawn in late winter.</td><td>Murphy and Lyle (1999)</td></tr>
<tr><td>Early life history</td><td>• Small juveniles settle from the plankton on reefs in large numbers at intervals of several years.</td><td>Edgar (2008)</td></tr>
<tr><td>Recruitment</td><td>• Variable. No-stock recruitment relationship established.</td><td></td></tr>
<tr><td>Gillnet post release survival</td><td>• High: 95 – 83% depending on gillnet soak duration.</td><td>Lyle et al. (2014a)</td></tr>
</table>

Background

Bastard Trumpeter was one of the first fish species to have been commercially exploited in Tasmania. Their apparent abundance around reefs close to newly established Hobart meant that they were an important source of seafood for the fledgling colony. Their exploitation was further aided by the relative ease at which they could be caught using gillnets set within accessible shallow inshore reefs. Recent commercial catches of Bastard Trumpeter are taken almost exclusively by gillnet. Recreational fishers have also long been targeting Bastard Trumpeter as an important fish.

Bastard Trumpeter reside on inshore reefs until about 4–5 years of age (approximately 50 cm long) before moving offshore into deeper water as they approach maturity and apparently remaining in that habitat for the remainder of their lives (Harries and Lake 1985, Murphy and Lyle 1999). Both commercial and recreational fisheries are based almost entirely on inshore juvenile fish.

FISHING METHODS	Gillnet
MANAGEMENT METHODS	**Input control:** • Gear licence (scalefish fishing licence, rock lobster licence) **Output control:** • Possession limit of 10 and bag limit of 5 individuals for recreational fishers • Trip limit of 200 kg for commercial scalefish licence holders • Trip limit of 30 fish for commercial rock lobster licence holders • Legal minimum length (380 mm TL)
MAIN MARKET	Local

Current assessment

Catch, effort and CPUE

Bastard Trumpeter catches have been declining steadily since the mid-1990s, have been <10 t since 2010/11 and another record low of 2.8 t was landed in 2018/19 (Fig. 7.1A). Bastard Trumpeter are taken almost exclusively by gillnet from inshore waters off the east, south and west coasts (Fig. 7.2). Catches and effort in 2018/19 were concentrated primarily around the southeast and southwest coasts (Fig. 7.2). Bastard Trumpeter have been predominantly taken by recreational fishers in recent years, although the latest estimated catches in 2012/13 and 2017/18 were also historic lows (9.8 t and 3.4 t, respectively) (Lyle et al. 2014b, 2019).

Commercial gillnet effort has followed a downward trend similar to catches since the mid-1990s (Fig. 7.1B). Daily catch rates have remained relatively stable since 2006/07. However, they are starting to show a declining trend over the most recent years with a record low in the current season (Fig. 7.1C). Bastard Trumpeter are taken primarily as by-product rather than as a target species. The majority of gillnet effort is now targeting Banded Morwong with 140 mm mesh sizes, selecting only the largest Bastard Trumpeter. Previously, a larger proportion of fishers used smaller mesh sizes (<114 mm) to target Bastard Trumpeter and Blue Warehou.

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian scalefish fishery, gillnetting was considered a medium risk activity with regard to Bastard Trumpeter due to: (1) the high assumed uncertainty about the status of populations, (2) the potential for growth overfishing given that the fishery is targeting juveniles, and (3) the possibility that current fishing pressure is too high for stocks to rebuild from historically more intense exploitation (Bell et al. 2016). There is no new information to suggest that this situation has changed.

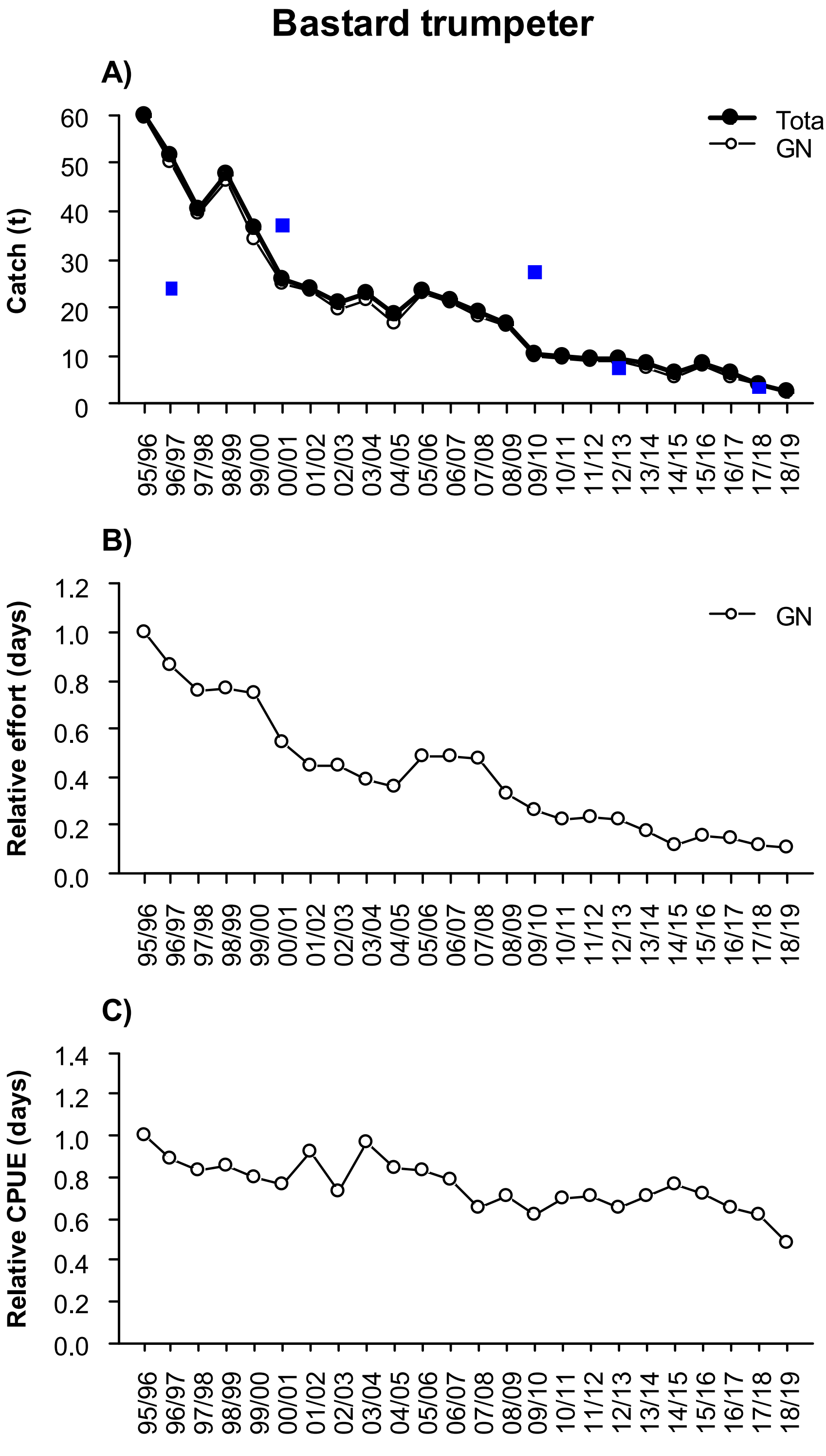
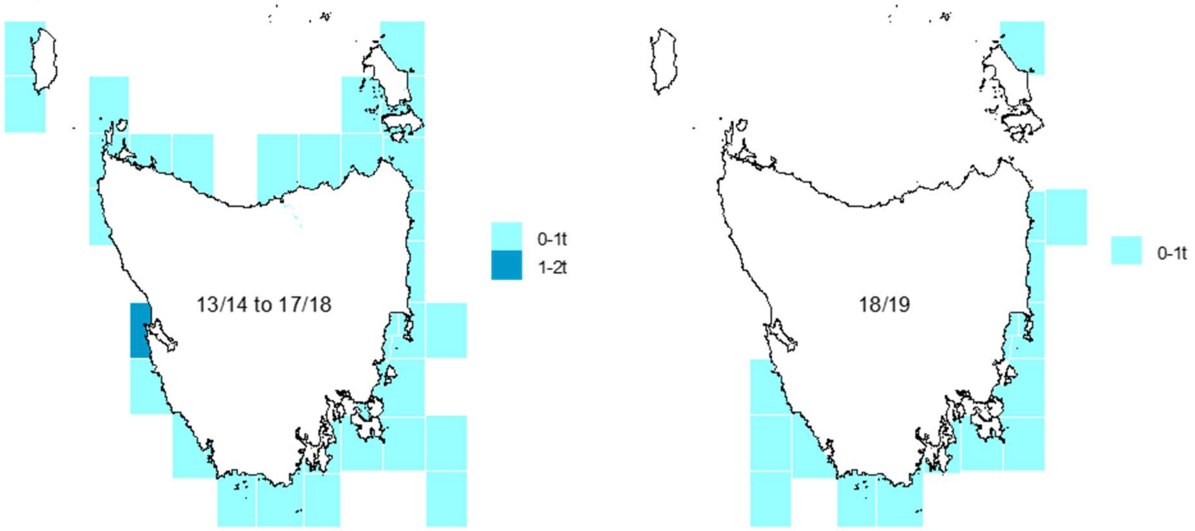


Figure 7.1 A) Annual commercial catch (t) by gear and best estimates of recreational catches (blue squares). B) Commercial effort by method (almost exclusively gillnet) based on days fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. GN=gillnet. Data includes Australian Fisheries Management Authority (AFMA) catch in State waters.

A) Catch



B) Effort

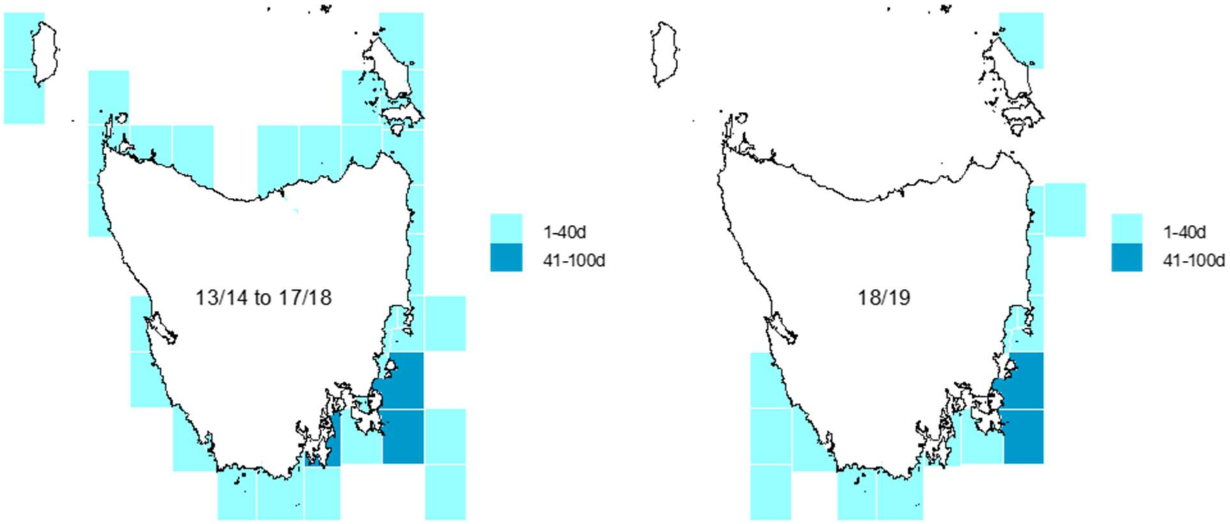


Figure 7.2 (A) Bastard Trumpeter catches (tonnes) and (B) effort (days) for gillnet fishing by fishing blocks averaged over the last five seasons (left) and during the current season (right). Data includes Australian Fisheries Management Authority (AFMA) catch taken in State waters.

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (47.7 t)	No	
	• Catch < 3rd lowest catch value from the reference period (21.3 t)	Yes	↓ 18.6 t (87.3%)
	• Catch variation from the previous year above the greatest inter-annual increase from the reference period (7 t)	No	
	• Catch variation from the previous year above the greatest inter-annual decrease from the reference period (-11.3 t)	No	
	• Latest recreational catch estimate > recreational catch estimate from the reference period (24 t)	No	
	• Proportion of recreational catch to total catch > previous proportion estimate (73.6% in 2010)	No	
Biomass	• CPUE< 3rd lowest CPUE value from the reference period (0.0108 t/days fished)	Yes	↓ 0.0041 t/day fished (-38%)
	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0011)	Yes	Same (-0.0011 t/days)

Stock status	DEPLETED

Due to a historic low in catches in 2018/19, the lowest catch and catch rate reference points were breached. As Bastard Trumpeter is a by-product species, catch is a presumably better indicator of abundance than catch rate. Consequently, the trend in commercial production suggests that inshore population abundance is at historically low levels. In accordance with this observation, industry and recreational representatives have expressed concerns about the scarcity of the species in recent years (Emery et al. 2017), although a lack of market demand for Bastard Trumpeter appears to be an additional factor influencing landings. On-board observations suggest that legal-sized Bastard Trumpeter are sometimes discarded by Banded Morwong fishers, but research suggests that post-release survivability is high (Lyle et al. 2014b). Given that the majority of gillnet effort is now targeted at Banded Morwong, thus using larger mesh sizes than those used historically to target Bastard Trumpeter, it is possible that trends in neither catch nor catch rates are representative of population status. However, fishing practices have remained fairly consistent in recent years (2007/08 – present), which is why steadily declining catches and recently declining catch rates are likely to represent a population that has not substantially rebuilt despite significant reduction in both commercial and recreational gillnet effort.

The Tasmanian Bastard Trumpeter fishery is based almost entirely on juveniles. As fish grow, they appear to move offshore and are rarely caught. No information is available on the adult portion of the population, but it is clear that fishing pressure exerted on those individuals that evade the inshore fishery is very low (by-catch in shark nets, trawl, Danish seine or deep-water fish traps used by the Commonwealth SESSF appears to be negligible). The species exhibits high recruitment variability, resulting in short-term variation in catches, which has been a feature of this fishery over the past century (Harries and Croome 1989). Anecdotal reports and low inshore catches suggest that recruitment has been low in recent years together with limited length frequency data available for 2011 and 2012 indicate a reduction in the number of smaller-sized individuals in the fishery relative to the late 1990s (Emery et al. 2016). Studies have demonstrated significantly higher abundances of Bastard Trumpeter in unfished marine reserves relative to fished sites around Tasmania (Edgar and Barrett 1999), which in combination with the fact that commercial and recreational fisheries are based entirely on juveniles, suggests that recruitment as well as growth overfishing may be occurring.

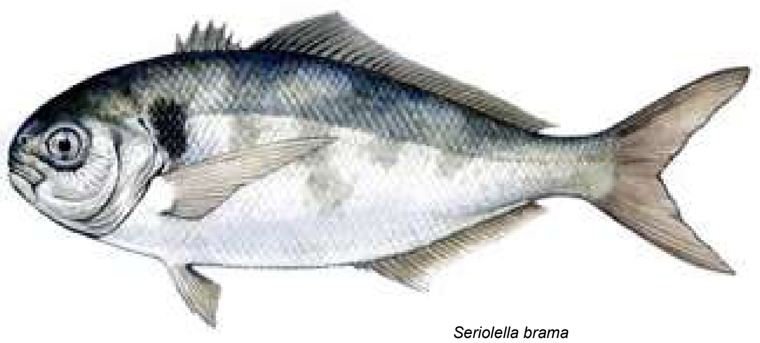
It is worth noting that the temporary stabilisation of catch from 2009/10 corresponds to the introduction of several management measures for the species (increase in the minimum legal size, introduction of commercial trip limits and reduction in recreational bag and possession limits). However, the current minimum size limit of 38 cm TL is still well below the size at maturity (>45 cm FL, Murphy and Lyle 1999). While there have been discussions about an increase of the minimum size limit to recover stocks, this management intervention is opposed because it would effectively close the current commercial and recreational fisheries for the species. Further reductions in the recreational bag limit for this species were introduced in 2015.

Given the continued reduction in catches, the rating of medium risk from gillnetting in the ERA, and the current minimum legal size limit below the size of maturity, Bastard Trumpeter are classified as depleted.

8. Blue Warehou

Seriolella brama

STOCK STATUS	**DEPLETED**
This is a predominately Commonwealth-managed species that is classified as overfished in the ABARES Fishery Status Reports 2019. It is classified as depleted in the 2018 Status of Australian Fish Stocks Report. This species is sporadically abundant in Tasmanian waters. Despite a reduction in Total Allowable Catch (TAC) for the Commonwealth fishery to 118 t and the initiation of a stock rebuilding strategy in 2008, there is no evidence of stock recovery.	
IMPORTANCE	Key
STOCK(S)	Tasmanian Scalefish Fishery/Southern and Eastern Scalefish and Shark Fishery (Commonwealth)
INDICATOR(S)	Catch, effort and CPUE trends



Seriolella brama
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Inshore reefs/harbours and open water down to 400 m depth.	Edgar (2008) Smith (1994)
Distribution	• New South Wales to South Australia, Tasmania, New Zealand.	Edgar (2008) Gomon et al.(2008)
Diet	• Invertebrates (mainly salps), krill, crabs, squids.	Gavrilov and Markina (1979) Annala (1994) Bulman et al. (2001)
Movement and stock structure	• Schooling fish, highly mobile. • Small juveniles pelagic, commonly in association with jellyfish in open coastal waters. Sub-adults often found in sheltered waters of large marine embayments. • Although genetics has not confirmed separate stocks, there are indications of population structuring. It is likely that two stocks occur in southern Australian waters (east and west of Bass Strait).	Gavrilov and Markina (1979) AFMA (2008, 2011) Bruce et al. (2001a) Robinson et al. (2008)

<table>
<tr><td>Natural mortality</td><td>• Estimated between *M*=0.30 and *M*=0.45.</td><td>Knuckey and Sivakumaran (2001)</td></tr>
<tr><td>Maximum age</td><td>• Up to 15 years.</td><td>AFMA (2012)</td></tr>
<tr><td>Growth</td><td>• Maximum length: 90 cm
• Maximum weight: 4 kg
• Growth (in New Zealand) described by von Bertalanffy growth function $L = L_\infty\left(1 - e^{-k(t-t_0)}\right)$ where *L* is the length (cm), *t* is the age (years), L_∞ is the average maximum length for the species, *k* is a constant and t_0 is the (theoretical) age where length equals zero.
Parameter estimates are:
<table>
<tr><th>Sex</th><th>L_∞</th><th>k</th><th>$t_{0\infty}$</th></tr>
<tr><td>Combined</td><td>54.65</td><td>0.37</td><td>-0.67</td></tr>
</table>
• Length-weight relationship was estimated at $W = 0.03L^{2.9}$ for females and males combined, where *W* is weight (g) and *L* is the total length (cm).</td><td>Gomon et al. (2008)
Frimodt (1995)
BWAG (1998)</td></tr>
<tr><td>Maturity</td><td>• Size-at-50% maturity estimated at 36 cm (3.67 years) for females.
• Batch fecundity (BF):
$ln(BF) = 2.614ln(L) + 2.366$, where *L* is length in cm.</td><td>Knuckey and Sivakumaran (2001)</td></tr>
<tr><td>Spawning</td><td>• Peak spawning in winter, with major regional differences in the magnitude and timing of spawning.
• Major spawning ground on the central west and northwest coasts in Tasmania.</td><td>Bruce et al. (2001a)</td></tr>
<tr><td>Early life history</td><td>• Larvae restricted to shelf and slope waters.
• Larvae likely to be transported by Zeehan Current from spawning grounds of western Tasmania to southeastern Tasmania nursery areas.
• Larvae settle to the bottom at length > 14.5 mm BL.</td><td>Bruce et al. (2001a)
Neira et al. (1998)</td></tr>
<tr><td>Recruitment</td><td>• Variable. No-stock recruitment relationship established.</td><td></td></tr>
<tr><td>Gillnet post release survival</td><td>• Low: 35%, but small legal minimum length so rarely discarded.</td><td></td></tr>
</table>

Background

Blue Warehou occur seasonally in Tasmanian inshore waters, the region representing the southern-most extent of its distribution. The availability of this species in coastal waters is assumed to be influenced by prevailing oceanographic conditions and the availability of prey species, in particular salps. Both these factors appear to result in marked inter-annual variability in abundance and, hence, catch taken from State waters.

Blue Warehou is a Commonwealth-managed species with a Memorandum of Understanding (MoU) existing to ensure that harvest in state waters are managed within historical levels. Although the species is assessed at the Commonwealth level, catches from Tasmania and other states are included in stock assessment modelling.

FISHING METHODS	Mainly gillnets, also small mesh nets, seine nets, and hook and line (recreational).
MANAGEMENT METHODS	**Input control:** • Gear licence (scalefish fishing licence, rock lobster fishing licence, small mesh gillnet licence, class seine licences) **Output control:** • Possession limit of 20 and bag limit of 10 individuals for recreational fishers • Minimum size (250 mm TL)
MAIN MARKET	Local and interstate

Current assessment

Catch, effort and CPUE

In Tasmania, Blue Warehou is taken primarily by gillnetting (Fig. 8.1A). A variety of methods is used by Commonwealth fisheries, including other gillnet categories (e.g. shark gillnets), Danish seine and trawl.

Due to the low availability of Blue Warehou since the early 2000s, the species has been rarely targeted. Catch had increased from a historic low of 2.8 t in 2014/15 to 12.6 t in 2017/18 prior to declining to a new historic low of 1.8 t in 2018/19. Peak Tasmanian landings were 317.6 t in 1991/92, which corresponded with the peak of Australia-wide landings of almost 3,000 t (AFMA 2012). Commonwealth commercial catches have also been down in recent years with only 25 t or less harvested in the 2017/18 and preceding fishing season, and 54 t harvested in 2018/19 (Patterson et al. 2019). Two stocks of Blue Warehou are believed to occur in southern Australian waters: the east and the west Bass Strait stocks (Bruce et al. 2001b), which has led to the species being managed by AFMA as two stocks. The Tasmanian fishery is now mainly centred off the southeast coast (Fig. 8.2), and thus probably concentrated on the eastern stock. Historically, catches have also been taken off the north and northwest coasts which are presumably harvested from the western stock.

Blue Warehou are also targeted by recreational fishers using gillnets, and to a lesser extent line fishing. Historically, recreational catches have been lower than commercial catches (Fig. 8.1A), although in 2010 catch estimates were similar for both sectors (32.5 t for recreational and 37.5 t for commercial). Firstly in 2012/13, the recreational catch of 15.4 t (Lyle et al. 2014a) was almost double the commercial catch of 8.5 t in that year. However, in 2017/18, a recreational catch of only 0.8 t was estimated, which is substantially less than the commercial catch in that year (12.6 t) and less than half of the commercial catch in the current season.

Following an increase in commercial gillnet effort and catch rates between 1995/96 and 1998/99 that resulted in an increase in landings, effort has fallen to substantially lower levels and has remained low ever since (Fig. 8.1B, C). This situation is influenced by the limited availability of Blue Warehou in Tasmanian waters. After an initial increase and subsequent drop, catch rates have stabilized since 2000/01 showing notable fluctuations around the reference value.

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian scalefish fishery, gillnetting was considered a high risk activity with regard to Blue Warehou, given the depletion status of this species as a consequence of historical overfishing (Bell et al. 2016). There is no new information to suggest that this situation has changed. Post-release survival of any by-catch of this species is very low (Lyle et al. 2014b).

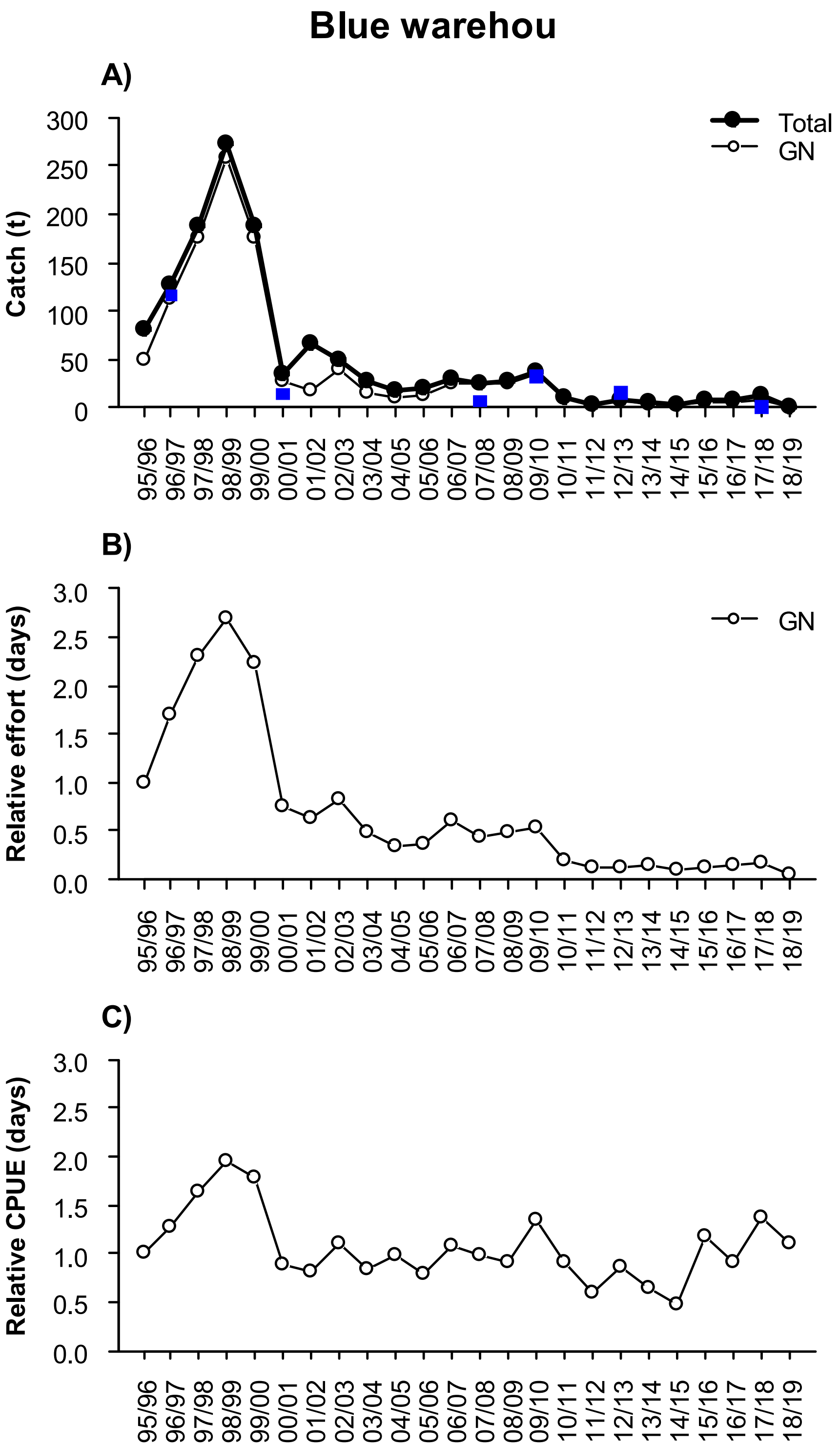


Figure 8.1 A) Annual commercial catch (t) by gear and best estimates of recreational catches (blue squares). B) Commercial effort by method based on day fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. GN=gillnet.

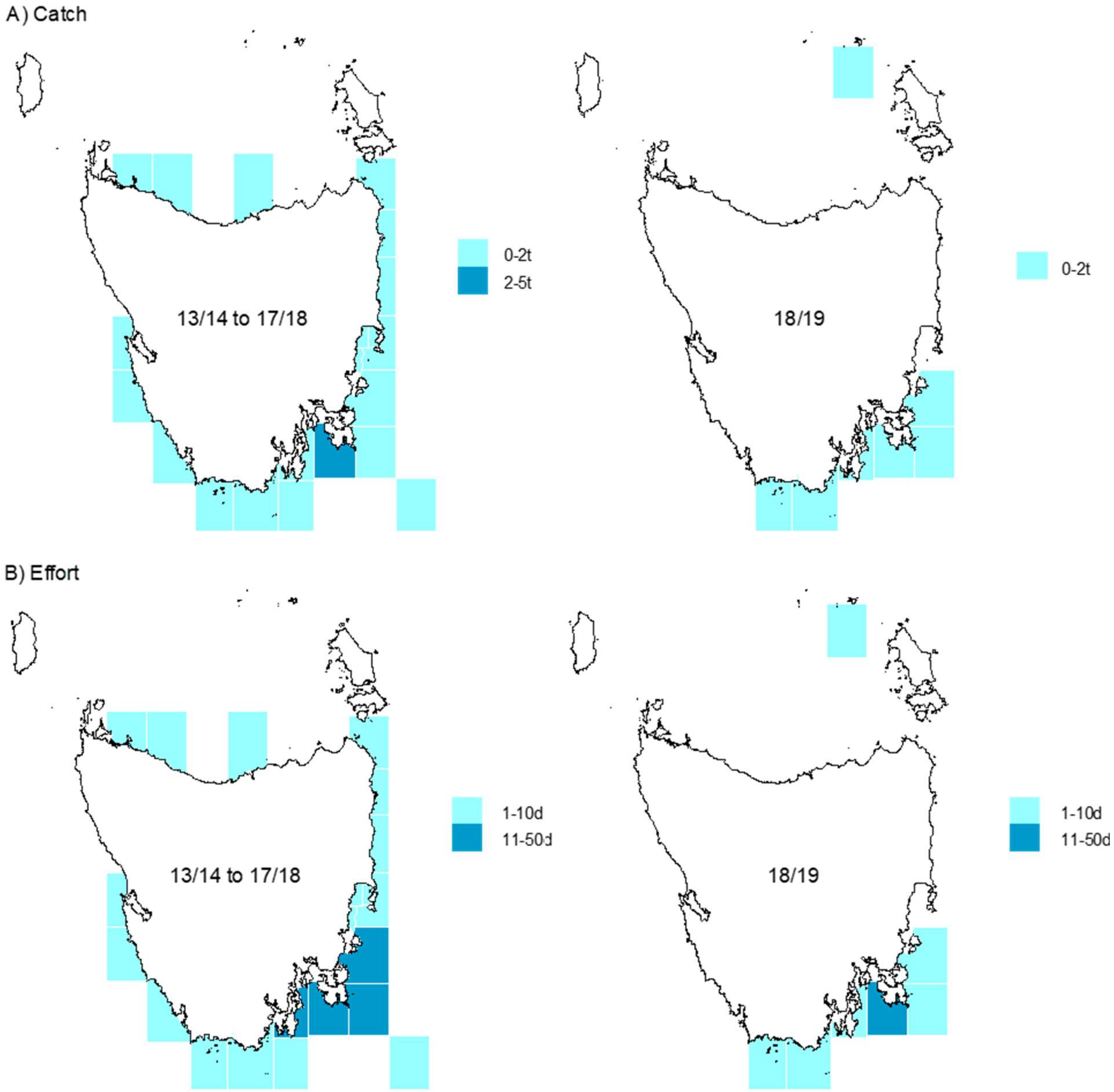


Figure 8.2 (A) Blue Warehou catches (t) and (B) effort (days) for gillnet fishing by fishing blocks averaged over the last five years (left) preceding the current year of assessment (right).

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Commercial catch limit of 318 t as per Memorandum of Understanding (MoU)	No	
	• Catch > 3rd highest catch value from the reference period (187 t)	No	
	• Catch < 3rd lowest catch value from the reference period (27.6 t)	Yes	↓ 25.8 t (93.4%)
	• Catch variation from the previous year above the greatest inter-annual increase from the reference period (84.7 t)	No	
	• Catch variation from the previous year above the greatest inter-annual decrease from the reference period (152.8 t)	No	
	• Latest recreational catch estimate > recreational catch estimate from the reference period (65.3 t)	No	
	• Proportion of recreational catch to total catch > previous proportion estimate (63.6%, in 2012/13)	No	
Biomass	• CPUE < 3rd lowest CPUE value from the reference period (0.0229 t/days fished)	No	
	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0126)	No	

Stock status

DEPLETED

The decreasing catch of Blue Warehou over the last 20 years is almost certainly linked to reduced biomass. This situation is predominantly a result of overfishing by Commonwealth and State fisheries during the 1990s when catches exceeded >2,500 t in several years and consistently reached >1000 t annually between 1987 and 1998 (AFMA 2012). These figures include state landings, of which Tasmanian catches accounted for about 10% of the total throughout much of this period (AFMA (2012); Appendix 3). In recent years, catches of Blue Warehou have declined substantially and it is now possible, as it was in the 2017/18 season, that the Tasmanian recreational catch exceeds the commercial catch. While the reduced Commonwealth and Tasmanian catches should benefit stock recovery, a lack of both fishery-dependent and fishery-independent data makes the “true” state of stock(s) difficult to assess.

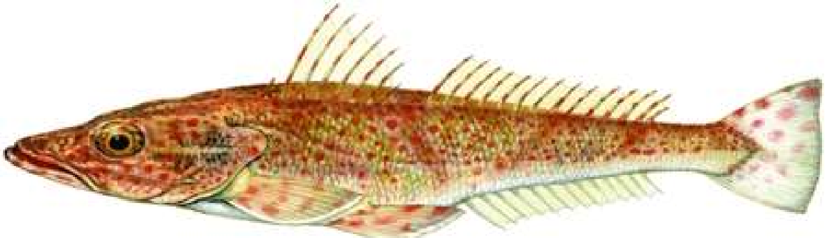
Blue Warehou is under a Commonwealth stock rebuilding strategy (first introduced in 2008 and later reviewed in 2014), which aims in the first instance to rebuild both east and west coast stocks to or above the default limit reference biomass point (B_{LIM}) of 20 per cent of the unfished spawning biomass by 2024 (AFMA 2014). Consequently, the Commonwealth Total Allowable Catch (TAC) for Blue Warehou has been progressively reduced since 2003, and it was further reduced to 118 t (split 27 t in the east and 91 t in the west) in 2012/13 (AFMA 2012). AFMA considers the reduction in recent catches (just 1.9 t in 2015/16, 16 t in 2016/17, 25 t in 2017/18, and 54 t in 2018/19) to be due in part to their active management and education program. Further management measures include SESSF fishery closures and gear restrictions. There was also a voluntary Commonwealth industry closure implemented between 2008 and 2012 in areas of high Blue Warehou abundance, which were believed to be spawning grounds. However, this assumption was challenged following a review in 2013 due to the patchiness and unpredictability of the species in these areas (AFMA 2014). In Tasmania, management measures include bag and possession limits and a minimum size limit. However, if Blue Warehou stocks start to recover, these regulations may be insufficient to prevent excessive catches from commercial and recreational fishers (SFAC 2015).

Despite the Commonwealth and Tasmanian management measures outlined above, there have been few signs of recovery of the species, which is why the ABARES Fishery Status Reports classified Blue Warehou stocks as overfished (for biomass) and uncertain (for fishing mortality (Patterson et al. 2019). Thus, Blue Warehou remains classified as depleted in Tasmanian waters.

9. Tiger Flathead

Platycephalus richardsoni

STOCK STATUS	**SUSTAINABLE**
This is a predominately Commonwealth-managed species that is classified as not overfished nor subject to overfishing in the ABARES Fishery Status Reports 2019. It is classified as sustainable in the 2018 Status of Australian Fish Stocks Report. In Tasmania, Tiger Flathead are caught predominately by the commercial sector. Catches fluctuate substantially, but they typically represent a small proportion of Commonwealth trawl landings.	
IMPORTANCE	Key
STOCK(S)	Tasmanian Scalefish Fishery/ Southern and Eastern Scalefish and Shark Fishery (Commonwealth)
INDICATOR(S)	Catch, effort and CPUE trends



Platycephalus richardsoni
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	Exposed sand and silt habitat. 10–400 m depth.	Edgar (2008) Tilzey et al. (1990)
Distribution	Victoria to New South Wales and around Tasmania.	Edgar (2008) Gomon et al.(2008)
Diet	Fish.	Coleman and Mobley (1984)
Movement and stock structure	Young inhabit shallow waters of the continental shelf and move into the outer shelf zone as they reach maturity.	Kailola et al. (1993) Jordan (1998)
Natural mortality	*M* between 0.21 and 0.46.	Klaer (2010)
Maximum age	12 years	Rowling (1994) Bani (2005)
Growth	Maximum length: 650 mm (FL) Maximum weight: 2.9 kg Growth (in NSW) described by von Bertalanffy growth function $L = L_{\infty}\left(1 - e^{-k(t-t_0)}\right)$	Edgar (2008) Gomon et al. (2008) Barnes et al. (2011)

<table>
<tr><td></td><td>where <i>L</i> is the length (mm), <i>t</i> is the age (years), L_∞ is the average maximum length for the species, <i>k</i> is a constant and t_0 is the (theoretical) age where length equals zero.
Parameter estimates are:
<table>
<tr><th><i>Sex</i></th><th>L_∞</th><th><i>k</i></th><th>$t_{0\infty}$</th></tr>
<tr><td>Females</td><td>750.2</td><td>0.13</td><td>-1.0</td></tr>
<tr><td>Males</td><td>418.9</td><td>0.26</td><td>-1.0</td></tr>
</table>
Length-weight relationship was estimated at $W = 3.25 \text{ x } 10^{-6} \, L^{3.13}$ for females and males combined where <i>W</i> is weight (g) and <i>L</i> is the total length (mm).</td><td></td></tr>
<tr><td>Maturity</td><td>Reach sexual maturity at 4-5 years and total length of 30 cm for males and 36 cm for females.</td><td>Fairbridge (1951)</td></tr>
<tr><td>Spawning</td><td>December to February.</td><td>Kailola et al. (1993)
Jordan (2001a)</td></tr>
<tr><td>Early life history</td><td>Unknown.</td><td>Jordan (2001a)</td></tr>
<tr><td>Recruitment</td><td>No-stock recruitment relationship established.</td><td></td></tr>
<tr><td>Gillnet post release survival</td><td>Moderate: 50% (all soak durations and including both graball and mullet nets).</td><td>Lyle et al. (2014b)</td></tr>
<tr><td>Rod and-line post release survival</td><td>High: >99% for circle hooks and 94–97% for conventional hooks.</td><td>Lyle et al. (2007)</td></tr>
</table>

Background

Several flathead species occur in Tasmanian waters with Tiger Flathead being the most dominant in commercial catches taken by Danish seine. Since Sand Flathead and Tiger Flathead were not routinely distinguished in commercial catch returns until 2007; species-specific catches prior to 2007 have been inferred using the species proportions, by method, for catches taken between 2007/08 and 2011/12. Species-specific fishing effort and catch rates are therefore considered reliable only since 2007/08.

Tiger Flathead constitute a minor component of the recreational harvest of flathead (5 -10%, Lyle et al. 2014a, 2019).

FISHING METHODS	Danish seine.
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence, Danish seine licence) **Output control:** • Possession limit of 30 and bag limit of 20 individuals (Sand and Tiger Flathead) for recreational fishers • Minimum size (320 mm TL)
MAIN MARKET	Mostly local

Current assessment

Catch, effort and CPUE

The 2018/19 total commercial catch of Tiger Flathead was 16.8 t, down further from recent peaks of >60 t in 2015/16 and 2016/17. As the commercial fishery for Flathead has not undergone major changes in its operations since 1995/96 it was feasible to back-calculate catches prior to 2007 (Fig. 9.1). Tiger Flathead landings have been variable over time, fluctuating between 20 and 80 t per annum without an obvious trend (Fig. 9.1 and 9.2).

Danish seine fishing effort and catch rates in 2018/19 declined relative to the previous two years. Given historically substantial fluctuation, it is possible that these variations reflect the degree of targeting of the species (Fig. 9.2). Peaks in Danish seine catches, effort and CPUE are influenced by a small number of operators that have primarily targeted Tiger Flathead during those years. All catches in recent years were derived from the southeast and east coasts (Fig. 9.3).

Recreational flathead catches were estimated at 361 t in 2000/01 (Lyle 2005), 292 t in 2007/08 (Lyle et al. 2009) and 235.9 t in 2012/13 (Lyle et al. 2014a). Tiger Flathead constitute a minor component of the total recreational flathead harvest (around 10% with Sand Flathead constituting the remainder). In 2017/18, the recreational fishing survey first considered the two flathead species separately. The recreational catch of Tiger Flathead was estimated at 15.4 t, which was about 8% of the recreational catch estimate for Sand Flathead (184.3 t) (Lyle et al. 2019).

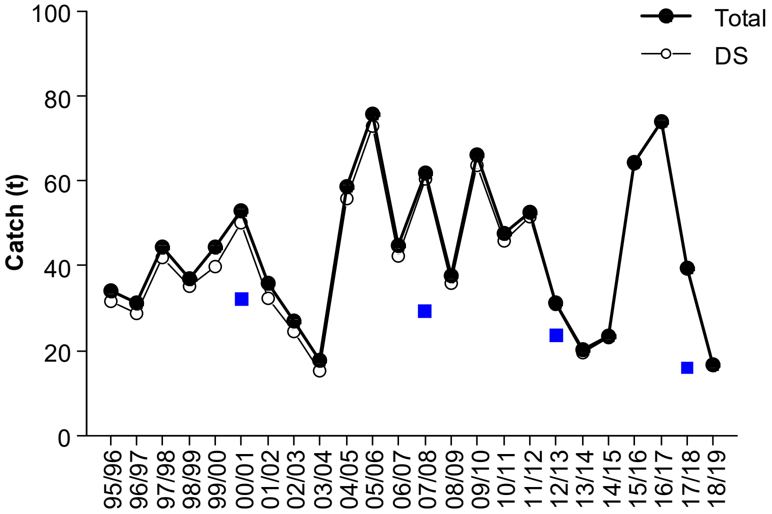


Figure 9.1 Back-calculated annual commercial catch (t) by gear for Tiger Flathead. Blue squares represent estimates of recreational catches from independent surveys. DS=Danish seine.

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian scalefish fishery, Danish seining was considered a low risk activity with regard to Tiger Flathead and very low risk to by-product species, such as sharks and mixed fish. Risks to the general ecosystem varied from very low, in terms of discarded fish attracting wildlife, to medium, for possible changes to the seafloor from the net dragging (Bell et al. 2016).

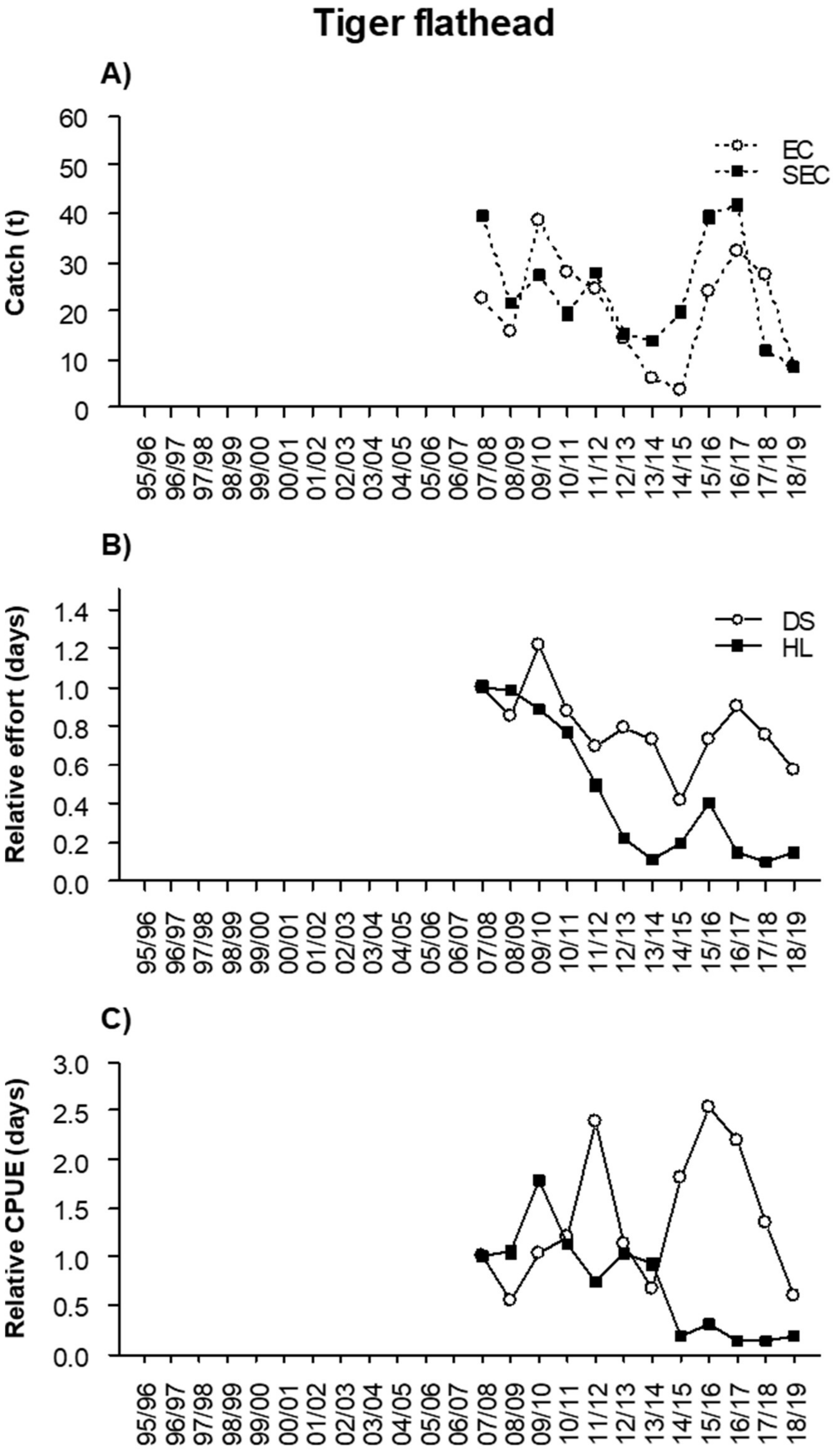
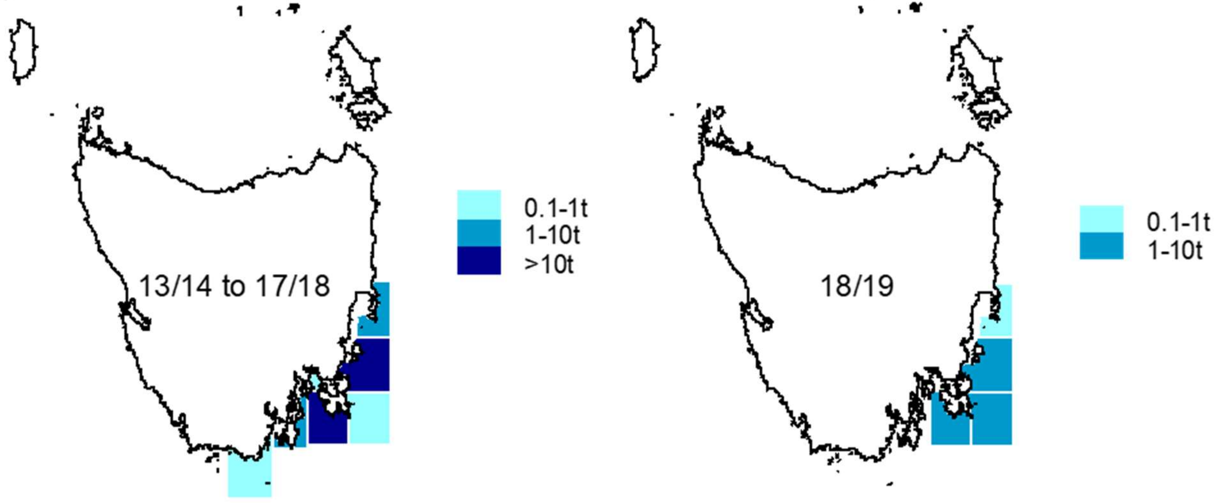


Figure 9.2 A) Tiger Flathead annual commercial catch (t) by region. B) Tiger Flathead commercial effort by method based on days fished relative to 2007/08. C) Tiger Flathead commercial catch per unit effort (CPUE) based on weight per day fished (right) relative to 2007/08. SEC = South-East Coast, EC = East Coast. DS=Danish Seine, HL=Handline.

A) Catch



B) Effort

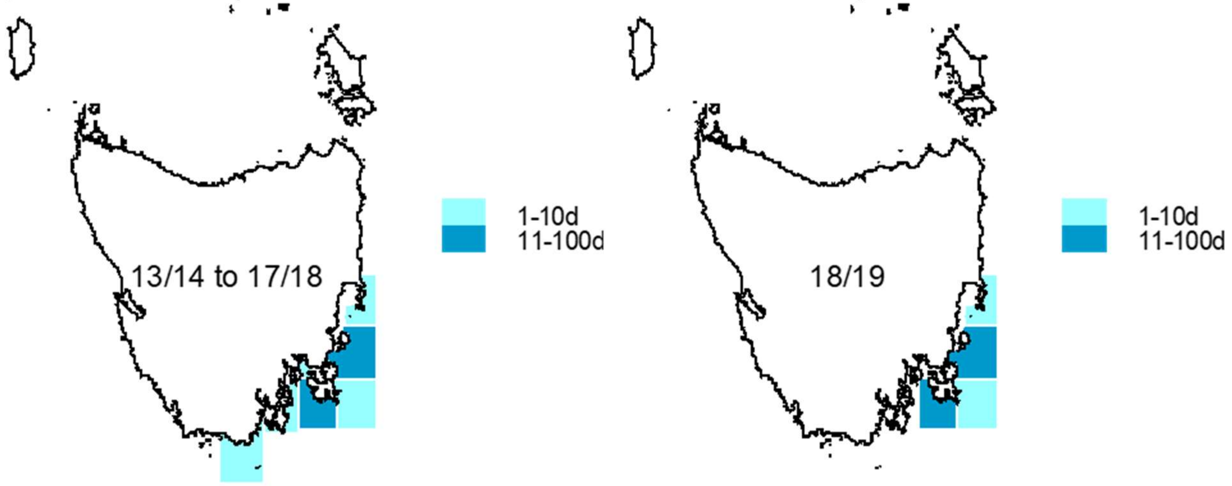


Figure 9.3 (A) Tiger Flathead catches (t) and (B) effort (days) by fishing blocks averaged over the preceding five years (left) and in the current assessment year (right).

Reference points for Flathead (combined).

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (63.1 t)	No	
	• Catch < 3rd lowest catch value from the reference period (50.5 t)	Yes	↓ 28.6 t (56.7%)
	• Catch variation from the previous year above the greatest inter-annual increase from the reference period (43.5 t)	No	
	• Catch variation from the previous year above the greatest inter-annual decrease from the reference period (-31.9 t)	No	
	• Latest recreational catch estimate > recreational catch estimate from the reference period (361 t)	No	
	• Proportion of recreational catch to total catch > previous proportion estimate (85.5% in 2012/13)	No	
Biomass	• CPUE< 3rd lowest CPUE value from the reference period (0.013 t/days fished)	Yes	↓ 0.0039 t/day fished (-29.9%)
	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0020)	Yes	↓ 0.0012 t/day fished (-60.2%)

Stock status	**SUSTAINABLE**

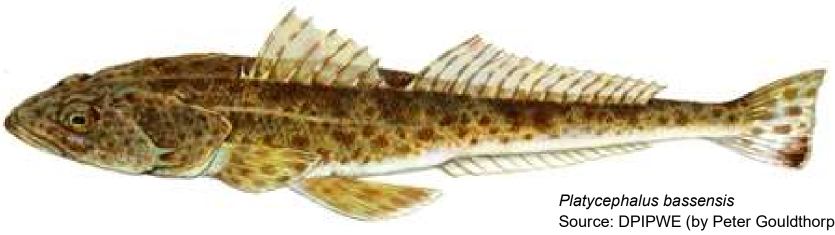
Danish seine catches are highly variable and have historically tended to be inversely related with catches of School Whiting (refer Fig. 2.1), which are targeted using the same fishing method. Thus, a decrease in catches of Tiger Flathead in 2018/19 was associated with an increase in catches of Eastern School Whiting (from 19 t in 2017/2018 to 42 t in 2018/19). Total commercial catches of Tiger Flathead have been maintained at comparable levels in the past with the most significant landings taken from Commonwealth waters by the South East Trawl (Patterson et al. 2019). In 2018/19, the total Commonwealth catch of flathead (almost exclusively Tiger Flathead) was 2,035 t, slightly down from 2,434 t in 2017/18 and 2,873 t in 2016/17 (Patterson et al. 2019). Tasmanian catches represent only a small fraction of these more significant catches, which have been classified as sustainable (Flood et al. 2014, Patterson et al. 2019). In accordance with this assessment, Tiger Flathead in Tasmanian waters is therefore classified as sustainable.

While Tiger Flathead constitute a minor component of the recreational flathead catch, various management changes were introduced in 2015 to improve the sustainability of flatheads in State waters, including an increase in the minimum size limit from 300 mm to 320 mm, and the introduction of both a daily bag limit of 20 per fisher and a possession limit of 30 per fisher.

10. Southern Sand Flathead

Platycephalus bassensis

STOCK STATUS	**DEPLETING**
Recreational catches dominate landings of Sand Flathead in Tasmania. Fishery independent surveys suggest relatively low abundances of legal sized fish, particularly in south-eastern Tasmania where populations are subject to heavy fishing pressure. While a recent increase in minimum size limit and reduction in bag limit seems to reduce catch, current levels of fishing pressure are likely to cause the stock to become recruitment impaired.	
IMPORTANCE	Key
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends



Platycephalus bassensis
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	Sheltered sand and silt habitat down to 100 m depth	Edgar (2008) Tilzey et al. (1990)
Distribution	From Western Australia to New South Wales and around Tasmania	Edgar (2008) Gomon et al. (2008)
Diet	Fish and crustaceans	Ayling et al. (1975)
Movement and stock structure	Seasonal movements between inshore and offshore in east and southeast Tasmania	Kailola et al. (1993) Jordan 1998
Natural mortality	*M* likely to range between values of 0.16 and 0.25 per year in south-eastern Tasmania, with a possible range between 0.28 and 0.59 per year elsewhere.	Ewing & Lyle (2019) Bani (2005)
Maximum age	20 years	Bani (2005)
Growth	• Maximum length: 51.5 cm • Maximum weight: 3.1 kg • Growth described by von Bertalanffy growth function $L = L_\infty\left(1 - e^{-k(t-t_0)}\right)$ where *L* is the length (cm), *t* is the age (years), L_∞ is the average maximum length for the species, *k* is a constant and t_0 is the (theoretical) age where length equals zero.	Edgar (2008) Gomon et al. (2008) Bani (2005) Gomon et al. (2008) Ewing & Lyle (2019)

<table>
<tr><td></td><td>Growth appears to vary by both location and year. Parameter estimates for the survey region are:
<table>
<tr><th>Sex</th><th>k</th><th>L_∞</th><th>$t_{0\infty}$</th><th>Year</th></tr>
<tr><td>Females</td><td>0.51</td><td>36</td><td>0.0</td><td>2019</td></tr>
<tr><td>Males</td><td>0.60</td><td>30</td><td>0.0</td><td>2019</td></tr>
</table></td><td></td></tr>
<tr><td>Maturity</td><td>• Size-at-50% maturity estimated at 21.7 cm for males, and between 24.7 and 26.3 cm for females depending on location
• Age at 50% maturity variable: 2.5–3.5 years for males and 2.6–5.2 years for females depending on location</td><td>Bani and Moltschaniwsky (2008)</td></tr>
<tr><td>Spawning</td><td>• From October to March, with a peak from October-December. Spawning occurs throughout their range in southern and eastern Tasmania, including on the shelf</td><td>Kailola et al. (1993)
Jordan (2001a)</td></tr>
<tr><td>Early life history</td><td>• Settlement occurs over an extended period, between 4 to 14 months after spawning
• Size at settlement around 2.1 cm</td><td>Jordan (2001a)</td></tr>
<tr><td>Recruitment</td><td>• No-stock recruitment relationship established</td><td></td></tr>
<tr><td>Gillnet post release survival</td><td>• Moderate: 50% (all soak durations and including both graball and mullet nets)</td><td>Lyle et al. (2014b)</td></tr>
<tr><td>Rod and line post release survival</td><td>• High: >99% for circle hooks and 94–97% for conventional hooks</td><td>Lyle et al. (2007)</td></tr>
</table>

Background

Sand Flathead are caught commercially mainly by handlining, but are also taken as a by-product in gillnets and Danish seines. Since Sand Flathead and Tiger Flathead were not routinely distinguished in commercial catch returns until 2007 species-specific catches prior to 2007 have been inferred using species proportions by method for catches taken between 2007/08 and 2011/12. Thus, species-specific effort and catch rates are considered reliable only since 2007/08.

Sand Flathead are targeted recreationally by handline (including rod and line) and constitute around 90% of the total flathead recreational harvest in Tasmania.

FISHING METHODS	Handline, rod and line, and gillnet
MANAGEMENT METHODS	**Input control:** • Gear licence (scalefish fishing licence and Danish seine licence) **Output control:** • Possession limit of 30 and bag limit of 20 individuals (Sand and Tiger Flathead) for recreational fishers • Minimum size (320 mm TL)
MAIN MARKET	Mostly local

Current assessment

Biological characteristics

Concerns surrounding the abundance of Sand Flathead led to the establishment of an annual fishery-independent survey, which has been conducted since 2012 (Ewing and Lyle 2019). The survey uses fishing gear and targeting practices typical of recreational fishers in areas of significant effort, including the D'Entrecasteaux Channel, Norfolk Bay and Frederick Henry Bay, and Great Oyster Bay, with sampling occurring during February and March. Fishing was generally conducted over three (not necessarily consecutive) days per region with 19-21 standard sites fished in each region. The sampling sites represent a range of suitable habitats (including depths) for targeting Sand Flathead, providing wide spatial coverage in each region.

Size composition

Length frequency histograms from the fishery-independent survey indicate that the majority of Sand Flathead in the D'Entrecasteaux Channel and Norfolk Bay and Frederick Henry Bay were below the minimum size limits, which indicate a low abundance of legal sized fish. Conversely, in Great Oyster Bay approximately half of the fish were larger than the legal limit over recent years. These results of the proportion of fish exceeding the new size limit of 320 mm appear to have stabilised from 2017 (Fig. 10.1).

Age composition

Age frequency histograms from the fishery-independent survey indicate that fish younger than five years old represent the dominant age classes of Sand Flathead, especially in the D'Entrecasteaux Channel, Norfolk Bay and Frederick Henry Bay (Fig. 10.2). Older age classes up to 12 years tend to be rare in all regions, but least obviously so in Great Oyster Bay, where large fishes above the legal size limit were most common. It is further evident that the abundance and proportion of females declines notably in the older age classes most likely reflecting an earlier fishery exposure due to the faster growth of females (Ewing and Lyle 2019).

Mortality

Estimates of fishing mortality F from the period prior to the increase in the minimum size limit (2012–2015) and after the expected recovery period in the last two assessment years are presented in Table 10.1 below. In all regions, F seems to be reduced, indicating that fishing mortality has decreased between 25% and 77% (see ratios of $F_{2019} / F_{2012\text{–}15}$ below). However, in absolute terms, the estimated fishing mortality of females remains high with ratios of F_{2019} / M varying between 1.6 and 2.5, thus, notably exceeding the generic estimate of natural mortality in all regions. In comparison, the fishing mortality of smaller males is relatively low (F_{2019} / M = 0.3-0.9).

Table 10.1. Sand Flathead fishing mortality estimates (*F*) by region for the years prior to, and after recovery from, the increase in the MSL. DEC is the D'Entrecasteaux Channel region, FHNB is the Frederick Henry-Norfolk Bay region, and GOB is the Great Oyster Bay region. *Z* is total mortality derived from catch curves, *M* is the mean of two estimates of natural mortality (Hoenig and Lawing 1982 and Ewing and Lyle 2014), *F* is fishing mortality [*Z* – (mean of 2 estimates for *M*)]. Parameters with a 2012–15 subscript represent mortality prior to the increase in the MSL and the 2017/18 subscript represent mortality just after the recovery period. From Ewing and Lyle (2019).

Parameter	DEC		FHNB		GOB	
	Fem	Male	Fem	Male	Fem	Male
M_{Mean}	0.2	0.2	0.2	0.2	0.2	0.2
$Z_{2012–15}$	0.99	0.51	0.74	0.45	0.71	0.32
$Z_{2017/18}$	0.95	0.37	0.69	0.45	0.65	0.22
Z_{2019}	0.7	0.33	0.54	0.38	0.51	0.26
$F_{2012–15}$	0.79	0.24	0.53	0.24	0.46	0.26
$F_{2017/18}$	0.72	0.25	0.52	0.12	0.48	0.05
F_{2019}	0.5	0.13	0.34	0.18	0.31	0.06
F_{2019} / $F_{2012-15}$	0.63	0.54	0.64	0.75	0.67	0.23
F_{2019} / M_{Mean}	2.5	0.65	1.7	0.9	1.55	0.3

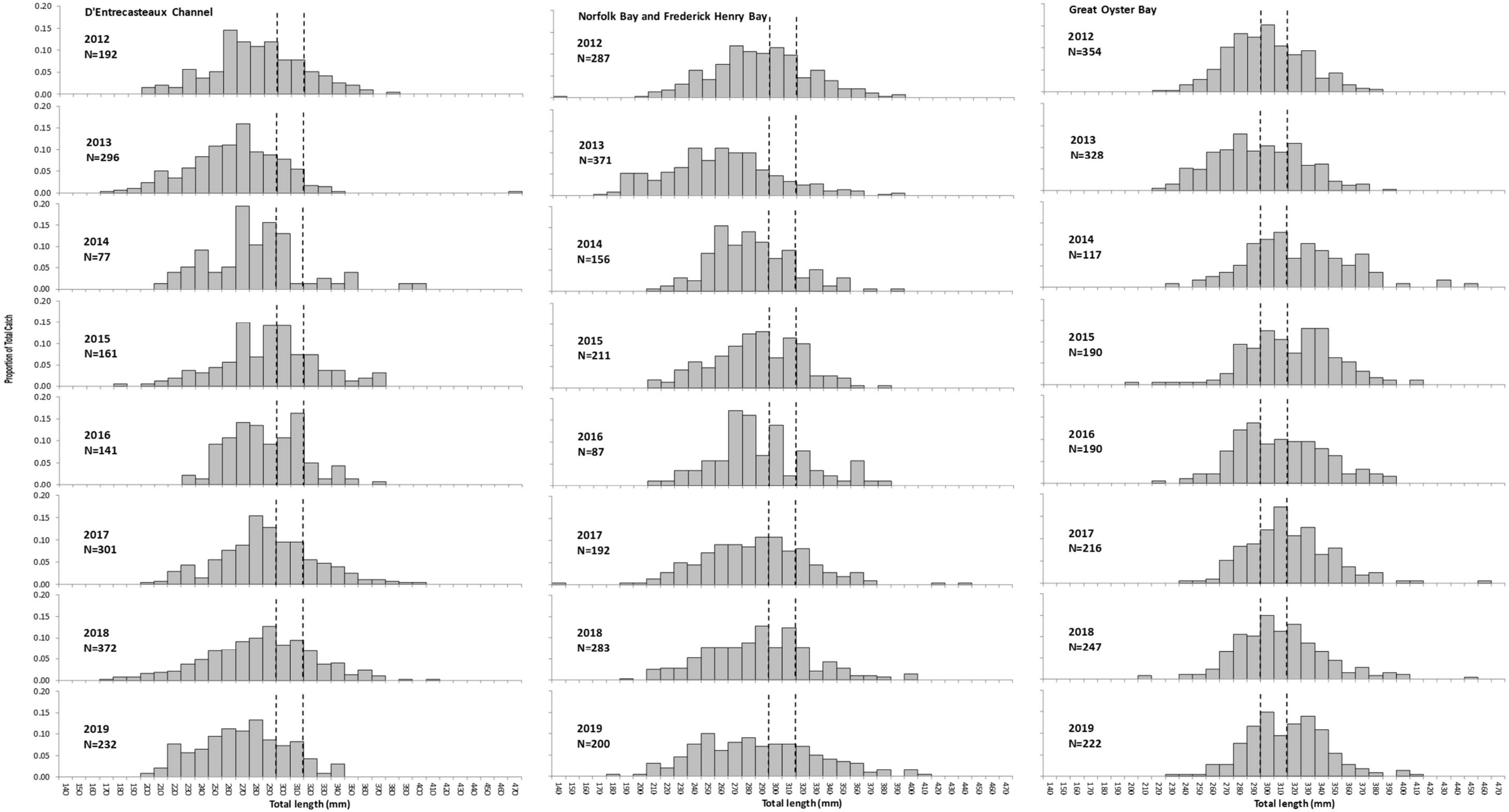


Figure 10.1 Length frequency histograms for Sand Flathead captured in (1) D'Entrecasteaux Channel (left), (2) Norfolk and Frederick Henry Bay (centre), and (3) Great Oyster Bay (right). Dotted lines indicated minimum legal size limits (300 mm applied to 2015, 320 mm thereafter).

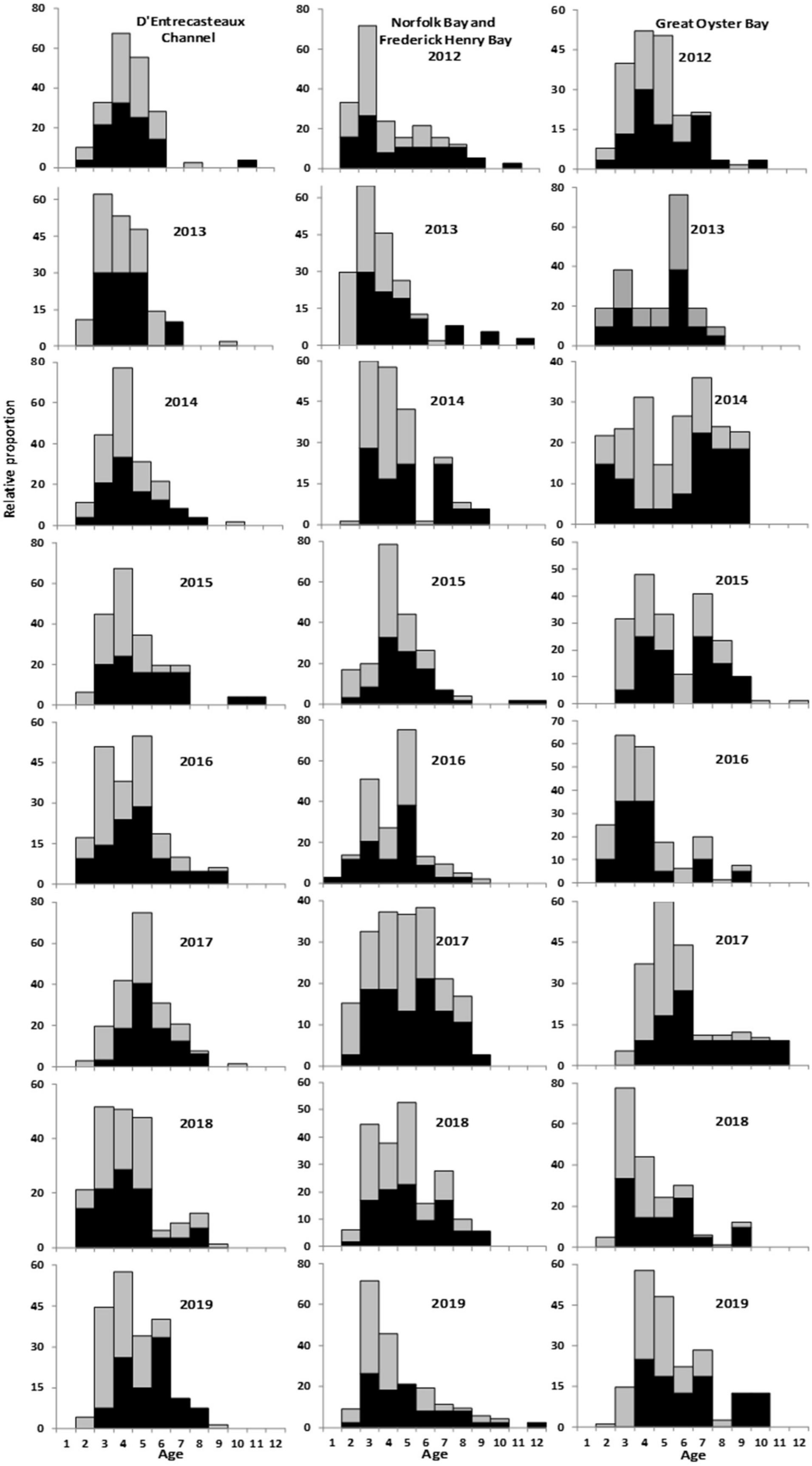


Figure 10.2 Age frequency histograms for aged Sand Flathead in (1) D'Entrecasteaux Channel (left), (2) Norfolk and Frederick Henry Bay (centre), and (3) Great Oyster Bay (right). The black bars indicate males and grey bars indicate females.

Survey-based CPUE

Standardised catch rates from the fishery-independent survey of legal sized Sand Flathead showed notable initial depletions compared to the first two survey years in 2012 and 2013 (Fig. 10.3). From 2017, catch rates started to indicate increases in all three regions, which is the likely result of the introduction of the higher minimum size limit of 320 mm in 2015 and the previously described associated reduction in fishing mortality.

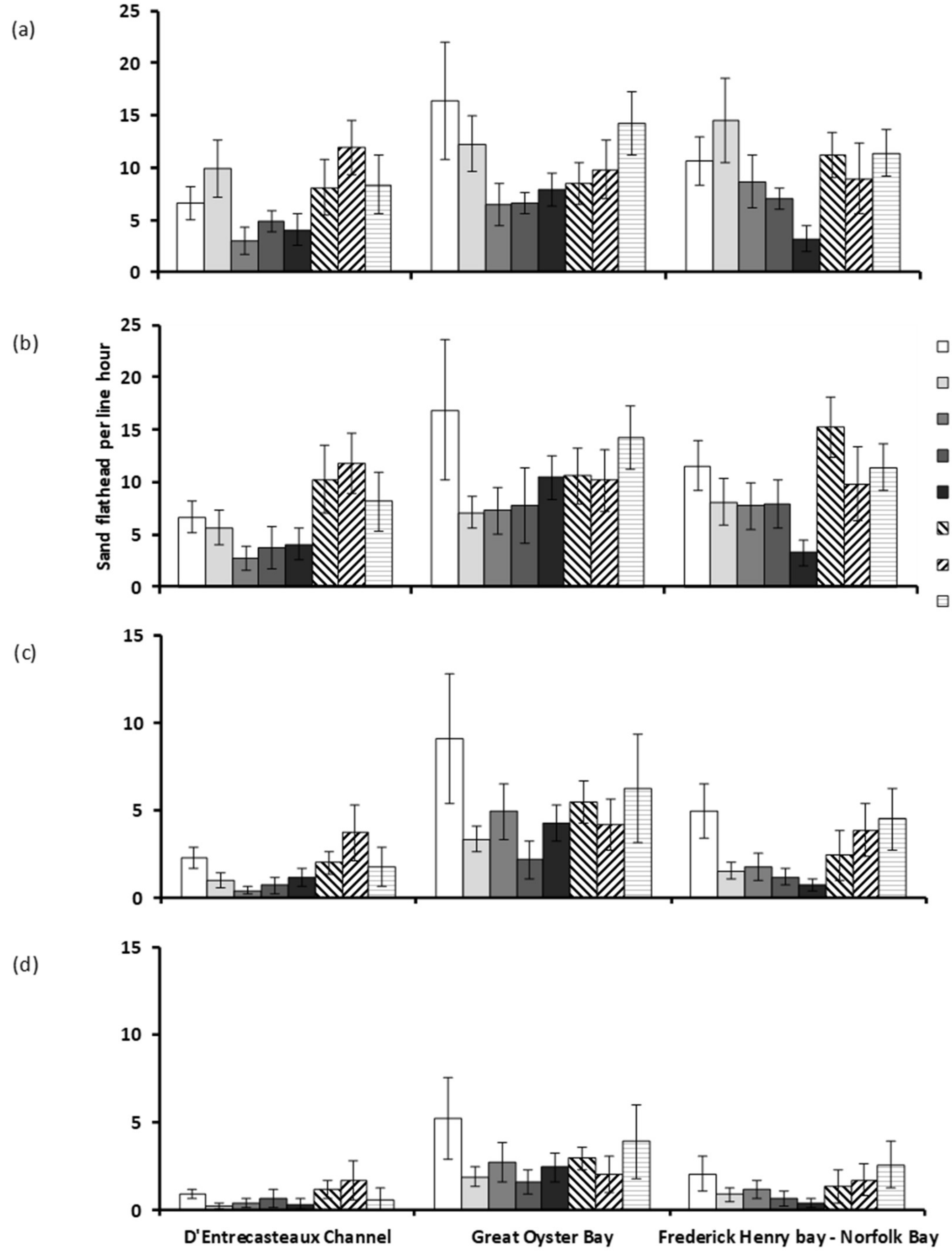


Figure 10.3 Mean catch rates (fish per line hour) by region and year for Sand Flathead: (A) raw catch rates; (B) standardised catch rates; (C) standardised catch rates for fish above the original 300mm MLS, and (D) standardised catch rates for fish above the new 320mm MLS. Error bars represent 95% confidence intervals.

Commercial catch, effort and CPUE

The commercial fishery for Flathead has not undergone major changes in its operations since 1995/96. It was therefore possible to back calculate catches for Sand Flathead prior to 2007 (when the two main flathead species were not distinguished) based on the average proportion of species by gear type from 2007/08 to 2011/12 (Fig. 10.4). Sand Flathead catches remained relatively stable until 2008/09, but have generally declined since then reaching a historical low of 2.7 t in 2015/16 (Fig. 10.4). In 2018/19, the catch was 2.8 t, down from 6.4 t and 3.5 t in the previous two years. In the last two years, almost all Sand Flathead catch was taken by handline and on the east coast (Fig. 10.4 and 10.5).

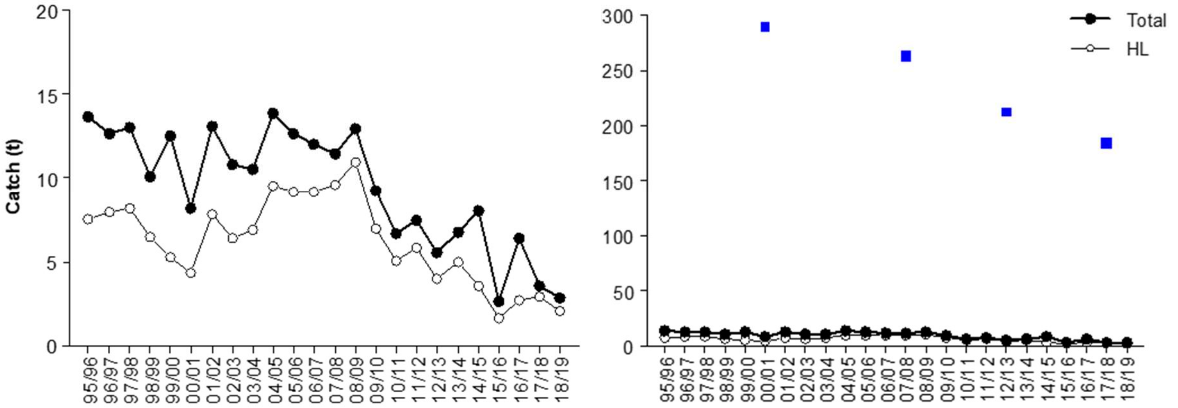


Figure 10.4 Back-calculated annual commercial catch (t) for Sand Flathead (left). The second graph on the right shows the same data but highlighting in blue squares the dominance of recreational catches estimated for this species (right). HL=handline (catches taken by other methods are not shown).

Handline fishing effort was relatively stable over the last three years, and in combination with declining catches, resulted in declining catch rates (Fig. 10.5). However, commercial catches of this species are negligible when compared to estimates for the recreational sector. For all flathead species combined, recreational catches were estimated at 361 t in 2000/01 (Lyle 2005), 292 t in 2007/08 (Lyle et al. 2009) and 235.9 t in 2012/13 (Lyle et al. 2014a), representing approximately 90% Sand Flathead. In 2017/18, the recreational fishing survey firstly considered the two flathead species separately. The recreational catch of Sand Flathead was estimated at 184.3 t, which was appr. 92% of the estimated total for both species (Lyle et al. 2019)

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian scalefish fishery, handlining was considered a medium risk with regard to Sand Flathead due to evidence of the population being subject to heavy fishing pressure. Handlining was considered a medium risk to by-product mixed fish species due to the uncertainty surrounding their population status. Impacts on communities and protected species were generally low or negligible although heavy fishing pressure on Sand Flathead populations in inshore and estuarine waters was considered to represent a medium risk to the trophic structure of these systems (Bell et al. 2016). There is no new information to suggest that the validity of this assessment has changed.

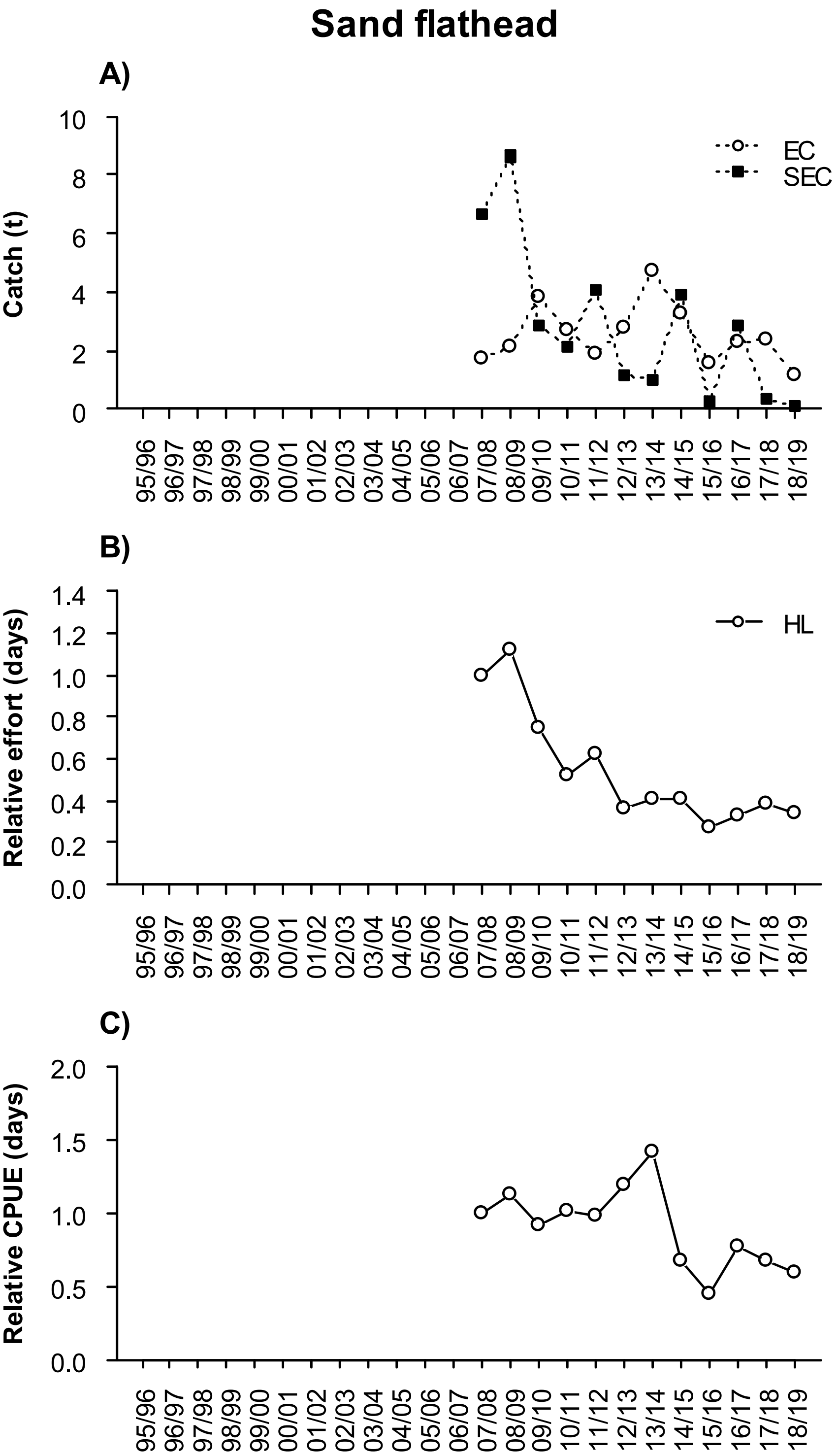


Figure 10.5 A) Sand Flathead annual commercial catch (t) by gear (left) and region (right). B) Sand Flathead commercial effort by method based on gear units (left) and day fished (right) relative to 2007/08. C) Sand Flathead commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 2007/08. HL=hand-line, SEC=southeast coast, EC=east coast.

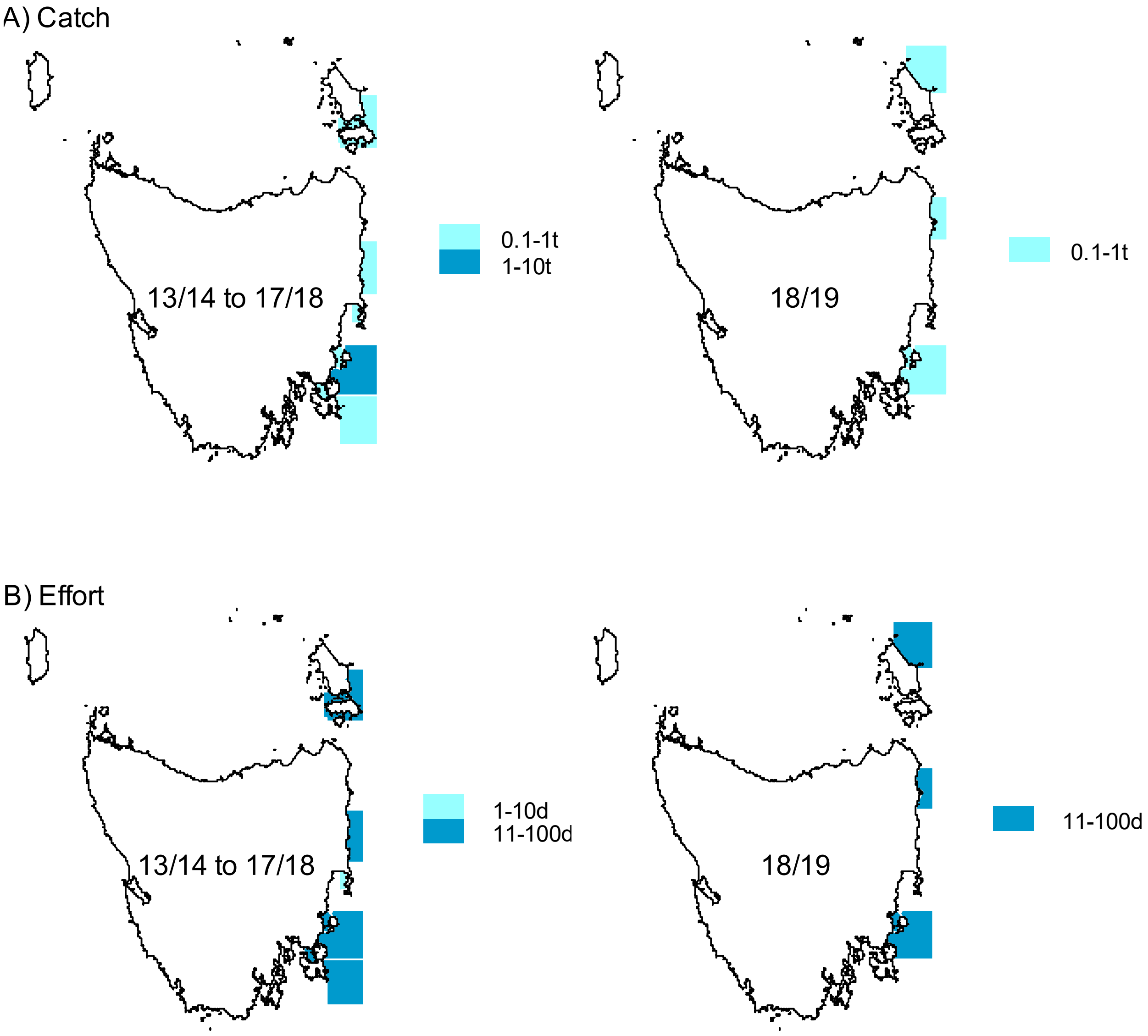


Figure 10.6 (A) Sand Flathead catches (t) and (B) effort (days) by fishing blocks averaged over the last five assessment years (left) and in the current assessment year (right).

Reference points for Flathead (combined)

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (63.1 t)	No	
	• Catch < 3rd lowest catch value from the reference period (50.5 t)	Yes	↓ 28.6 t (56.7%)
	• Catch variation from the previous year above the greatest inter-annual increase from the reference period (43.5 t)	No	
	• Catch variation from the previous year above the greatest inter-annual decrease from the reference period (-31.9 t)	No	
	• Latest recreational catch estimate > recreational catch estimate from the reference period (361 t)	No	
	• Proportion of recreational catch to total catch > previous proportion estimate (85.5% in 2012/13)	No	
Biomass	• CPUE< 3rd lowest CPUE value from the reference period (0.013 t/days fished)	Yes	↓ 0.0039 t/day fished (-29.9%)
	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0020)	Yes	↓ 0.0012 t/day fished (-60.2%)

Stock status	DEPLETING

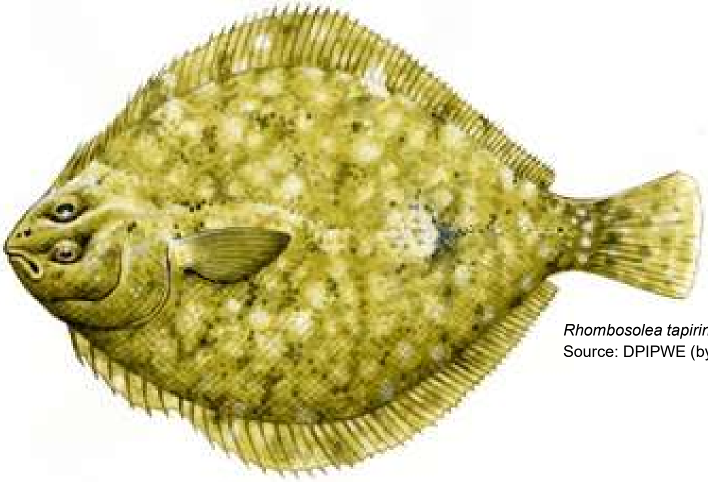
The main impact on Sand Flathead stocks is from the recreational sector with commercial catches estimated to represent less than 2% of the combined total catch. Due to an absence of targeting among commercial fishers, a Sand Flathead fishery-independent survey commenced in 2012 to support the assessment of this species.

The survey over recent years has identified a low relative abundance of legal-size fish, particularly in the D'Entrecasteaux Channel and Frederick Henry-Norfolk Bay, suggesting that stocks in the main fishing areas are depleted. In late 2015, various management changes were introduced to improve the status of this species including: (1) an increase in the minimum size limit from 300 mm to 320 mm, and the introduction of (2) a daily bag limit of 20 per fisher and (3) a possession limit of 30 per fisher. Estimates of fishing mortality and catch rates suggest that these management measures have started to initiate stock recovery. However, fishing mortality of females remains high and close monitoring is required for more in-depth analysis of assumed stock recovery. With the high current fishing pressure likely causing the stock to become recruitment impaired, Sand Flathead remains classified as depleting.

11. Flounder

Pleuronectidae family

STOCK STATUS	**UNDEFINED**
Greenback Flounder (*Rhombosolea tapirina*) constitute the majority of the commercial catch, which remains low due to the ban on overnight gillnetting and limited market demand. Catch and catch rates are considered unreliable estimators of abundance and the status of the stock remains uncertain.	
IMPORTANCE	Minor
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends



Rhombosolea tapirina
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Sheltered sand, silt and mud substrates in estuaries and coastal waters. Between 0 and 100 m depth	Edgar (2008)
Distribution	• Southern Western Australia to southern New South Wales, and around Tasmania. Also in New Zealand	Edgar (2008)
Diet	• Polychaetes and benthic crustaceans	Edgar (2008) Ferguson (2006)
Movement and stock structure	• Several genetically distinct stocks in Australia: west coast of Tasmania, east coast of Tasmania, Victoria	van den Enden (2000)
Natural mortality	• Estimated at M = 0.85 (for populations in New Zealand)	Sutton et al. (2010)
Maximum age	• 10 years	Sutton et al. (2010)
Growth	• Maximum length: 45 cm • Maximum weight: 0.6 kg	Edgar (2008) Kailola et al. (1993)

<table>
<tr><td></td><td>

- Growth described by the von Bertalanffy growth function $L = L_{\infty}\left(1 - e^{-k(t-t_0)}\right)$, where *L* is the fork length (cm), *t* is the age (years), L_{∞} is the average maximum length for the species, *k* is a constant and t_0 is the (theoretical) age where length equals zero

Parameter estimates for populations in New Zealand are:

<table>
<tr><th>Sex</th><th>L_{∞}</th><th>k</th><th>$t_{0\infty}$</th></tr>
<tr><td>Females</td><td>55.82</td><td>0.26</td><td>-1.06</td></tr>
<tr><td>Males</td><td>52.21</td><td>0.24</td><td>-1.32</td></tr>
</table>

- Length-weight relationship was estimated at $W = 0.036\ L^{2.7}$ for females and $W = 0.039\ L^{2.64}$ for males where *W* is weight (g) and *L* is the tail length (cm)

</td><td>Sutton et al. (2010)</td></tr>
<tr><td>Maturity</td><td>

- Sexual maturity at about 218.6 mm TL for females and 190 mm TL for males

</td><td>Crawford (1984)</td></tr>
<tr><td>Spawning</td><td>

- From June to October
- Females are serial spawners and move from the shallows in deeper areas of tidal rivers and estuaries, and offshore for spawning
- The relationship between batch fecundity and fork length is linear between 24.7 and 34.3 cm with $F = -1053.65 + 85.85L$, where *F* is the fecundity (in number of eggs) and *L* is the tail length (cm)
- Pelagic eggs, 0.7–1.0 mm in diameter

</td><td>Crawford (1984)</td></tr>
<tr><td>Early life history</td><td>

- Incubation of 82–93 hours
- Larvae hatch at 1.9 mm between May and November Larvae remain in the plankton for over 30 days until they reach 6 mm, and then undergo metamorphosis which finishes 65 days post-hatching
- Settlement inshore occurs during late winter to early summer
- Juveniles live on sand flats in water less than a meter deep

</td><td>Edgar (2008)
Crawford (1984, 1986)
Jenkins (1986)</td></tr>
<tr><td>Recruitment</td><td>

- No-stock recruitment relationship established

</td><td></td></tr>
<tr><td>Gillnet post release survival</td><td>

- High: 96.1%

</td><td>Lyle et al. (2014b)</td></tr>
</table>

Background

Catches of flounder comprise of various species which are not always differentiated in logbooks. Greenback Flounder (*Rhombosolea tapirina)* constitute the vast majority of the commercial catch. Long-snouted Flounder (*Ammotretis rostratus*) are also taken, but in small quantities. The main fishing methods used to target flounder are spear and gillnet. A ban on the overnight setting of gillnets in most waters from 2010 has resulted in a marked reduction in gillnet fishing for flounder.

FISHING METHODS	Spear, gillnet, some beach seine.
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence) • Recreational gear licence (graball and/or mullet net licence) **Output control:** • Possession limit of 30 and bag limit of 15 individuals for recreational fishers • Minimum size: 25 cm
MAIN MARKET	Local (Tasmania)

Current assessment

Catch, effort and CPUE

Flounder landings have declined steadily since the mid-1990s, reaching a historical low of 1.0 t in 2015/16 (Fig. 11.1A). Catches decreased slightly from 3.9 t in 2017/18 to 2.2 t in 2018/19, which is similar to catches five years ago. Since the ban on night netting, Flounder have been caught almost exclusively using spear (Fig. 11B). Commercial catches have contracted spatially over recent years to Norfolk Bay and the Tamar estuary (Fig. 11.2). In 2017/18, fishing was concentrated around these areas as well as within Macquarie Harbour (Fig. 11.2).

Consistent with the trend in catches, effort for both methods has been declining steadily since the mid-1990s (Fig. 11.1B). Catch rates showed opposing trends compared to last year (an increase for gillnet and decrease for spear) and remain at levels close to the reference year (Fig. 11.1C).

Flounder are relatively important recreational species, and in recent years, catches for the recreational sector have matched or exceeded those of the commercial sector (Fig. 11.1A). Similar to commercial catches, recreational catches appear to have declined progressively over recent years. Recreational catches were estimated at 15.2 t in 2000/01 (Lyle 2005), 10.1 t in 2007/08 (Lyle et al. 2009), 7.2 t in 2012/13 (Lyle et al. 2014a), and 3.8 t in 2017/18 (Lyle et al 2019).

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian scalefish fishery, spearing was considered a very low risk to flounder populations due to the negligible fishing effort directed at this species in recent years. All other ecosystem components were considered negligible risk because spearing has rarely been used in recent years and is highly selective with fish sighted and captured individually (Bell et al. 2016). There is no new information to suggest that this has changed otherwise since then.

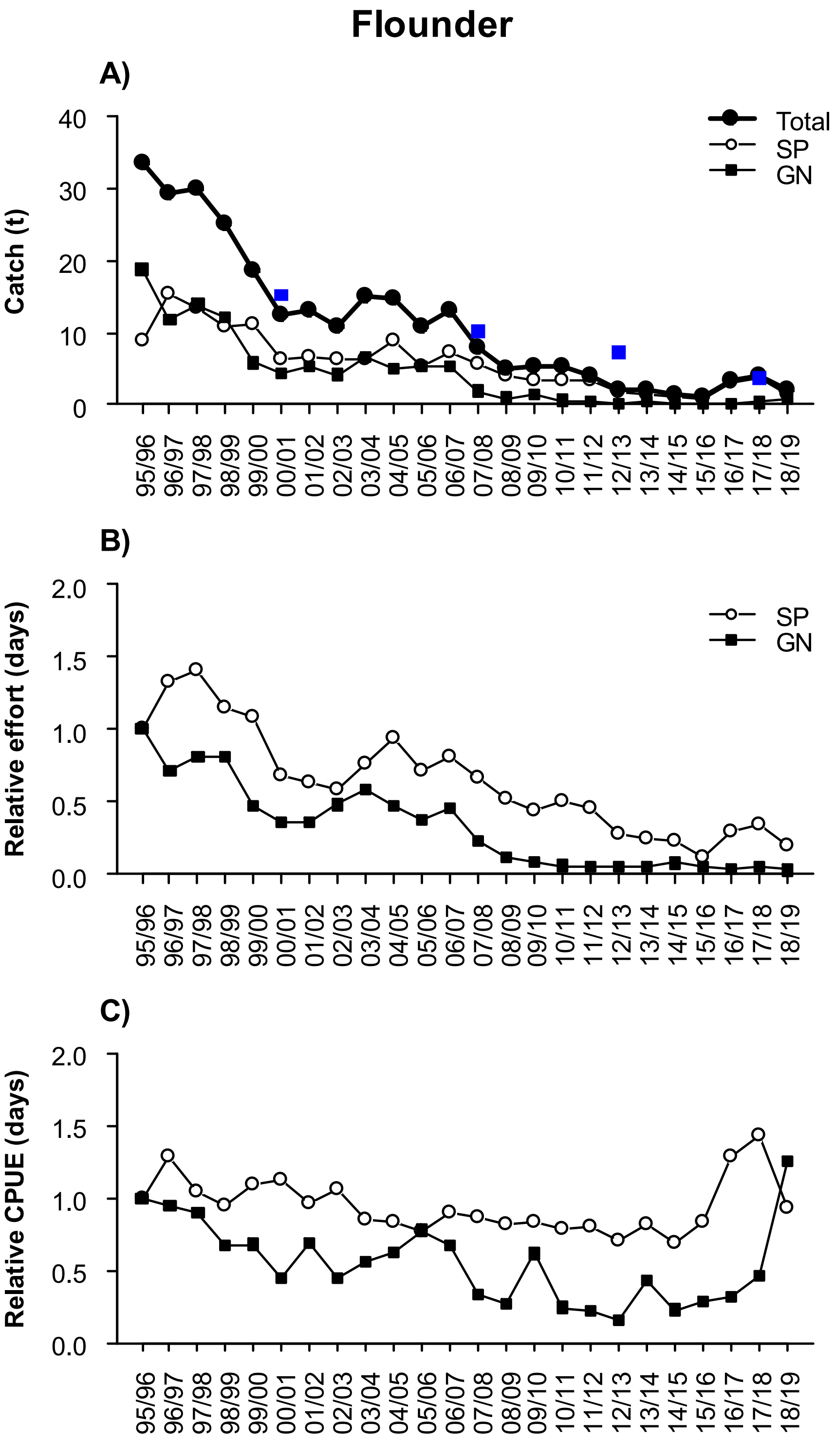
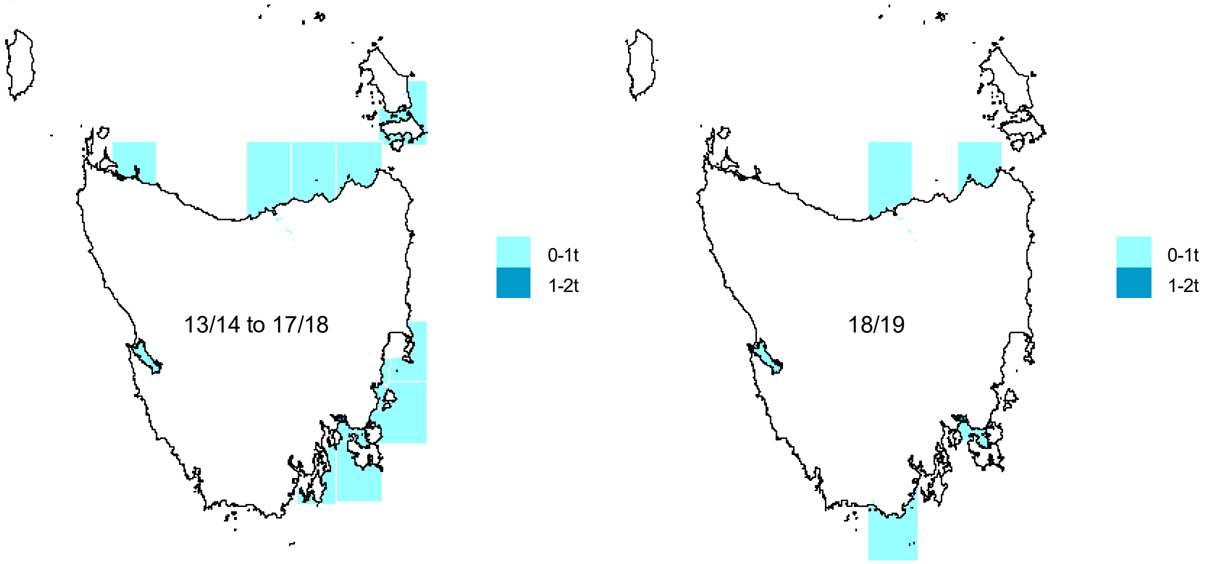


Figure 11.1 A) Annual commercial catch (t) by gear and best estimates of recreational catches (blue squares). B) Commercial effort by method based on day fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. SP=spear, GN=gillnet.

A) Catch



B) Effort

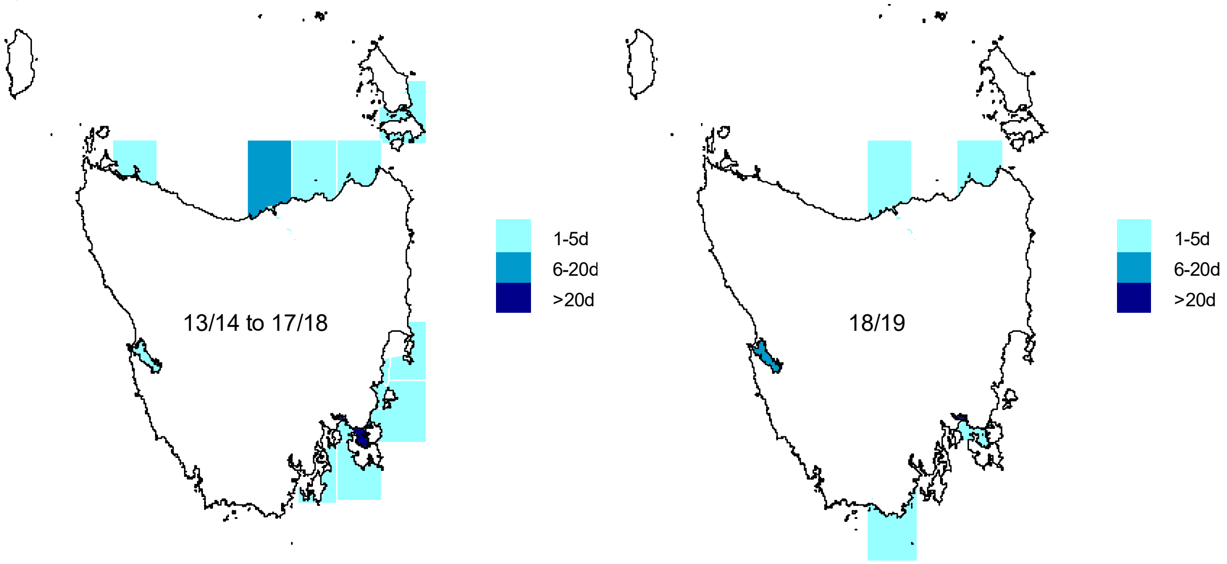


Figure 11.2 (A) Flounder catches (t) and (B) effort (days) by fishing blocks averaged over the last five assessment years (left) and in the current assessment year (right).

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (29.4 t)	No	
	• Catch < 3rd lowest catch value from the reference period (12.3 t)	Yes	↓ 10.2 t (82.6%)
	• Latest recreational catch estimate > recreational catch estimate from the reference period (15.2 t)	No	
	• Proportion of recreational catch to total catch > previous proportion estimate (77.4% in 2012/13)	No	
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0017)	No	

Stock status

UNDEFINED

The declining catch of Flounder is presumably related to reduced market demand. However, the ban on overnight gillnetting is another influencing factor. The Tasmanian catch is sold locally and demand for Flounder has decreased over the last two decades to the extent that catch and catch rates are considered unreliable estimators of trends in abundance. Thus, there is insufficient information to confidently classify this stock.

12. Gould’s Squid

Nototodarus gouldi

STOCK STATUS	**SUSTAINABLE**
This is a predominately Commonwealth-managed species that is classified as not overfished nor subject to overfishing by ABARES for 2018. Dual-licensed vessels fish in Tasmanian waters, especially in years of peak abundance. The species is characterised by high inter-annual variability in abundance in state waters and generally low catches in recent years.	
IMPORTANCE	Minor
STOCK(S)	Tasmanian Scalefish Fishery/Southern Squid-jig Fishery (Commonwealth)
INDICATOR(S)	Catch, effort and CPUE trends

Nototodarus gouldi
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Open water. Inhabits coastal, inner shelf and shelf break waters down to 600 m depth	Stark (2008)
Distribution	• From southern Queensland to mid-Western Australia, and around Tasmania	Dunning (1998) Dunning and Förch (1998)
Diet	• Small planktonic crustaceans, fish and squids	Machida (1983) O'Sullivan and Cullen (1983) Smith (1983) Uozumi (1998)
Movement and stock structure	• Move widely within a 300 km^2 area but no large-scale migration between feeding and spawning areas as for other similar squid species • Stock structure uncertain but appears to be only one population in southern Australia	Jackson et al. (2005a) Triantafillos et al. (2004)

Natural mortality	• No estimates available	
Maximum age	• Around 1 year	Jackson et al. (2005b)
Growth	• Maximum length: 40 cm • Maximum weight: 1.6 kg • Size-at-age highly variable between individuals, years and locations • Growth rate rapid: between 2.559 and 5.596 $g.d^{-1}$ for females, and between 1.622 and 5.307 $g.d^{-1}$ for males	Norman and Reid (2000) Jackson et al. (2005b) Jackson et al. (2003)
Maturity	• Size-at-50% maturity: between 30.6 to 31.4 cm mantle length (ML) for females, and 20.5 to 21.5 cm ML for males	Stark (2008)
Spawning	• Spawns once and then die • Spawning all year-round • Egg mass are free-floating gelatinous sphere of at least 1.5 m in diameter and contains several thousands of eggs	Jackson et al. (2005b) Uozumi (1998) O'Shea et al. (2004)
Early life history	• Hatching throughout the year	Jackson et al. (2005b) Uozumi (1998)
Recruitment	• Highly variable. No-stock recruitment relationship established	

Background

Gould's Squid, like most cephalopod species, has a very brief life cycle and can vary significantly in abundance between years. Environmental conditions are acknowledged as drivers of larval and juvenile mortality (Flood et al. 2012).

It is likely that there is only one biological stock throughout southern Australian waters. The stock is targeted by the Commonwealth Southern Squid-jig Fishery, which operates in Bass Strait waters using automatic squid-jigs. Gould's Squid are a regular by-product also in the South East Trawl Fishery. Occasionally, Gould's Squid are available in high numbers in Tasmanian state waters, particularly around southeast Tasmania. Consequently, dual licensed vessels tend to fish in state waters during summer before moving back to traditional fishing grounds in Bass Strait.

Gould's Squid are processed into 'tubes' and frozen. Given the unpredictable occurrence of the species in Tasmanian waters, there is limited local processing capacity which has restricted the development of the fishery. There is also limited market demand with a preference of consumers for Southern Calamari. In conclusion, Tasmanian catch does not necessarily reflect biomass of this species.

FISHING METHODS	Automated squid jig
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence, Automatic squid-jig licence) • Temporal and spatial closures (October-November) of some east coast waters **Output control:** • Possession limit of 30 and bag limit of 15 individuals for recreational fishers
MAIN MARKET	Interstate

Current assessment

Catch, effort and CPUE

Gould's Squid availability in Tasmanian waters is highly variable as reflected in its catch history (Fig. 12.1A). Since 1995/96, there have been a few peaks of abundance, notably in 1999/2000, 2011/12, 2012/13 and again in 2015/16. The Gould's Squid catch for 2012/13 was the highest since 1995/96 (~1000 t) with the Australia-wide catch predominantly coming from Tasmanian waters (Flood et al. 2014). In 2017/18 a total of 528 t of Gould's Squid were taken from Tasmanian waters, all but 1.0 t of which was caught by automatic jig. In 2018/19, a total of 155 t were caught, with only 24 t reported under scalefish licences. The majority of the catch in 2018/19 was taken around South-Eastern Tasmania (Fig.12.2).

Gould's Squid catches from the recreational sector (Fig. 12.1A) were estimated at 5 t in 2000/01 (Lyle 2005), 36.6 t in 2007/08 (Lyle et al. 2009), 21.4 t in 2012/13 (Lyle et al. 2014a), and 23.7 t in 2017/18 (Lyle et al. 2019). These numbers match levels of commercial catches during normal (i.e. low catch) seasons but are much lower than commercial catches in the last two seasons.

Effort tends to match temporal patterns in catch, presumably resembling the availability of the species. In some years, higher catches have been achieved with relatively low effort, including the peak in catch observed in 2012/13 (Fig. 12.1B). In the 2018/19 season, catches were lower than in 2017/18 although effort was similar, thus resulting in a notable drop in catch rate.

Overall, catch rates remained comparatively low until 2008/09. In the more recent years, catch rates generally fluctuated around values 5-10 times higher than during the reference period (Fig. 12.1C).

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian Scalefish Fishery, automatic squid jig fishing was considered a very low risk activity with regard to Gould's Squid, non-retained species and the general environment (Bell et al. 2016). There is no new evidence to suggest that the validity of this assessment has changed.

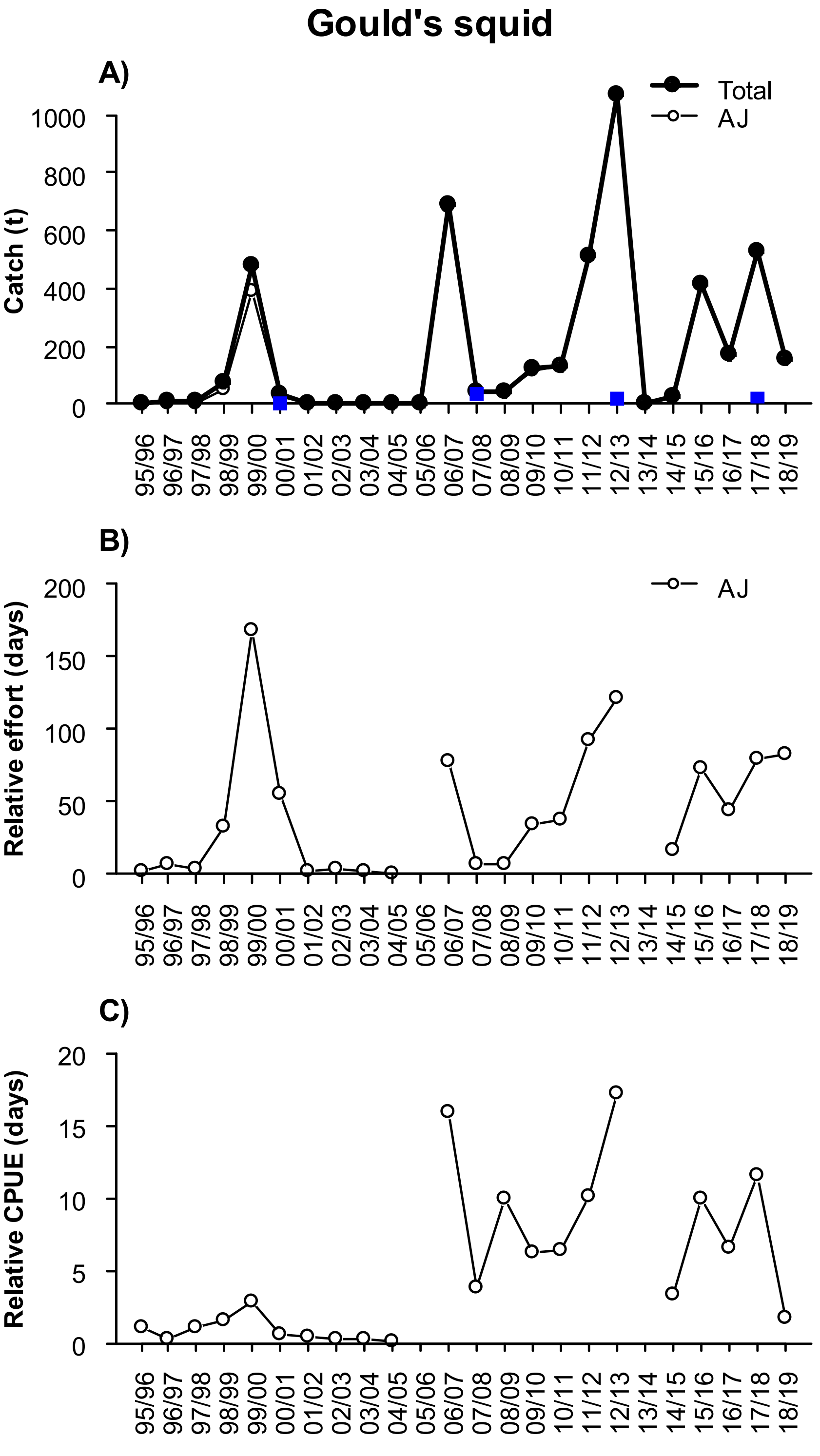


Figure 12.1 A) Annual commercial catch (t) by gear and best estimates of recreational catches (blue squares). B) Commercial effort by method based on days fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished (right) relative to 1995/96. AJ=automatic squid jig. Data includes Australian Fisheries Management Authority (AFMA) catch in State waters. Note: no catch or effort using Automatic squid jig was recorded for 2005/06, 2006/07 or 2013/14.

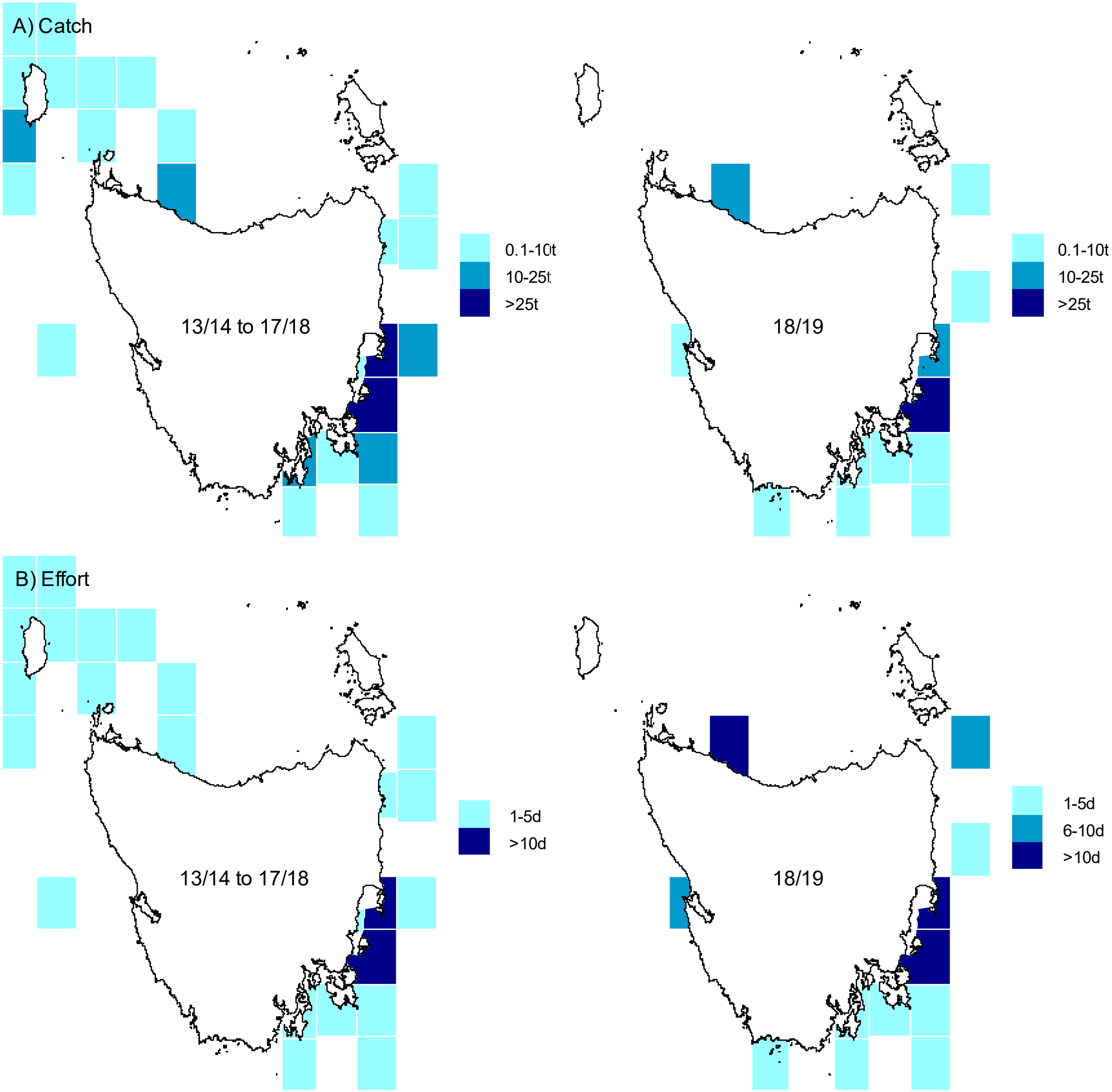


Figure 12.2 (A) Gould's Squid catches (t) and (B) effort (days) by fishing blocks averaged over the last assessment years (left) and in the current assessment year (right). No notable catch of Gould's Squid was recorded in 2013/14. Data includes Australian Fisheries Management Authority (AFMA) catch in Tasmanian state waters.

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (79.7 t)	Yes	↑ 75.5 t (+94.8%)
	• Catch < 3rd lowest catch value from the reference period (2.1 t)	No	
	• Latest recreational catch estimate > recreational catch estimate from the reference period (5 t)	Yes	↑ 18.7 t (+474%)
	• Proportion of recreational catch to total catch > previous proportion estimate (44.4% in 2007/08)	No	
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0657)	No	

Stock status

SUSTAINABLE

Gould's Squid are short lived, spawn year-round and display highly variable growth and size/age at maturity, which means that they can show rapid increases in abundance during favourable environmental conditions. As a result, Gould's Squid might be less susceptible to overfishing than longer-lived species (Flood et al. 2012). However, their short life span (1 year) implies a reliance on a single cohort, which leaves the species susceptible to environmental and fishing impacts on subsequent recruitment.

Fishing effort in the Commonwealth Southern Squid-jig Fishery has decreased markedly since the late 1990s, presumably due to economic factors. A study on the depletion of the Gould's Squid stock concluded that no overfishing had occurred (Sahlqvist and Skirtun 2011). Peak catches in Tasmanian waters (e.g. >500 t in 2017/18) represent less than half of the total Commonwealth catch in recent years (828 t in 2017 and 1,649 t in 2018), which is assumed to be sustainable (Patterson et al 2019). Standard catches by scalefish licence holders (e.g. 24 t in 2018/19) represent only a small proportion of these recent Commonwealth catches.

Although two reference points for stock status were breached in the current assessment (high commercial and recreational catch), the highly dynamic nature of the fishery makes it difficult to assess catch and effort dynamics against a fixed baseline value. In accordance with Commonwealth assessments and the most recent Status of Australian Fish Stock Reports (Flood et al. 2012, Flood et al. 2014, Noriega et al 2018), the Tasmanian Gould's Squid fishery is thus classified as sustainable.

13. Jack Mackerel

Trachurus declivis

STOCK STATUS	**SUSTAINABLE**
This is a predominately Commonwealth-managed species that is classified as not overfished nor subject to overfishing by ABARES for 2018. Only minor catches of this species have been taken from Tasmanian waters in recent years due to one operator leaving the fishery. Patterns of catch and effort are unlikely to reflect stock status, but the current level of fishing pressure in Tasmania is unlikely to cause the stock to become recruitment impaired.	
IMPORTANCE	Minor
STOCK(S)	Tasmanian Scalefish Fishery/Small Pelagic Fishery (Commonwealth)
INDICATOR(S)	Catch, effort and CPUE trends

Trachurus declivis
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Open water between 0–500 m depth	Edgar (2008)
Distribution	• Western Australia (Shark Bay) to southern Queensland and around Tasmania and New Zealand	Edgar (2008)
Diet	• Krill, planktonic crustaceans, fish	Kailola et al. (1993)
Movement and stock structure	• Schooling fish. Normally live in continental shelf waters. May move close to seabed during winter. • Most likely two subpopulations: one eastern Australian (east Tasmania and along the eastern seaboard of Australia) and one western Australian (west Tasmania, Great Australian Bight and Western Australia	Kailola et al. (1993) Bulman et al. (2008)
Natural mortality	• Estimated between M = 0.63 and 0.70	Stevens and Hansfeld (1982)
Maximum age	• 25 years	Paul (2000)
Growth	• Maximum length: 64 cm • No difference between male and female growth • Growth described by van Bertalanffy growth function $L = L_\infty\left(1 - e^{-k(t-t_0)}\right)$,	Paul (2000) Lyle et al. (2000)

<table>
<tr><td></td><td>where L is the length (cm), t is the age (years), L_∞ is the average maximum length for the species, k is a constant and t_0 is the (theoretical) age where length equals zero.
Parameter estimates are:
<table>
<tr><th>Sex</th><th>L_∞</th><th>k</th><th>$t_{0\infty}$</th></tr>
<tr><td>Combined</td><td>36.2</td><td>0.267</td><td>-1.21</td></tr>
</table>
Length-weight relationship (in g and cm) was estimated at $W = 1.46.10^{-8}L^{2.982}$ for both males and females</td><td></td></tr>
<tr><td>Maturity</td><td>Sexual maturity between 3 and 4 years of age, at sizes around 27 cm and weights around 250 g.</td><td>Webb (1976)</td></tr>
<tr><td>Spawning</td><td>Occurs over a wide area in Tasmania.
Between late December and early March.
Pelagic eggs.</td><td>Stevens and Hansfeld (1982)</td></tr>
<tr><td>Early life history</td><td>Larvae carried by inshore currents.
Juveniles inhabit coastal and estuarine waters although they may sometimes be found offshore.</td><td>Kailola et al. (1993)
Williams and Pullen (1986)</td></tr>
<tr><td>Recruitment</td><td>No-stock recruitment relationship established.</td><td></td></tr>
<tr><td>Gillnet post release survival</td><td>NA</td><td></td></tr>
</table>

Background

The Jack Mackerel fishery in Tasmania started in the early 1970s with a one-year venture catching 6,300 t in 1973. In 1985, another venture aimed at fishmeal production using purse seine nets commenced. Landings started rising rapidly to over 40,000 t in 1986/87 (Kailola et al. 1993). By 2000, fishers were struggling to catch surface schools and the industry began mid-water trawling (also for redbait) in Commonwealth waters. Small quantities of Jack Mackerel are also taken inshore as by-product from beach seine and inshore purse seine fishing.

FISHING METHODS	Mainly purse seine, also beach seine
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence, class seine licence). • Species licence (Mackerel A or B). • Recreational gear licence (beach seine). **Output control:** • Possession limit of 60 and bag limit of 30 individuals for recreational fishers • Commercial catches taken by Mackerel licence holders A & B in Commonwealth waters are agreed (but not officially decremented) to enable Commonwealth Small Pelagic Fishery TAC allocations
MAIN MARKET	Local (Tasmania)

Current assessment

Catch, effort and CPUE

Catches of Jack Mackerel in Tasmanian waters that are reported in the General Fishing Returns have been variable since 1995/96, oscillating between 2.6 and 59.8 t up until 2007/08, when there was a sharp increase in purse seine effort targeting Jack Mackerel (Fig. 13.1A). Jack Mackerel catches peaked at 919.6 t in 2008/09, however, declined sharply in 2010/11 and 2011/12 to around 60 t because the major purse seine operator ceased activities. In 2018/19, only 202 kg of Jack mackerel were caught in Tasmania, slightly up from the historic low of 66 kg recorded in 2016/17. Purse and beach seine catches are usually taken on the southeast coast, but in the current year all reported catch was taken by either gillnet (mostly), small mesh net or handline on the North-East coast (Fig. 13.2).

It should be noted that between 1995 and 1999, purse seine catches were taken as part of a separately documented fishery (Zone A fishery) ranging from 447 t in 1995/96 to 8,458 t in 1997/98 and averaging 4,485 t per year for that period. These data are not presented in Fig. 13.1A.

Jack Mackerel is not a significant recreational species with catches estimated at 3.2 t in 2000/01 (Lyle 2005), 1.0 t in 2007/08 (Lyle et al. 2009), 5.2 t in 2012/13 (Lyle et al. 2014a), and 900 kg in 2017/18 (Lyle et al 2019).

The use of purse seining by a major operator between 2008/09 to 2009/10 resulted in a spike in effort and catch during this particular period. Beach seine effort has been declining slowly over time, noting that Jack Mackerel represent a by-product and no meaningful catch rate trends can be drawn from these data (Fig. 13.1B). Purse seine catch rates were low until the species began being targeted in 2008/09, and remained high until 2011/12 when the species ceased being targeted (Fig. 13.1C). Since that time, landings have been low and there has been no targeted fishing in Tasmanian waters. In contrast, landings increased sharply in the Commonwealth Small Pelagic Fishery due to the start of operations of a large factory trawler.

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian Scalefish Fishery, offshore purse seining was considered a negligible risk activity to populations of Jack Mackerel due to the small amount of catch currently taken in the fishery. However, it is noted that if catches increased then the risks would need to be reassessed (Bell et al. 2016). There is no new information to suggest that the validity of this assessment has changed.

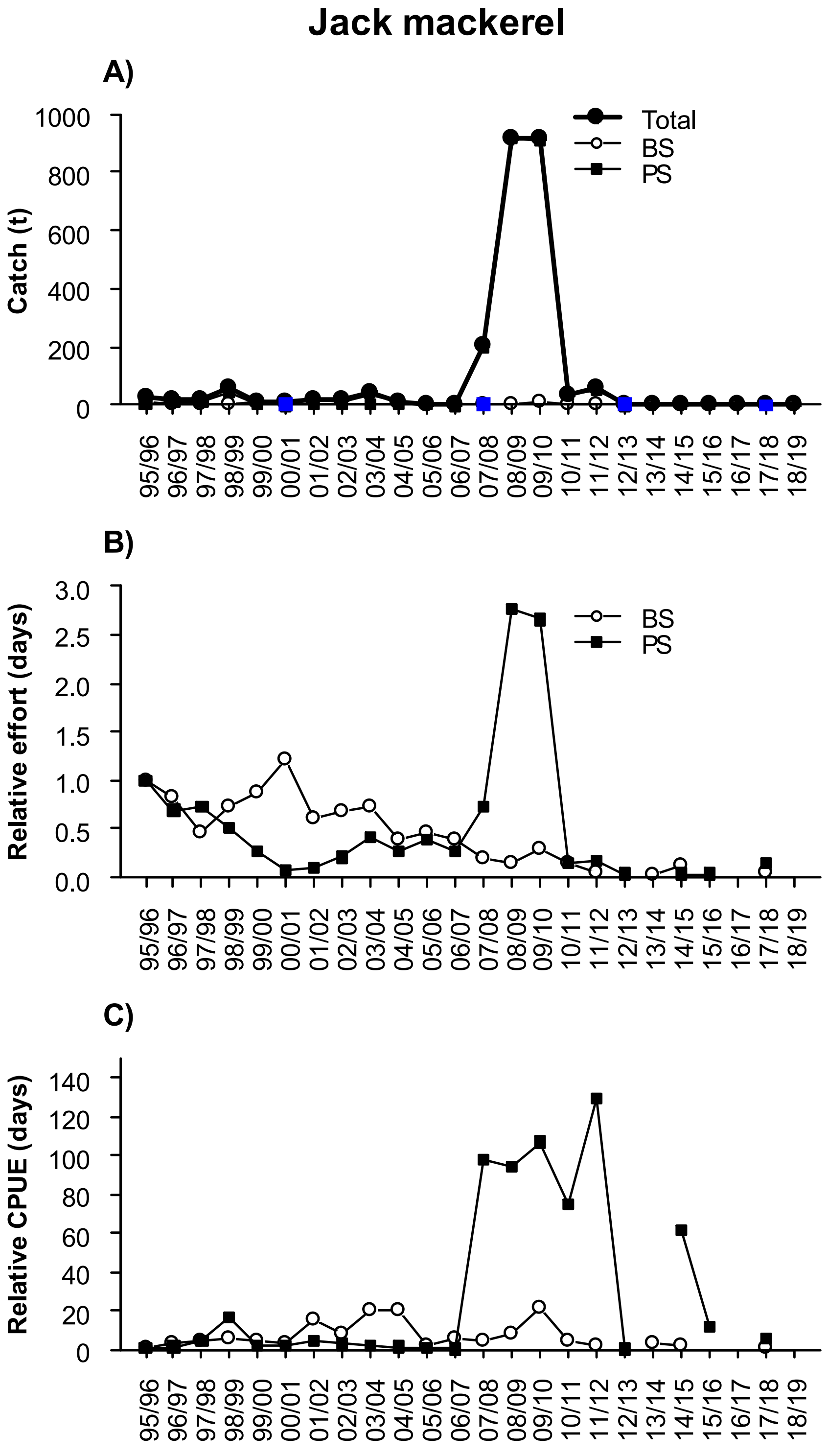


Figure 13.1 A) Annual commercial catch (t) by gear and best estimates of recreational catches (blue squares). B) Commercial effort by method based on day fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. BS=beach seine, PS=purse seine. Note: no purse seine catch for Jack Mackerel was reported in Tasmanian waters during 2013/14, and no beach seine or purse seine catch for Jack Mackerel was recorded in 2016/17 and 2018/19.

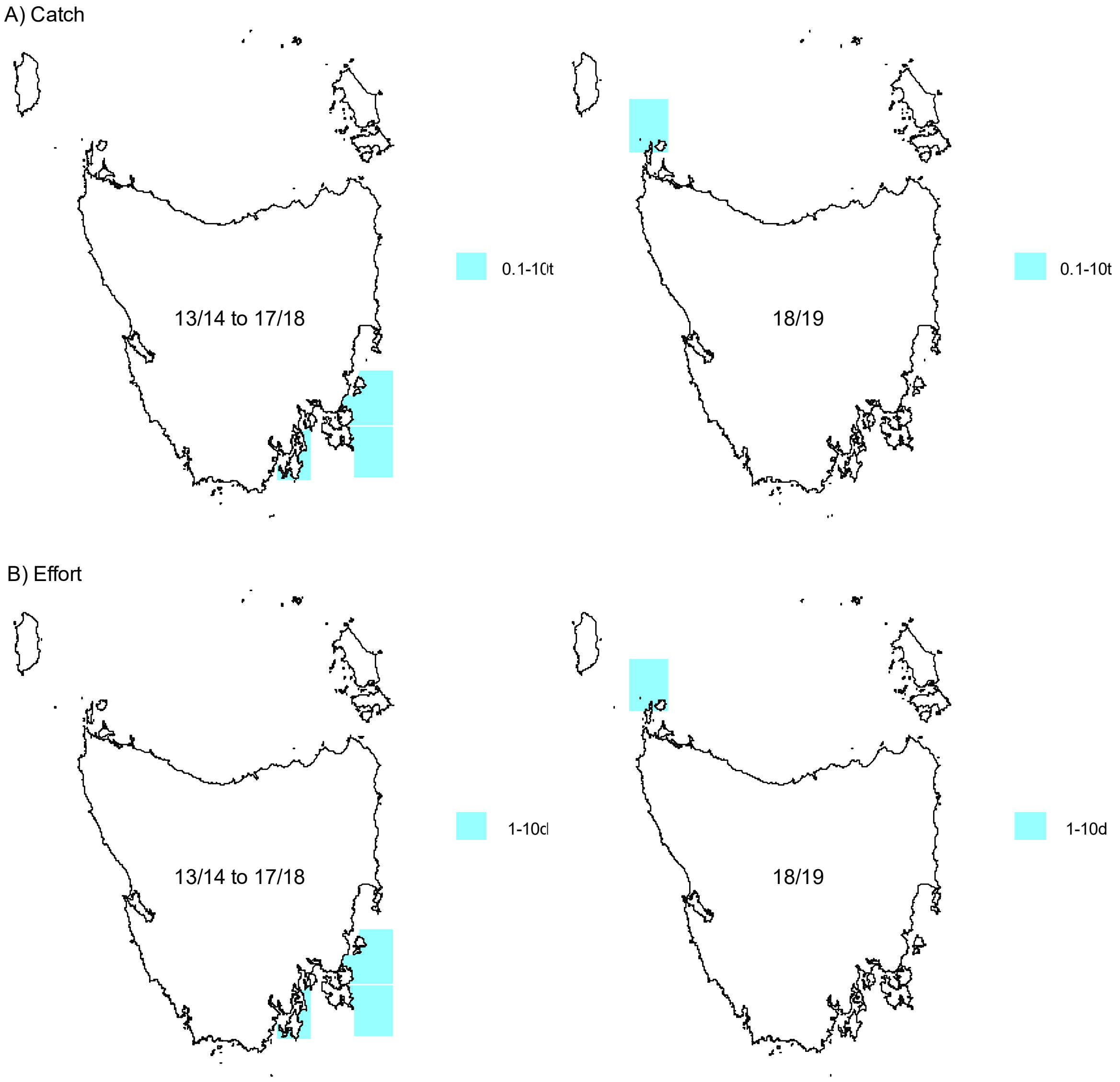


Figure 13.2 (A) Jack Mackerel catches (t) and (B) effort (days) for beach seine and purse seine by fishing blocks averaged over the last five assessment years (left) and in the current assessment year (right). Note no beach seine or purse seine catch for Jack Mackerel was recorded in Tasmanian waters in 2016/17 and 2018/19.

Limit reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (26.2 t)	No	
	• Catch < 3rd lowest catch value from the reference period (9.1 t)	Yes	↓ 8.9 t (-97.3%)
	• Latest recreational catch estimate > recreational catch estimate from the reference period (3.2 t)	No	
	• Proportion of recreational catch to total catch > previous proportion estimate (96.3% in 2012/13)	No	
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0254)	No	

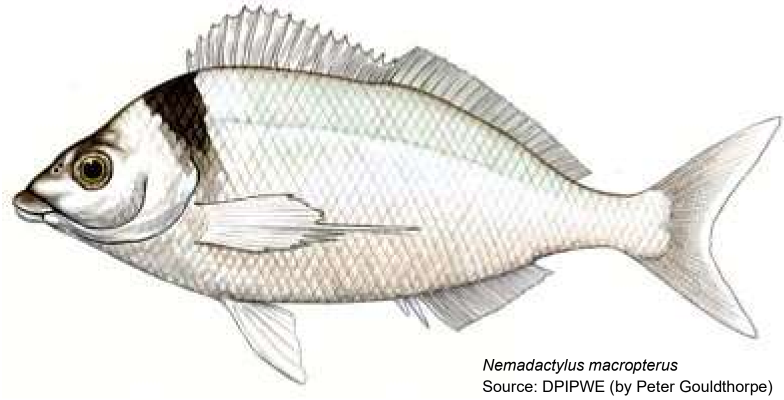
Stock status	**SUSTAINABLE**

The reference point for lowest catch was breached due to minimal fishing occurring in 2018/19. Very low commercial catch in recent years also means that the proportion of recreational catches tend to be higher than historically. Recent trends in the commercial fishery have been the response of a single operator entering and leaving the fishery and do not reflect the stock status. A 2014 study assessed the spawning stock biomass for eastern Australia to be in the order of 150,000 tonnes (Ward et al. 2015). Jack Mackerel are assessed by the Commonwealth Small Pelagic Fishery Scientific Panel and, based on current catch levels and spawning biomass, the eastern Jack Mackerel stock is assessed as not overfished nor subject to overfishing (Patterson 2019). This assessment has been applied to the Tasmanian component of the fishery.

14. Jackass Morwong

Nemadactylus macropterus

STOCK STATUS	**SUSTAINABLE**
This is a predominately Commonwealth-managed species that is classified as not overfished nor subject to overfishing by ABARES for 2018. It is classified as sustainable in the Status of Australian Fish Stocks Report 2018. Commercial catches in Tasmania are low.	
IMPORTANCE	Minor
STOCK(S)	Tasmanian Scalefish Fishery/Southern and Eastern Scalefish and Shark Fishery (Commonwealth)
INDICATOR(S)	Catch, effort and CPUE trends



Nemadactylus macropterus
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Exposed sand and silt, reefs. Between 5 and 400 m depth.	Edgar (2008)
Distribution	• From central Queensland to southern Western Australia, and around Tasmania, New Zealand, southern Africa and South America	Edgar (2008)
Diet	• Polychaete worms, crustaceans, molluscs and echinoderms	Godfriaux (1974)
Movement and stock structure	• No genetic variation in southern Australia indicating larval mixing • Existence of at least three sub-populations: Tasmania, New South Wales/Victoria and Great Australian Bight	Richardson (1982) Grewe et al. (1994) Elliott and Ward (1994) Thresher et al. (1994)
Natural mortality	• M = 0.10 (New Zealand population)	Parker and Fu (2011)
Maximum age	• 50 years	Edgar (2008)
Growth	• Maximum length: 70 cm TL • Maximum weight: 2.9 kg • Growth varies according to location. Growth described by von Bertalanffy growth function $L = L_\infty\left(1 - e^{-k(t-t_0)}\right)$,	Kailola et al. (1993) Jordan (2001b)

<table>
<tr><td></td><td>where *L* is the length (cm FL), *t* is the age (years), L_∞ is the average maximum length for the species, *k* is a constant and t_0 is the (theoretical) age where length equals zero
Parameter estimates are:
<table><tr><th>Sex</th><th>L_∞</th><th>k</th><th>t_0</th></tr><tr><td>Females</td><td>38.4</td><td>0.36</td><td>-0.07</td></tr><tr><td>Males</td><td>36.2</td><td>0.42</td><td>0.15</td></tr></table></td><td>)</td></tr>
<tr><td>Maturity</td><td>• Sexual maturity at about 25 cm TL and ca. 3 years of age</td><td>Edgar (2008)</td></tr>
<tr><td>Spawning</td><td>• Between February and June
• At least two spawning areas: northern one (probably southern New South Wales and eastern Victoria) and a southern one (probably western and southern Tasmania)</td><td>Lyle and Ford (1993)
Bruce et al. (2001b)</td></tr>
<tr><td>Early life history</td><td>• Planktonic larval stage of 7–10 months
• Larvae up to 30 mm drift with current on the surface up to 250 km east of Tasmania
• Settlement at 7–9 cm long
• Juveniles live near shallow reefs</td><td>Francis (2001)
Bruce et al. (2001b)
Kailola et al. (1993)</td></tr>
<tr><td>Recruitment</td><td>• No-stock recruitment relationship established</td><td></td></tr>
<tr><td>Gillnet post release survival</td><td>• Moderate: 52%</td><td>Lyle et al (2014b)</td></tr>
</table>

Background

Jackass Morwong is a predominately Commonwealth-managed species. While there is a good market for Jackass Morwong, the species is not available in large numbers in Tasmanian waters. Rather than representing a target species, it is thus landed mainly as a by-product of gillnetting. Tasmanian commercial catches by the inshore demersal trawl fishery reached a maximum of around 250 t in the late 1980s. In 2001, this fishery ceased operations following the introduction of a state-waters ban on otter board trawling. Most of the Jackass Morwong catch now originates from trawling outside of Tasmanian waters. Stocks were assessed as overfished from 2008 to 2010. However, they have been classified as sustainable (not overfished nor subject to overfishing) in the Commonwealth Fishery Status Reports since 2011 (Patterson et al. 2019).

FISHING METHODS	Mainly gillnet, also hand-line and drop-line
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence). • Recreational licence (graball and/or mullet net). **Output control:** • Possession limit of 20 and bag limit of 10 individuals for recreational fishers • Minimum size: 25 cm TL
MAIN MARKET	Local

Current assessment

Catch, effort and CPUE

Total commercial catch of Jackass Morwong was 2.6 t in 2018/19, which is less than last year (3.9 t) (Fig 14.1A). Commercially, Jackass Morwong is caught mainly by gillnet. Landings have declined steadily since 1995/96, fluctuating between 1 and 4 t over the last couple of years. The majority of the catch is taken from the South-East and East coast (Fig. 14.2).

Jackass Morwong is an important recreational species with all estimates of catch at higher levels than those of the commercial fishery (Fig. 14.1A). Estimates were 31.9 t in 2000/01 (Lyle 2005), 6.8 t in 2007/08 (Lyle et al. 2009), 7.7 t in 2011/12 (Tracey et al. 2013), 16.1 t in 2012/13 (Lyle et al. 2014a), and 8.4 t in 2017/18 (Lyle et al. 2019). In addition to gillnetting, Jackass Morwong are commonly caught by handline and often associated with targeted fishing for Striped Trumpeter.

Catches seem to fluctuate in agreement with fishing effort (Fig. 14.1B), which has resulted in relatively stable catch rates over recent years (Fig. 14.1C). However, when compared to the period from 1995/96 until 2004/05 the recent catch rates are notably reduced.

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian Scalefish Fishery, gillnetting was considered a medium risk activity with regard to Jackass Morwong (Bell et al. 2016). There is no new information to suggest that the validity of this assessment has changed.

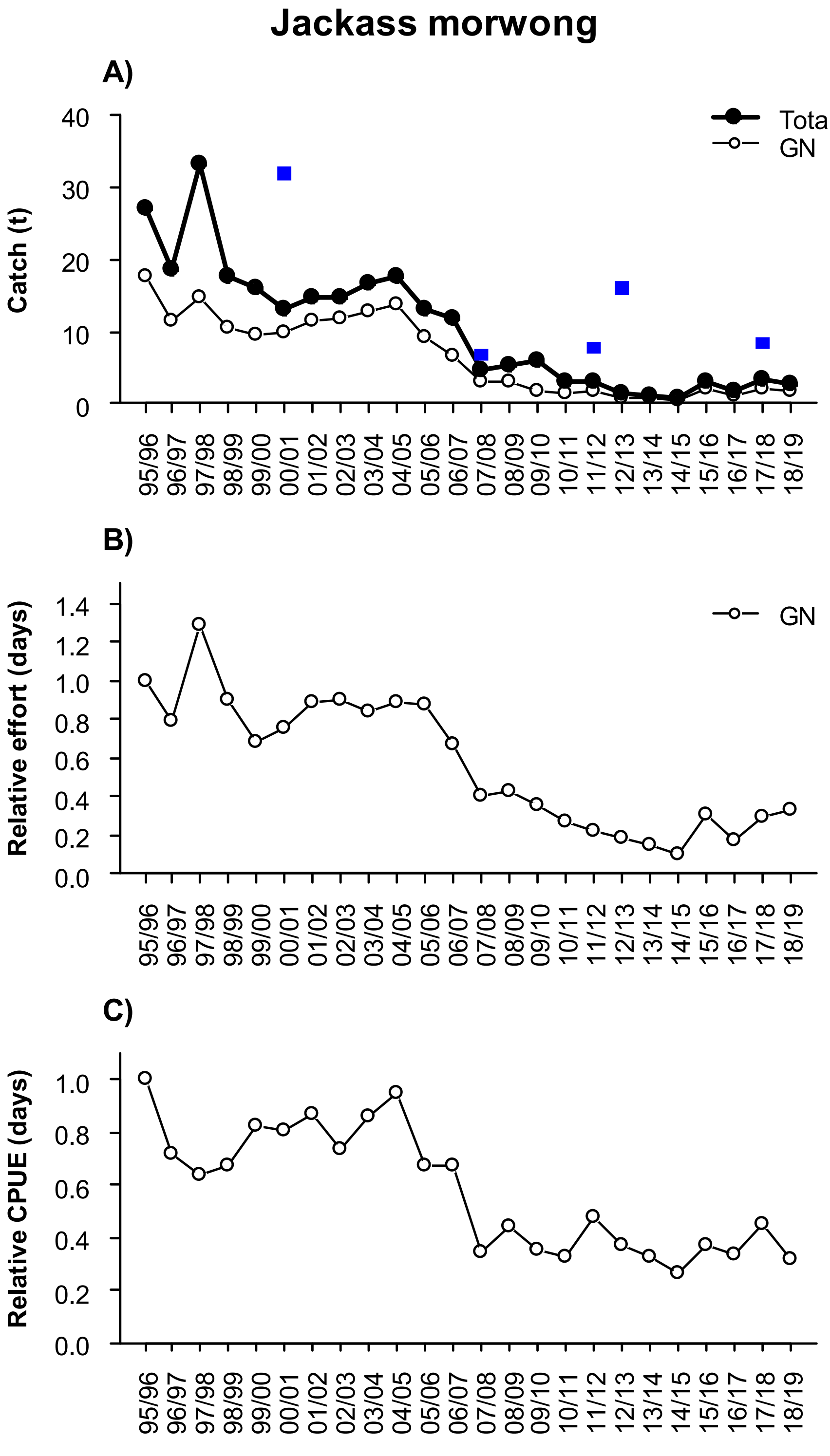
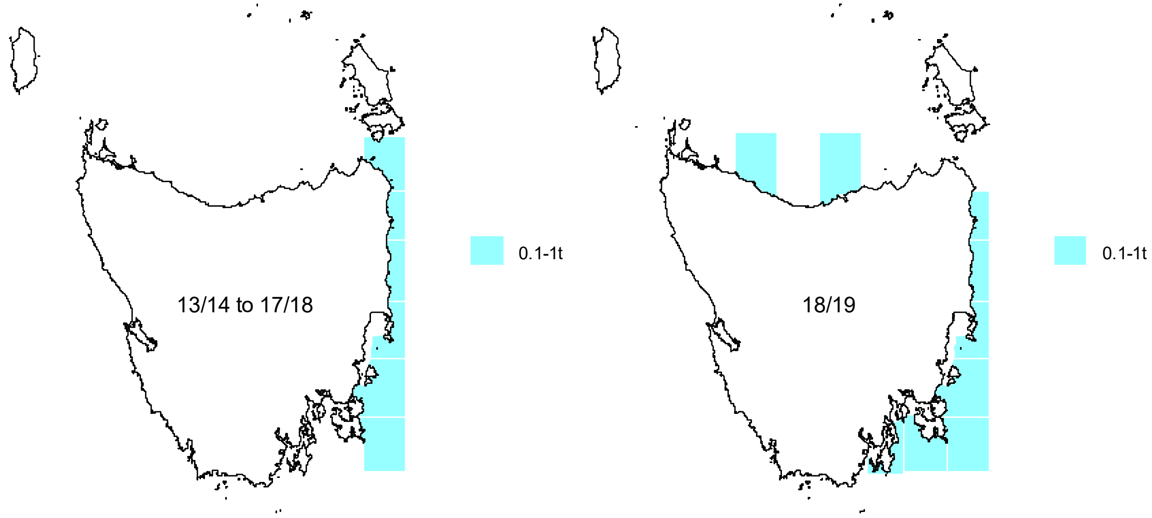


Figure 14.1 A) Annual commercial catch (t) by gear (left) and best estimates of recreational catches (blue squares). B) Commercial effort by method based on day fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. GN=gillnet.


A) Catch

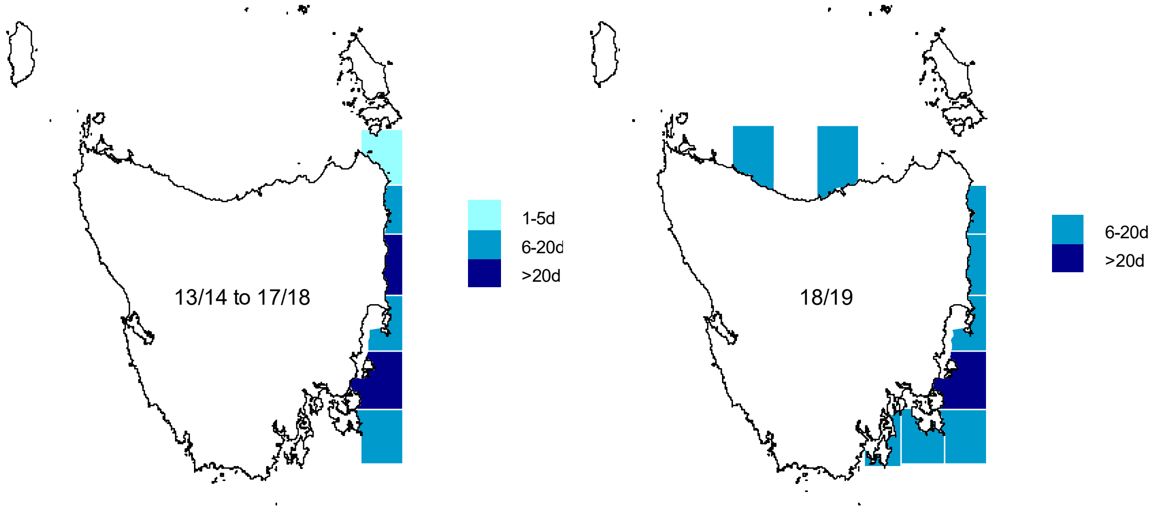

B) Effort

Figure 14.2 (A) Jackass Morwong catches (t) and (B) effort (days) for gillnet, handline and dropline by fishing blocks averaged over the last five assessment years (left) and in the current assessment year (right).

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (18.7 t)	No	
	• Catch < 3rd lowest catch value from the reference period (13.1 t)	Yes	↓ 10.5 t (-80%)
	• Latest recreational catch estimate > recreational catch estimate from the reference period (31.9 t)	No	
	• Proportion of recreational catch to total catch > previous proportion estimate (88.5% in 2012/13)	No	
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period • (-0.0017)	No	

Stock status **SUSTAINABLE**

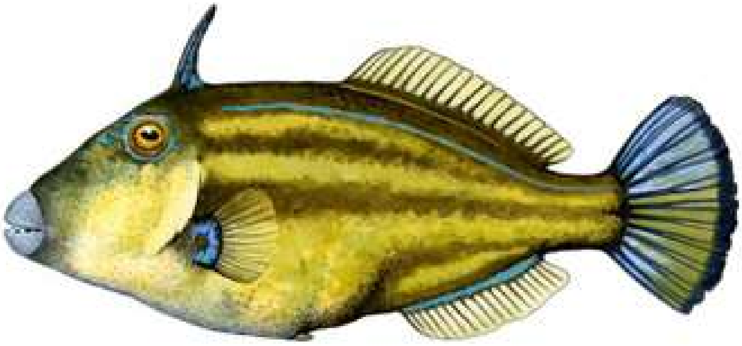
A single east Australian stock of Jackass Morwong is shared between the Commonwealth and Tasmania. Catch and catch rates have declined in a similar fashion. Catch declines may have been driven, in part, by a prolonged period of reduced recruitment that might to be a result of climate-induced changes to ocean current flow in eastern Tasmania (Wayte 2013). Due to an extended early life history period of Jackass Morwong in the open ocean, the species might be particularly sensitive to changes in ocean current flow, which can cause widespread larval dispersal and highly variable levels of recruitment success (Wayte 2013).

The Jackass Morwong stock was considered to be overfished in the late 2000s, but since 2011 has been classified as not overfished nor subject to overfishing (Woodhams et al. 2013, Flood et al. 2014, Patterson et al. 2019). The change of assessment status was associated with a reduction of catches for the species in response to management actions in the Commonwealth fishery as well as a revision of the stock assessment model. The total catch (recreational and commercial) of Jackass Morwong in Tasmania (11 t in 2018/19) is low compared to the Commonwealth catch (186 t in 2018/19). Although there has been no formal Commonwealth assessment since 2012, unpublished Commonwealth data seem to indicate that the East coast stock is rebuilding under currently allowable catch levels. No further reductions in allowable catch are anticipated. As Fishery Status Reports describe both the stock biomass and fishing mortality as sustainable (Patterson et al. 2019), this classification is applied to the Tasmanian fishery.

15. Leatherjackets

Monacanthidae family

STOCK STATUS	**UNDEFINED**
Several undifferentiated species of Leatherjacket are found in coastal waters around Tasmania. Leatherjackets are a by-product and not actively targeted due to a lack of market demand. Therefore, catch is not a good indicator of abundance, and there is little biological information to confidently classify the status of Leatherjacket stocks.	
IMPORTANCE	Minor
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends



Leatherjacket
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Seagrass and reefs. Down to 200 m depending on species	Edgar (2008)
Distribution	• Australia is the centre of diversity for this family with more than half of the estimated 90 species occurring here, mainly in temperate areas	Edgar (2008)
Diet	• Epiphytes attached to seagrass, algae, fish flesh, molluscs and crustaceans depending on species. Many species are omnivorous	FishBase (2013)
Movement and stock structure	• Many species are site-attached	Barrett (1995a)
Natural mortality	• Undefined for most species	
Maximum age	• No information	
Growth	• Maximum length: from 90 mm to 600 mm	Edgar (2008)
Maturity	• Little information	
Spawning	• Little information.	

Early life history	- Little information	
Gillnet post release survival	- High: 95%	Lyle et al (2014b)

Background

Leatherjackets are a generally discarded by-product of fish traps and netting operations. Leatherjackets are consumed on the mainland, but there is little market demand for these species in Tasmania.

FISHING METHODS	Mainly fish trap, also gillnet and handline
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence) • Recreational gear licence (graball and/or mullet net) **Output control:** • Possession limit of 20 and bag limit of 10 individuals for recreational fishers • Minimum size: 20 cm
MAIN MARKET	Local

Current assessment

Catch, effort and CPUE

Leatherjacket catches have declined continuously since the early 2000s reaching a minimum of 1.3 t in 2015/16 t (Fig. 15.1A). Total commercial catches in 2018/19 were 4.3 t, which represent an increase of 1-3 t compared to recent years. Catches from gillnets have declined consistently since 1995/96. Declines are also evident for catches from fish traps, but over the last three years fish trap catches have increased. Leatherjackets are now primarily caught on the East and Southeast coasts (Fig. 15.2).

Leatherjackets are also caught by the recreational sector with catch estimates in recent surveys at a similar level to commercial catches (Fig. 15.1A). Estimates were 8.2 t in 2000/01 (Lyle 2005), 2.6 t in 2007/08 (Lyle et al. 2009), 2.3 t in 2009/10, 1.8 t in 2012/13 (Lyle et al. 2014a), and 4.9 t in 2017/18 (Lyle et al. 2019).

Both fish trap and gillnet fishing effort have decreased through time (Fig. 15.1B), but fish trap effort has shown a slight increase over recent years. Abalone gut used to be the preferred bait in fish traps. However, a ban on its use has been in place since 2008 to prevent the spread of abalone viral ganglioneuritis (AVG).

Catch rates have remained relatively stable over time for gillnets, while fluctuating more for fish traps and showing a rise to historical peak levels in the current year (Fig. 15.1C).

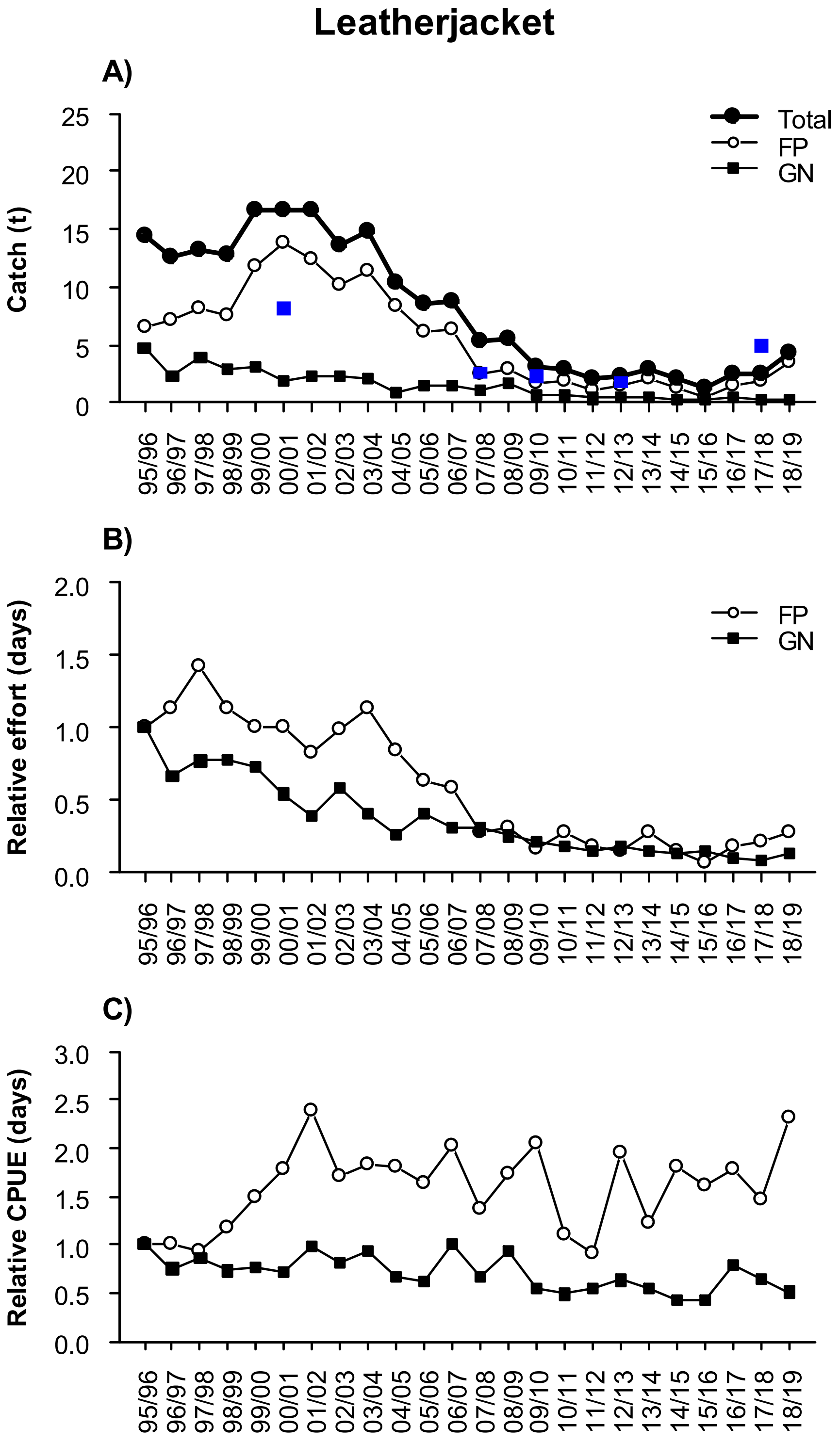
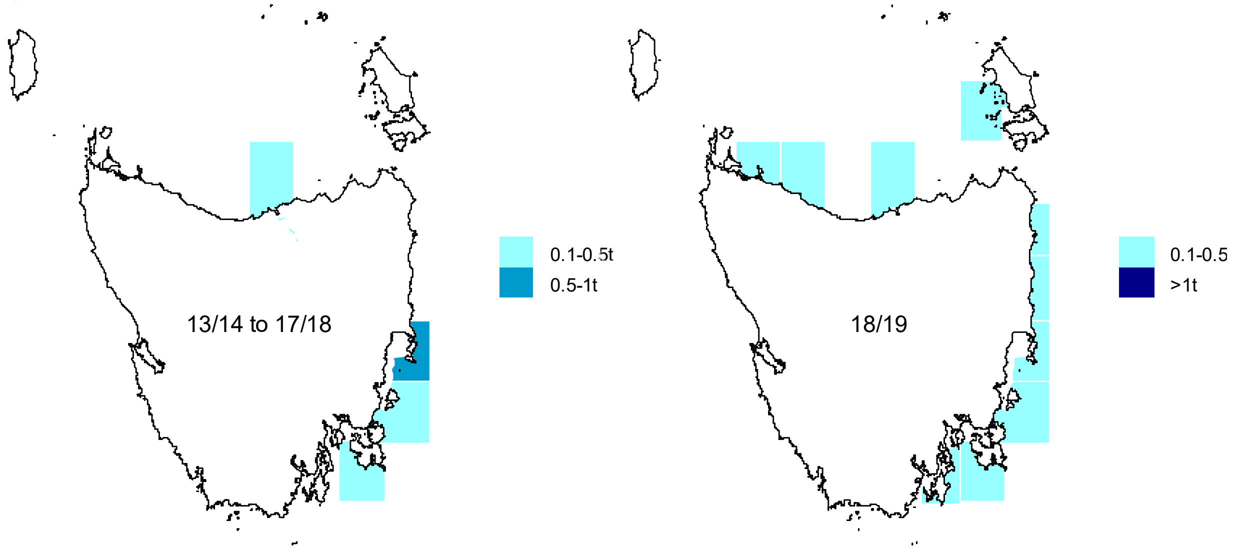


Figure 15.1 A) Annual commercial catch (t) by gear and best estimates of recreational catches (blue squares). B) Commercial effort by method based on day fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. FP=fish trap, GN=gillnet.

A) Catch



B) Effort

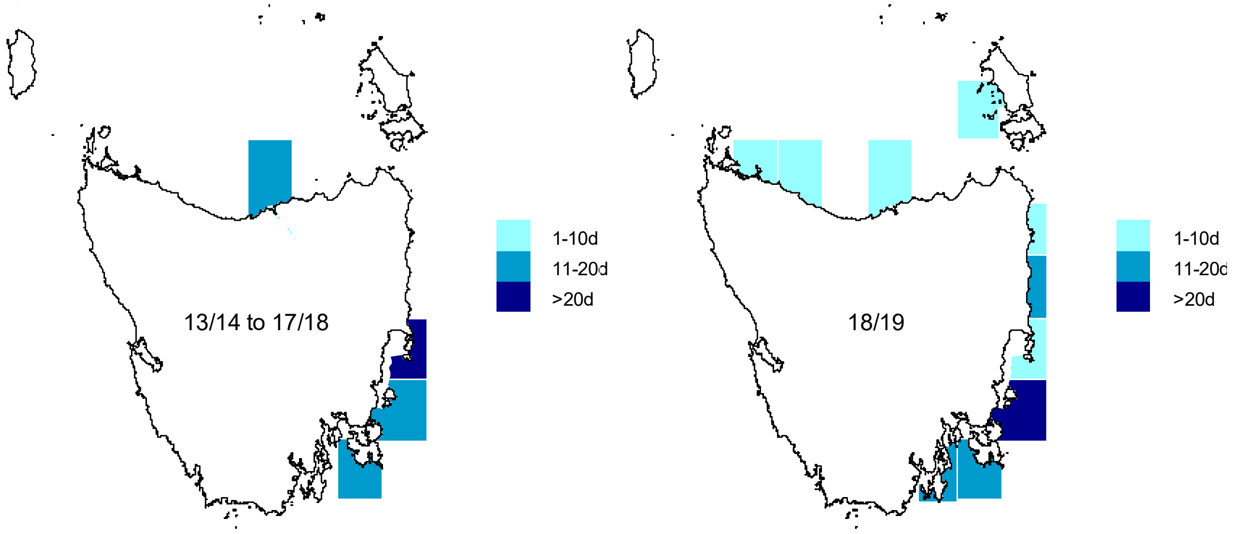


Figure 15.2 (A) Leatherjacket catches (t) and (B) effort (days) for fish trap and gillnet by fishing blocks averaged over the last five assessment years (left) and in the current assessment year (right). Note that highest catches >1 t in the current year were reported for Blackman Bay.

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian Scalefish Fishery, fish trapping was considered a very low risk to Leatherjacket species, which is the main by-product of fishing for Wrasse. This is because more recent catches of Leatherjacket were low due partly to the ban on using abalone gut for bait, which significantly reduced trapping effort. Risks to non-retained species and the general ecosystem were assessed as either low or negligible (Bell et al. 2016).

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (16.6 t)	No	
	• Catch < 3rd lowest catch value from the reference period (10.4 t)	Yes	↓ 6.1 t (-58.9%)
	• Latest recreational catch estimate > recreational catch estimate from the reference period (8.2 t)	No	
	• Proportion of recreational catch to total catch > previous proportion estimate (42.9% in 2012/13)	Yes	Latest estimate (2017/18): 65.4%
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0015)	No	

Stock status	UNDEFINED

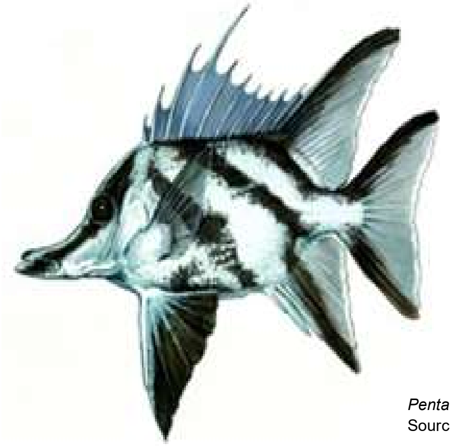
Consistently low landings of Leatherjacket mean that reference points for the lowest catch and for the proportion of recreational to commercial catch were breached in recent assessments. However, low catches are the likely result of a general decline in the use of fish traps and a lack of demand rather than an indication of relative abundance.

Leatherjackets tend to be site-attached and have limited home ranges. Two decades of monitoring eastern Tasmanian Marine Protected Areas (MPAs) indicate that there is no significant difference in the abundance of several Leatherjacket species, including Brown Striped Leatherjacket and Toothbrush Leatherjacket within vs outside of MPAs (Lyle et al. 2014b). Leatherjackets are assumed to show high post-release survival following capture in gillnets (Lyle et al. 2014b). This information suggests that fishing might not have a significant impact on Leatherjacket populations. However, there is overall insufficient information to confidently classify the status of Leatherjacket stocks, especially as multiple species are involved.

16. Longsnout Boarfish

Pentaceropsis recurvirostris

STOCK STATUS	**UNDEFINED**
Boarfish are a by-product species of Banded Morwong fishing with low catches due to the large minimum legal size. There is insufficient information available to confidently classify this stock.	
IMPORTANCE	Minor
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends



Pentaceropsis recurvirostris
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Exposed reef between 4 and 260 m depth	Edgar (2008)
Distribution	• From mid New South Wales to southern Western Australia, and around Tasmania	Edgar (2008)
Diet	• Brittle stars, polychaetes and brown algae	Edgar (2008) Scott et al. (1974)
Movement and stock structure	• Unknown	
Natural mortality	• Unknown	
Maximum age	• Unknown	
Growth	• Maximum length: 61 cm	Edgar (2008)
Maturity	• Unknown	
Spawning	• Unknown	
Early life history	• Unknown	
Gillnet release survival	• High: 99.7%	Lyle et al (2014b)

Background

Boarfish are a by-product of gillnetting operations primarily targeting Banded Morwong. The main species caught is the Longsnout Boarfish (*Pentaceropsis recurvirostris*). Due trip limits, its high minimum legal size and the requirement to release undersized fish, Longsnout Boarfish are regularly discarded. Longsnout Boarfish are locally marketed for consumption. Boarfish are also caught as by-product in shark net operations, but these catches are reported to the Commonwealth since 2000/01.

FISHING METHODS	Gillnet, shark net (in the past)
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence) • Recreational gear licence (graball and/or mullet net) • No spearing **Output control:** • Trip limit of 50 kg for commercial fishers • Possession limit of 4 and bag limit of 2 individuals for recreational fishers • Minimum size: 45 cm
MAIN MARKET	Mainly local

Current assessment

Catch, effort and CPUE

In Tasmania, Boarfish catches are now primarily derived from gillnet (Fig. 16.1A). Catches have been declining through time, however, appear to have stabilised at low levels since 2013/14 with landings of 925 kg reported in 2018/19 (Fig. 16.1A). Catches are taken exclusively from the East and Southeast coast (Fig. 16.2). Boarfish are not caught by rod and line and no recreational catch estimates are available for gillnet for this species. However, about 1000 individuals were recorded (both kept and released) in the 2012/13 survey (Lyle et al. 2014a), which indicates that Boarfish are not a common recreational species.

Following a peak in 2007/08, commercial gillnetting effort has declined slowly and then stabilized at low levels since 2013/14 (Fig. 16.1B). Catch rates have remained relatively stable (Fig. 16.1C).

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian Scalefish Fishery, gillnetting was considered a medium risk activity with regard to Boarfish as a by-product of fishing operations targeting Banded Morwong (Bell et al. 2016). There is no new information to suggest that the validity of this assessment has changed.

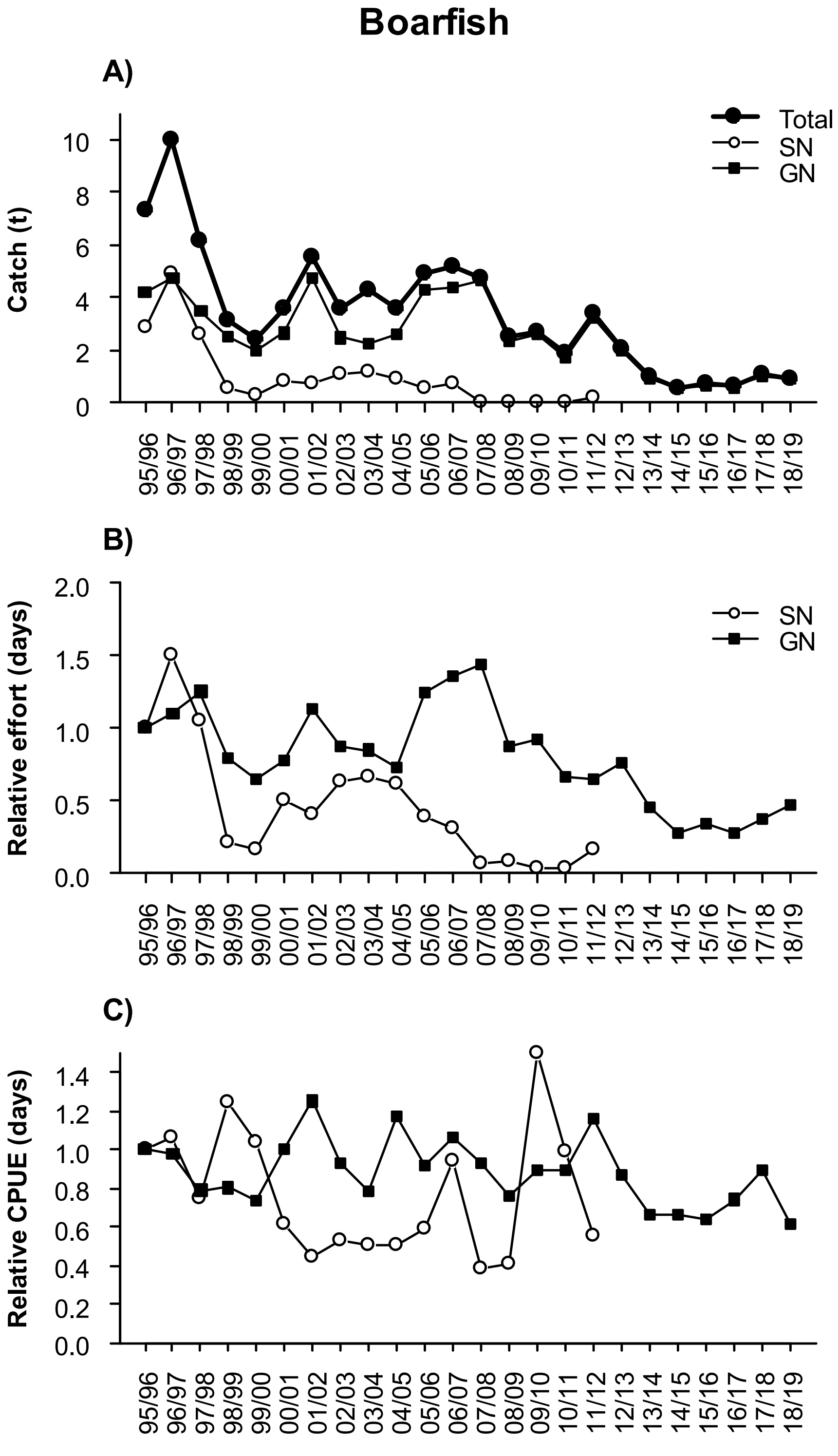
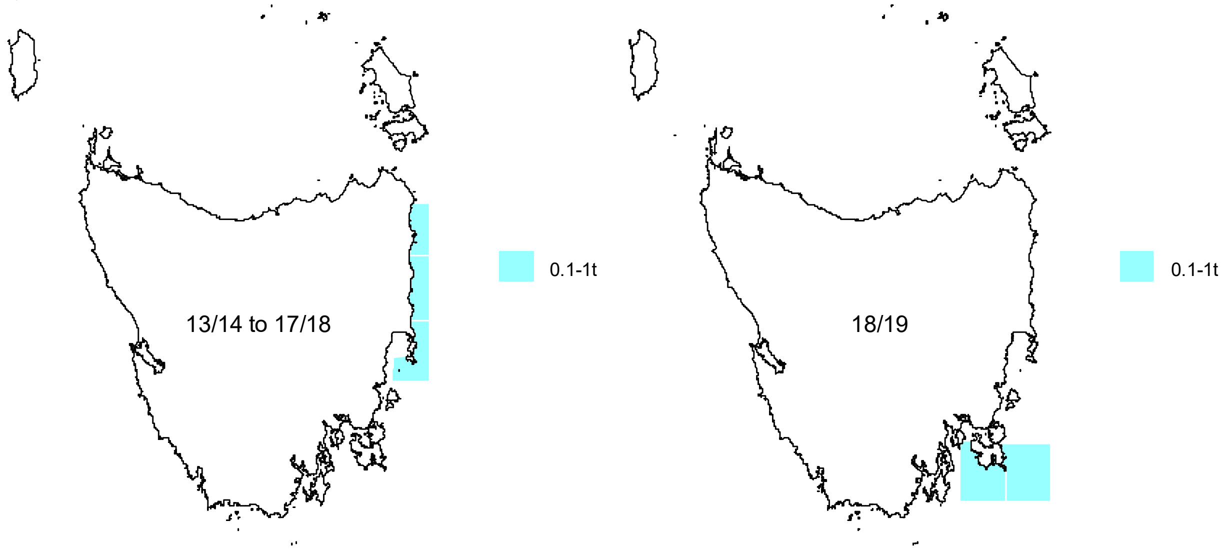
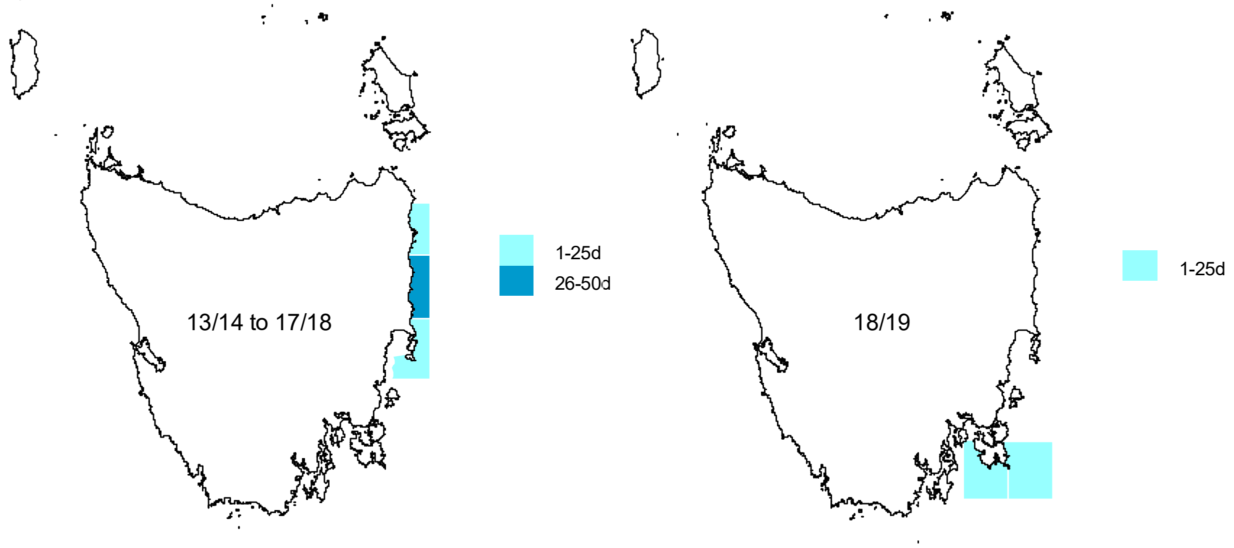


Figure 16.1 A) Annual commercial catch (t) by gear and best estimates of recreational catches (blue squares). B) Commercial effort by method based on day fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. GN=gillnet.



A) Catch



B) Effort

Figure 16.2 (A) Boarfish catches (t) and (B) effort (days) for gillnet fishing by fishing blocks averaged over the last five assessment years (left) and in the current assessment year (right).

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (6.2 t)	No	
	• Catch < 3rd lowest catch value from the reference period (3.6 t)	Yes	↓ 2.7 t (-75.1%)
	• Latest recreational catch estimate > recreational catch estimate from the reference period	Not estimated	
	• Proportion of recreational catch to total catch > previous proportion estimate	Not estimated	
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0009)	No	

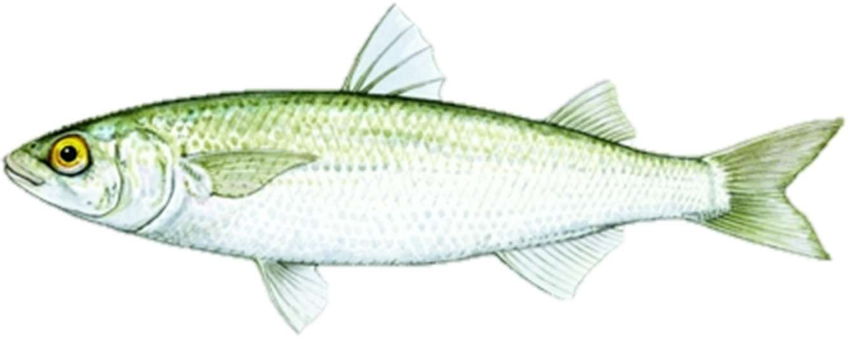
Stock status	**UNDEFINED**

The reference point associated with low catch was breached in all recent assessments. This situation is due to reduced gillnetting effort compared to the reference period, noting that catch rates have remained relatively stable over time. Boarfish are a by-product that is taken in very small quantities. In addition to catches taken in state waters, there is also a by-product fishery from Commonwealth shark netting activity. The high minimum size limit and commercial trip limit of 50 kg mean that many individuals are released, but the species is assumed to show high post-release survival (Lyle et al. 2014b). Overall, there is insufficient information available to confidently classify this stock.

17. Yelloweye Mullet

Aldrichetta forsteri

STOCK STATUS	**SUSTAINABLE**
Yelloweye Mullet are most abundant in estuarine habitats where netting is prohibited or restricted, thereby, providing a high degree of protection throughout most of their range. Catches are at low levels, but unlikely to reflect abundance. It is overall unlikely that the stock is recruitment impaired or that the current fishing pressure is high enough that the stock might become recruitment impaired in the future.	
IMPORTANCE	Minor
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends



Aldrichetta forsteri
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Sheltered sand, seagrass, up to 20 m depth. May ascend rivers into freshwaters	Edgar (2008)
Distribution	• Western Australia (Shark Bay) to New South Wales, and around Tasmania, New Zealand	Edgar (2008)
Diet	• Planktonic animals for juveniles, benthic crustaceans and molluscs for medium-sized fish and almost exclusively algae for larger fish	Edgar (2008)
Movement and stock structure	• Schooling fish • No genetic studies but there appears to be two populations (eastern Australia and western Australia)	Kailola et al. (1993)
Natural mortality	• *M* estimated at 0.66 (New Zealand)	Paul and Taylor (1998)
Maximum age	• 7 years	Curtis and Shima (2005)
Growth	• Maximum length of 50 cm • Maximum weight: 950 g • Differential growth between sexes and locations	Edgar (2008) Curtis and Shima (2005

<table>
<tr>
<td></td>
<td>

Growth described by von Bertalanffy growth function $L = L_\infty\left(1 - e^{-k(t-t_0)}\right)$, where <i>L</i> is the fork length (cm), <i>t</i> is the age (years), L_∞ is the average maximum length for the species, <i>k</i> is a constant and t_0 is the (theoretical) age where length equals zero.

Parameter estimates are:
<table>
<tr><th><i>Sex</i></th><th>L_∞</th><th>k</th><th>$t_{0\infty}$</th></tr>
<tr><td>Combined</td><td>40</td><td>0.51</td><td>-0.03</td></tr>
</table>

Length-weight relationship was estimated at $W = 0.000239\ L^{3.2}$ for females and males combined where <i>W</i> is weight (g) and <i>L</i> is the fork length (cm)

</td>
<td>Gorman (1962)
Last et al. (1983)
Chubb et al. (1981)</td>
</tr>
<tr>
<td>Maturity</td>
<td>2–3 years</td>
<td>Kailola et al. (1993)</td>
</tr>
<tr>
<td>Spawning</td>
<td>Form large aggregations prior to spawning
Spawn in coastal waters in summer and autumn, probably in estuaries
Fecundity between 125,000 and 630,000 eggs
Pelagic eggs</td>
<td>Chubb et al. (1981)
Kailola et al. (1993)</td>
</tr>
<tr>
<td>Early life history</td>
<td>Juveniles enter estuaries and sheltered bays when they are 3–4 cm long, and remain there until they reach 25–30 cm tail length
As they grow older, animals gradually move to more open coastal waters</td>
<td>Kailola et al. (1993)</td>
</tr>
<tr>
<td>Gillnet post release survival</td>
<td>Low: 10%</td>
<td>Lyle et al (2014b)</td>
</tr>
</table>

Background

Mullet are occasionally targeted using beach and purse seines as well as small mesh nets. The vast majority of the catch is considered to be Yelloweye Mullet, but it is possible that some of the catch includes Sea Mullet (*Mugil cephalus*). Mullet are also targeted by recreational fishers using rod and line or small mesh gillnets referred to as 'mullet nets'.

FISHING METHODS	Mostly beach seine, also small mesh net (mullet net for recreational) and purse seine
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence, small mesh gillnet licence) • Recreational gear licence (graball and/or mullet net) **Output control:** • Possession limit of 30 and bag limit of 15 individuals for recreational fishers – all mullet species combined • Minimum size: 25 cm
MAIN MARKET	Mostly local

Current assessment

Catch, effort and CPUE

After peaking in 1999/2000 at about 5 t, commercial mullet catches have decreased to generally less than 2 t since 2006/07. The commercial catch in 2018/19 was 212 kg, a low level comparable to that in the last three years and close to the historic low of 100 kg in 2007/08 (Fig. 17.1A). Beach seine has historically been the dominant fishing method used to harvest mullet, but small mesh nets started to increase in relative importance since 2010/11. Recent fishing activity tended to be concentrated off the North coast, although in 2018/19 this was not evident (Fig. 17.2). Recreational catches of mullet were estimated at 6.5 t in 1996/97, 30 t in 2000/01, 1.7 t in 2009/10 and 7.1 t in 2012/13 (Lyle et al. 2014a), and 4.6 t in 2017/18 (Lyle et al. 2019) (Fig. 17.1A), and thus, represent a more considerable source of impact on species than commercial activities.

Beach seine effort increased and remained at a relatively high level until 2005/06 after which it declined steadily until now (Fig. 17.1B). Catch rates for beach seine remain high and relatively constant, but with notable increases specifically over recent years. Catch rates for mesh net fluctuate around a reduced level compared to 1995/96 (Fig. 17.1C).

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian Scalefish Fishery, beach seining was considered a negligible risk activity with regard to Yelloweye Mullet due to the low annual catch and the fact they are widespread and not targeted in estuarine habitats (Bell et al. 2016). There is no new information to suggest that the validity of this assessment has changed.

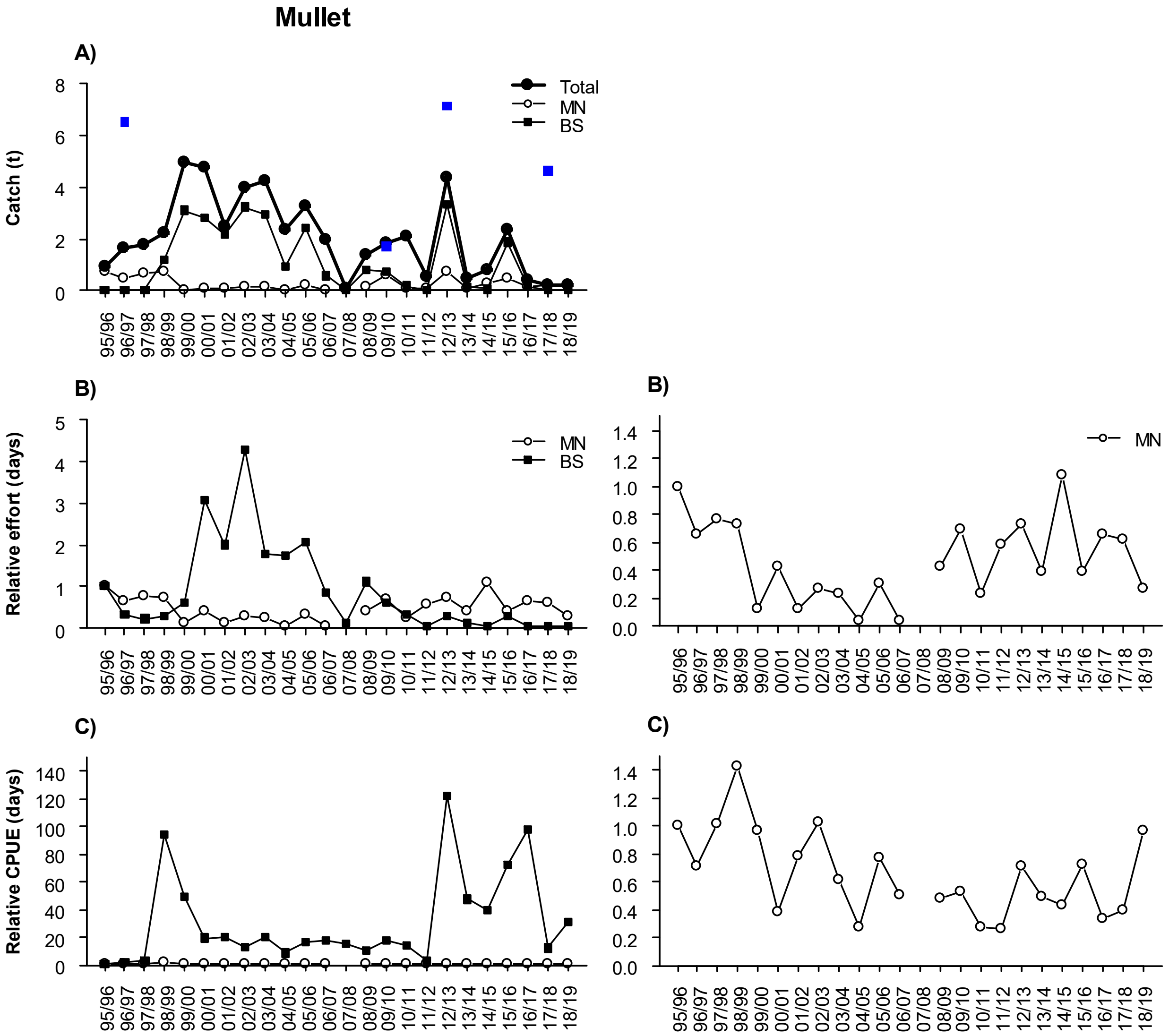


Figure 17.1 A) Annual commercial catch (t) by gear and best estimates of recreational catches (blue squares). B) Commercial effort by method based on days fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. BS=beach seine, MN=small mesh net. For clarity, plots on the right show trends for mesh net separately.

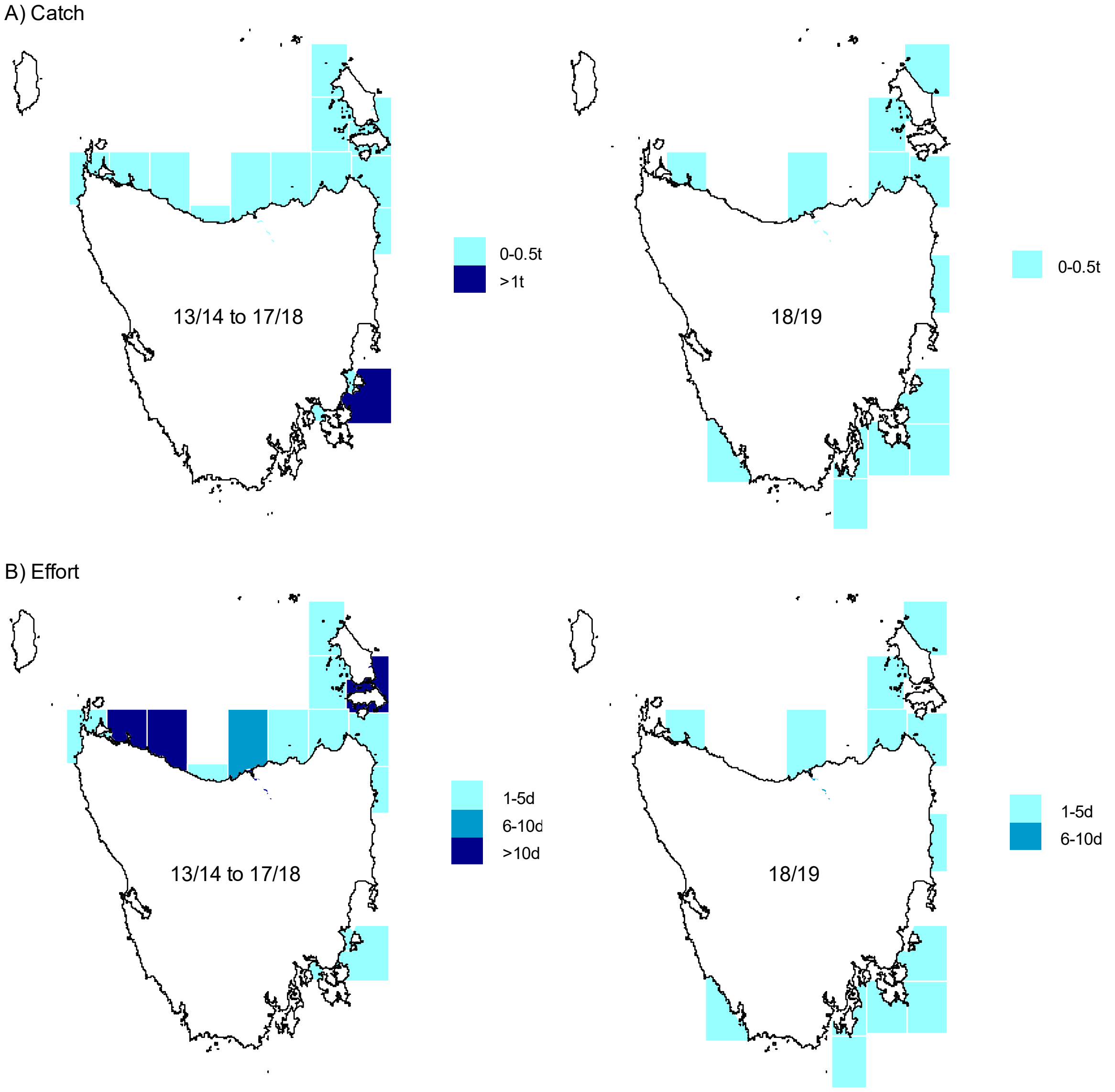


Figure 17.2 (A) Mullet catches (t) and (B) effort (days) for by fishing blocks averaged over the last five assessment years (left) and in the current assessment year (right).

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (4.3 t)	No	
	• Catch < 3rd lowest catch value from the reference period (1.7 t)	Yes	↓ 1.5 t (-85.8%)
	• Latest recreational catch estimate > recreational catch estimate from the reference period (30.0 t)	No	
	• Proportion of recreational catch to total catch > previous proportion estimate (73.3% in 2007/08)	Yes	Latest estimate (2017/18): 93.9%
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.013)	No	

Stock status

SUSTAINABLE

Yelloweye Mullet are the by far most abundant mullet species in southern Australia and highly abundant in Tasmanian estuaries (Edgar 2008). Excepting 2012/13, catches of mullet (predominantly Yelloweye Mullet) have been stable at low levels for the past six years, following a decrease in effort in the traditional fishing grounds in northern Tasmania. Limited commercial fishing and no recreational gillnetting occurs in most Tasmanian estuaries, meaning that the species experiences a high degree of protection throughout much of its range. Recreational catches are the main source of fishing mortality for Yelloweye Mullet (>90% of total fishing mortality in 2017/18), but total catches on the order of 5 t are unlikely to result in recruitment impairment. Yelloweye Mullet stocks in Tasmanian waters are thus classified as sustainable.

18. Snook

Sphyraena novaehollandiae

STOCK STATUS	**SUSTAINABLE**
Current catches of Snook approach historically lowest levels. Catch rates are considered unreliable to estimate abundance due to the species not being actively targeted. Recent biological analyses indicate that the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired.	
IMPORTANCE	Minor
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends

Species biology

Parameters	Estimates	Source
Habitat	Exposed reef, sand, seagrass and offshore waters down to a depth of 20 m	Edgar (2008)
Distribution	Western Australia to southern Queensland, and northern Tasmania	Edgar (2008)
Diet	Fish	Coleman and Mobley (1984) Scott et al. (1974)
Movement and stock structure	Highly migratory pelagic species that often occurs in shoals of 50 or more individuals	Kailola et al. (1993)
Natural mortality	$M = 0.24$	Webb (2017)
Maximum age	19 years	Webb (2017)
Growth	Maximum length of 1.1 m, maximum weight of 5.6 kg, maximum age of about 20 years	Edgar (2008) Kailola et al. (1993)
Maturity	Around 42 cm in length	Bertoni (1995)
Spawning	Assumed to take place from October to January	Kailola et al. (1993)
Early life history	No information	
Gillnet post release survival	NA	

Background

Two separate species of 'Pike' are caught in Tasmania, the Longfin Pike (*Dinolestes lewini,* Dinolestidae) and Snook (*Sphyraena novaehollandiae,* Sphyraenidae). Both species are mainly targeted by trolling and small-mesh net (North coast only) and are also a by-product of beach seining and gillnetting. While there is a local and interstate market for Snook, Longfin Pike are of low demand. There are some uncertainties about the correct reporting of the two species in logbooks, but the vast majority of 'Pike' catches are likely to be Snook, which is confirmed by anecdotal reports from the industry. Therefore, this assessment refers to Snook.

FISHING METHODS	Troll, also beach seine, gillnet and small mesh net
MANAGEMENT METHODS	**Input control:** • Gear licence (scalefish fishing licence, small mesh gillnet licence) • Recreational gear licence (graball and/or mullet net) **Output control:** • No possession or bag limits for recreational fishers
MAIN MARKET	Local and interstate (Victoria)

Current assessment

Catch, effort and CPUE

Snook catches were variable, however, followed a relatively stable trend around 5 t since 1998/99. A historical low of 2.4 t was recorded in 2015/16. After increases over the last two years, catch in the current season is down again to similarly low levels (2.7 t) (Fig. 18.1A). Snook catch and effort tended to concentrate on the North coast over recent years, while in the current season most of the effort and catch was recorded on the East and South-East coast (Fig. 18.2).

There are no estimates of recreational landings (by weight), but past surveys suggest that neither Pike species are an important target for recreational fishers (Lyle et al. 2009, Lyle and Tracey 2012), and that around 57% of all Pike caught by recreational fishers are released (Lyle et al. 2009). Nevertheless, in 2012/13, 3,895 Pike were estimated to have been landed by recreational fishers (Lyle et al. 2014a). In 2017/18, landings were estimated at 9,441 individuals. Assuming an average weight of 1 kg per fish, this number translates to approximately 9 t.

Commercial troll effort, as the main capture method for Snook. has been variable through time and is currently fluctuating around values similar to the reference year (Fig. 18.1B). Beach seine effort has remained stable over time, but Snook are not targeted by beach seining.

Catch rates for troll have remained high and variable through time, which is influenced by species availability and targeting practices, whereas catch rates for both beach seine and mesh net have been comparatively stable (Fig. 18.1C).

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian Scalefish Fishery, trolling was considered a low risk activity with regard to Snook. While Snook are targeted throughout most of their range by multiple fishing methods, the low combined catch is assumed to be within sustainable limits. Trolling was also considered a negligible risk to all other ecosystem components (Bell et al. 2016). There is no new information to suggest that the validity of this assessment has changed.

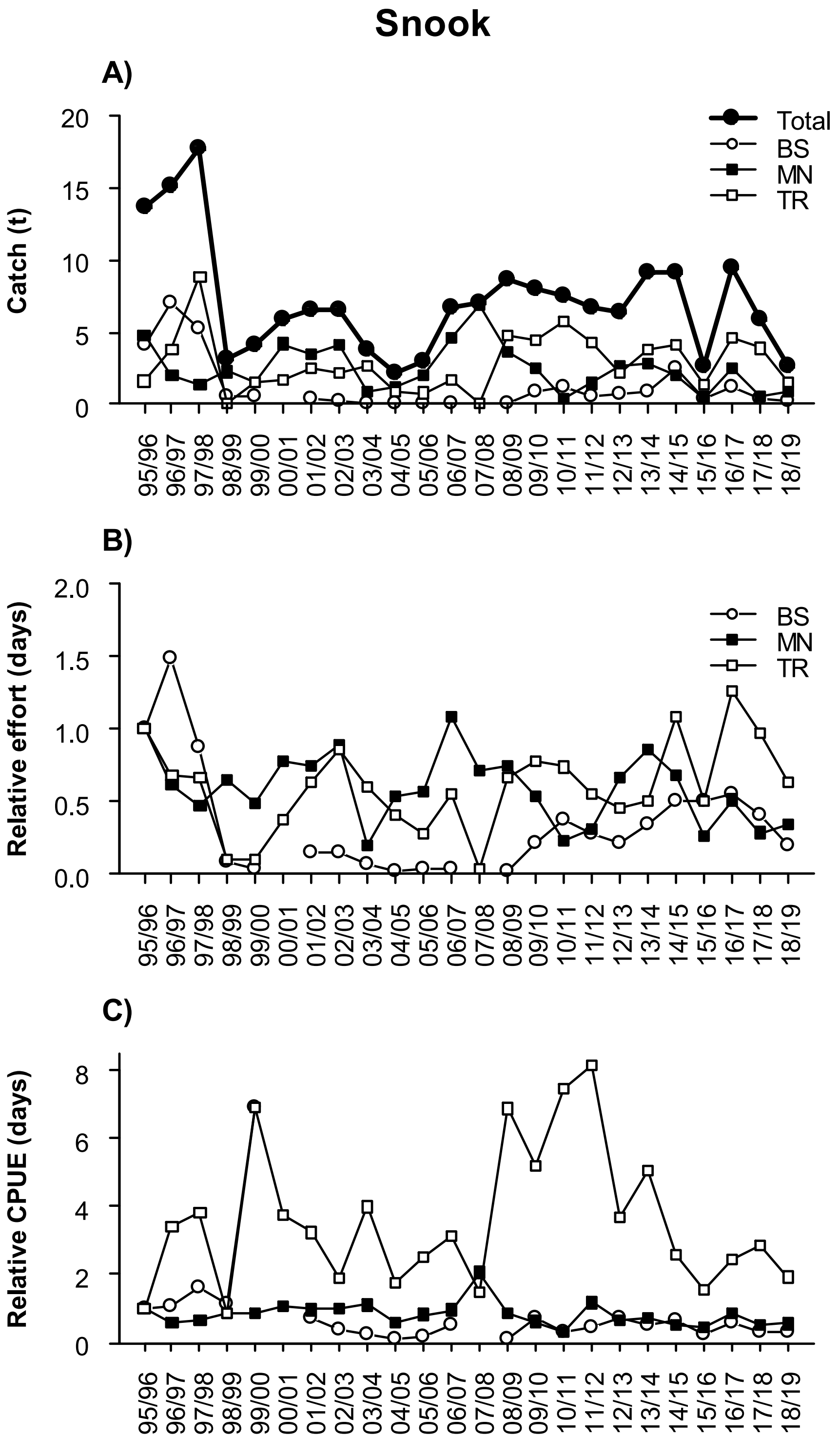
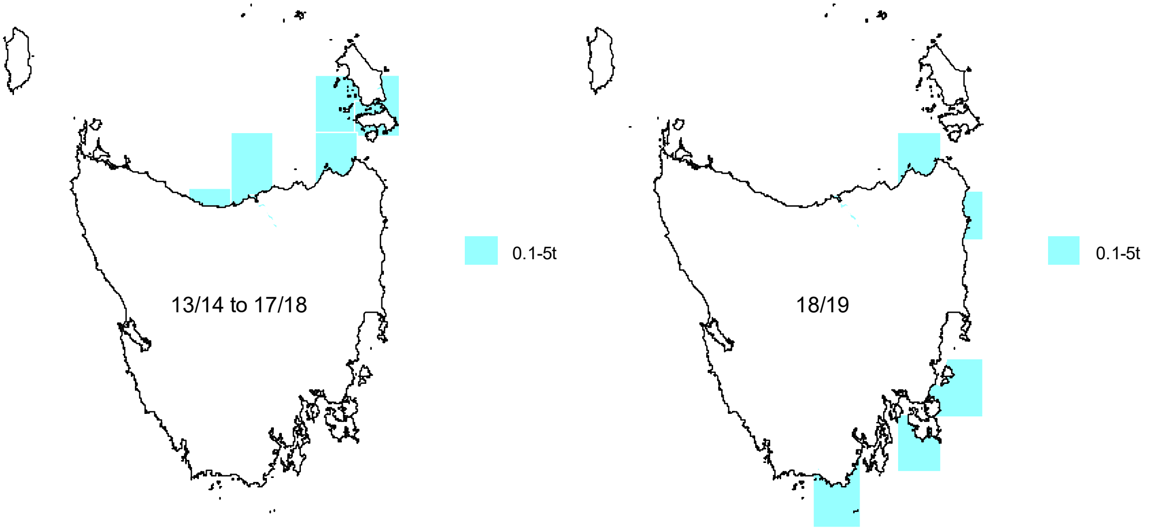


Figure 18.1 A) Annual commercial catch (t) by gear. B) Commercial effort by method based on day fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. BS=beach seine, TR=troll, MN=small mesh gillnet.

A) Catch



B) Effort

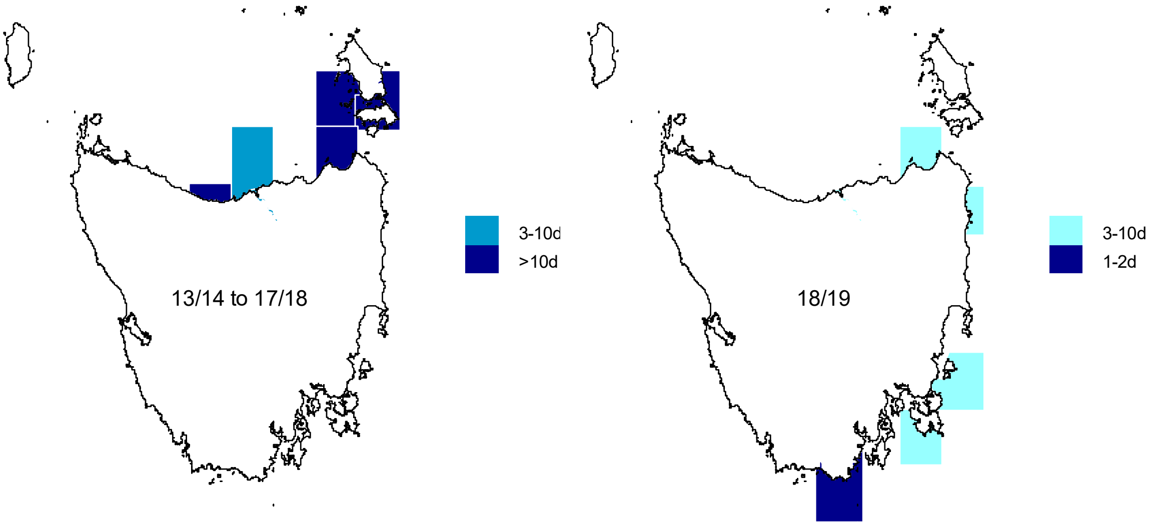


Figure 18.2 (A) Snook catches (t) and (B) effort (days) for troll, beach seine and small mesh net by fishing blocks averaged over the last five assessment years (left) and in the current assessment year (right).

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (13.7 t)	No	
	• Catch < 3rd lowest catch value from the reference period (3.2 t)	Yes	↓ 0.5 t (-15.7%)
	• Latest recreational catch estimate > recreational catch estimate from the reference period (based on numbers)	No	
	• Proportion of recreational catch to total catch > previous proportion estimate	Likely according to numbers caught (catch in weight was not assessed)	Latest estimate (2017/18): Possibly >50%
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0035)	No	

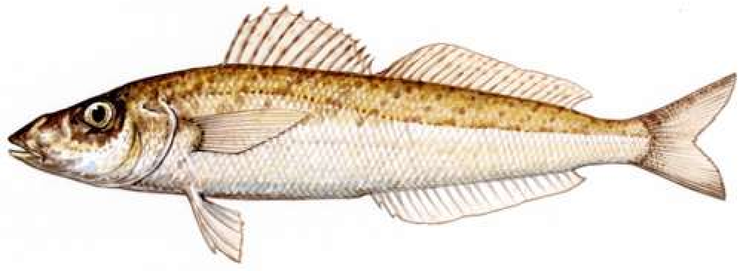
Stock status	**SUSTAINABLE**

The commercial fishery for Snook is relatively small and commonly limited to the northern part of Tasmania. In spite of comparatively high estimates of recreational landings, the species is not assumed to be an important target for recreational fishers. A recent fishery-dependent sampling program conducted in the north of the state estimated that fishing mortality (*F*) is approximately one quarter of natural mortality (*M*) (*F*=0.06 per year and *M*=0.24 per year) (Webb 2017), which is indicative of sustainable exploitation. The current level of fishing pressure is thus unlikely to cause the stock to become recruitment impaired.

19. Eastern School Whiting

Sillago flindersi

STOCK STATUS	**SUSTAINABLE**
This is a predominately Commonwealth-managed species that is classified as not overfished nor subject to overfishing by ABARES for 2018. It is classified as sustainable in the 2018 Status of Australian Fish Stocks Report. Tasmanian catches fluctuate with market demand, but generally represent only a small proportion of the Commonwealth commercial catch.	
IMPORTANCE	Minor
STOCK(S)	Tasmanian Scalefish Fishery/Southern and Eastern Scalefish and Shark Fishery (Commonwealth)
INDICATOR(S)	Catch, effort and CPUE trends



Sillago flindersi
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Coastal lakes, estuaries and along outer coast down to 170 m depth	Gomon et al. (2008)
Distribution	• Endemic to southeastern Australia; from southern Queensland to western Victoria and around Tasmania	Gomon et al. (2008)
Diet	• Feed mainly on crustaceans, amphipods, decapods, mysids and copepods (juveniles)	Burchmore et al. (1988)
Movement and stock structure	• There is some evidence of four genetically distinct stocks (two in New South Wales, one in Tasmania and one in Victoria) • Commonwealth assessments state that the evidence for separate stocks is weak and manage the species as a single stock	Dixon (1987) Morison et al. (2012)
Natural mortality	• No information but likely to be around $M = 0.7$ based on related species	Butcher and Hagedoorn (2003)
Maximum age	• 7 years	Kailola et al. (1993)
Growth	• Maximum length: 33 cm SL • Growth described by von Bertalanffy growth function $L = L_\infty\left(1 - e^{-k(t-t_0)}\right)$,	Gomon et al. (2008) Tilzey (1994

<table>
<tr><td></td><td>where L is the length (cm), t is the age (years), L_∞ is the average maximum length for the species, k is a constant and t_0 is the (theoretical) age where length equals zero
Parameter estimates are:
<table><tr><th>Sex</th><th>L_∞</th><th>k</th><th>t_0</th></tr><tr><td>Combined</td><td>23.9</td><td>0.46</td><td>-0.50</td></tr></table></td><td></td></tr>
<tr><td>Maturity</td><td>• Reached at 2 years and a size of 14–16 cm FL</td><td>Hobday and Wankowski (1987)
Burchmore et al. (1988)</td></tr>
<tr><td>Spawning</td><td>• Spring to late summer
• Females release between 30,000 and 110,000 eggs in total during the season</td><td>Hobday and Wankowski (1987)</td></tr>
<tr><td>Early life history</td><td>• Juveniles inhabit inshore waters</td><td>FishBase (2013)</td></tr>
<tr><td>Gillnet post release survival</td><td>• NA</td><td></td></tr>
</table>

Background

School Whiting have been exploited in Tasmania since the mid-1970s with total catches ranging between 20 t and 175 t throughout the 1980s (Kailola et al. 1993). The vast majority of the catch is taken by Danish seine in the South of the state. Danish seine fishing operations target either School Whiting (with Flathead as a by-product) or Flathead (with School Whiting as by-product). This situation tends to cause opposing trends in catches for these two species. School Whiting are marketed and processed primarily in Melbourne.

The largest share of School Whiting catches in Australia is landed in Commonwealth waters. The Commonwealth fishery alone accounted for 1,000–2,500 t per year over the last 30 years, of which about 75% of this catch taken by Danish seine vessels operating out of Lakes Entrance, Victoria (Morison et al. 2012). Fisheries in other states are also important. The New South Wales state-managed fishery for School Whiting has been increasing in recent years and now accounts for about 60% of the total catch, which has led to equity disagreements given that state catches are deducted from the Commonwealth Total Allowable Catch (Morison et al. 2012).

In recent years, small catches of King George Whiting (*Sillaginodes punctatus*) have been recorded from small mesh netting operations in the north of Tasmania. King George Whiting is increasingly important as a target for both commercial and recreational fishers. Northern Tasmania may be an important spawning location for this species, which might explain why large individuals appear to be common. King George Whiting fisheries in Victoria, in contrast, appear to comprise primarily juveniles with the seed stock believed to come from South Australia.

FISHING METHODS	Danish seine
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence, small mesh gillnet) • Danish seine licence (with whiting cod-end endorsement) **Output control:** • Possession limit of 30 and bag limit of 15 individuals for recreational fishers
MAIN MARKET	Interstate

Current assessment

Catch, effort and CPUE

Eastern School Whiting landings in Tasmania have fluctuated widely since 1998/99. A catch of 41.5 t in 2018/19 is close to historical peaks (Fig. 19.1A). Catches are influenced by the practices of a small number of operators. Catches in 2018/19 were concentrated on the southeast coast (in particular the Derwent Estuary) as has been the case in previous years (Fig. 19.2). Recreational catches are generally low with estimated weights of 0.8 t in 2000/01 (Lyle 2005), 3.4 t in 2007/08 (Lyle et al. 2009), 2.1 t in 2012/13 (Lyle et al. 2014a), and 8.6 t (including King George Whiting) in 2017/18 (Lyle et al. 2019) (Fig. 19.1A).

Danish seine fishing effort has been variable over time, showing several notable drops in some years (Fig. 19.1B). Effort increased slightly in 2018/19, but not as much as catch, therefore, resulting in an increase in catch rates per days fished compared to last year (Fig. 19.1C).

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian Scalefish Fishery, Danish seining was considered a low risk activity with regard to School Whiting due to the low effort and the fact that fishing activities operate within a small fraction of the species range (Bell et al. 2016). There is no new information to suggest that the validity of this assessment has changed.

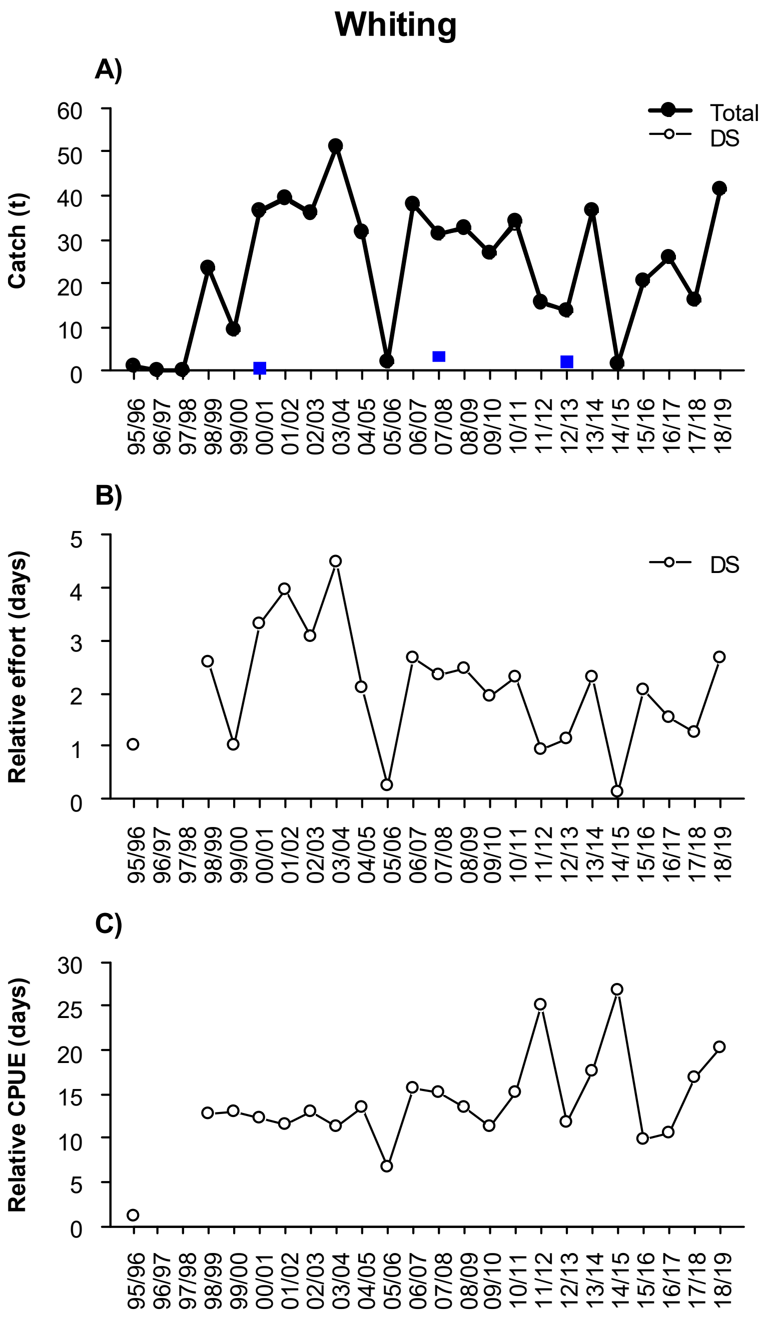
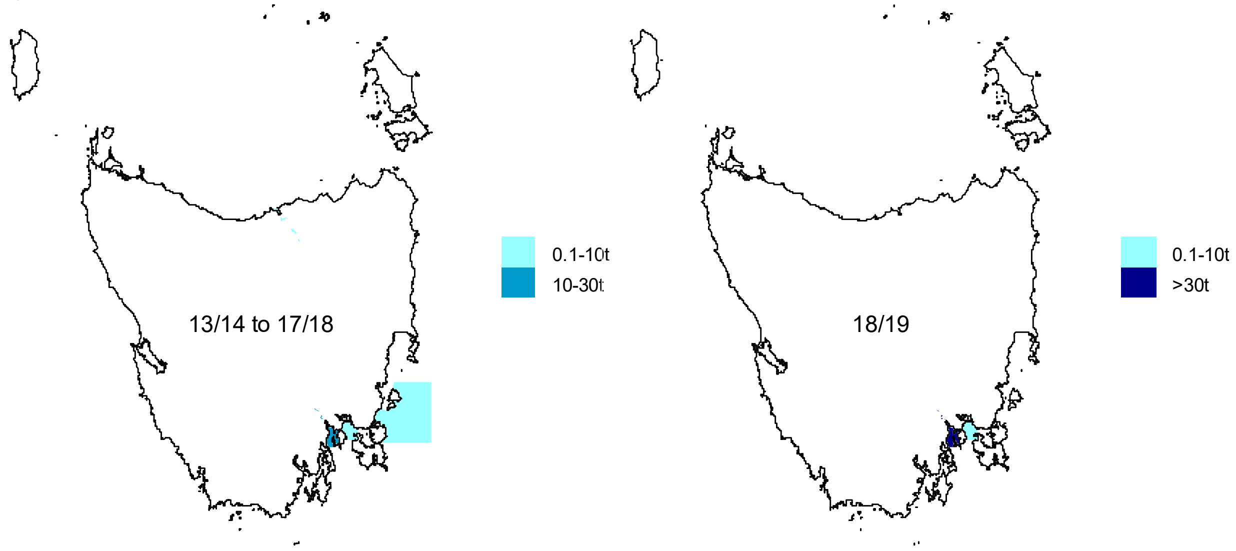


Figure 19.1 A) Annual commercial catch (t) by gear and best estimates of recreational catches (blue squares). B) Commercial effort by method based on day fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. DS=Danish seine.

A) Catch



B) Effort

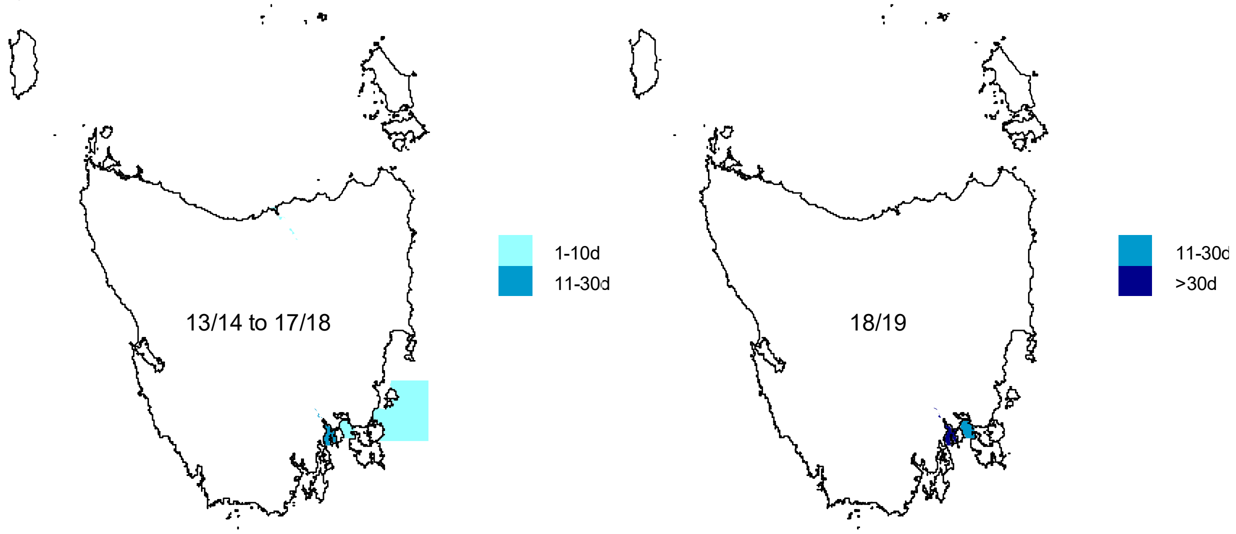


Figure 19.2 (A) Eastern School Whiting catches (t) and (B) effort (days) for Danish seine by fishing blocks averaged over the last five assessment years (left) and in the current assessment year (right).

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (38.1 t)	Yes	↑ 3.3 t (+8.7%)
	• Catch < 3rd lowest catch value from the reference period (1.4 t)	No	
	• Latest recreational catch estimate > recreational catch estimate from the reference period (0.8 t)	Yes	Latest estimate (2017/18): 1.4 t (175%)
	• Proportion of recreational catch to total catch > previous proportion estimate (8.7% in 2007/08)	No	
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0954)	No	

Stock status	**SUSTAINABLE**

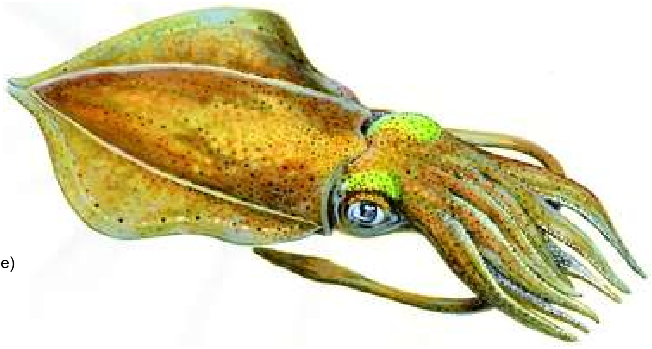
Catch, effort and catch rate patterns for School Whiting have been determined to a large extent by the level of targeting. The primary fisher is known to switch between Tiger Flathead and School Whiting, presumably depending on market demand. While the most recent recreational catch estimate was higher than during the reference period, catches by the recreational sector remain low and are inconsequential given the assumed size and distribution of the School Whiting stock.

Overall, the Tasmanian component of the fishery lands only a small proportion of the catch when compared with Commonwealth landings (736 t and 537 t in the last two years). The latest Fishery Status Report (Patterson et al. 2019) classifies the Eastern School Whiting fishery as sustainable in terms of both stock status and current fishing mortality. In accordance with this assessment, the Tasmanian component of this fishery is classified as sustainable.

20. Southern Calamari

Sepioteuthis australis

STOCK STATUS	**DEPLETING**
State-wide commercial catches in 2017/18 declined by more than 50% from 2016/17, which is largely due to a decline in catch in the northern areas of the state. Fishing effort also declined, particularly on the North coast, but remained high relative to historic levels. In 2018/19, both catch and effort increased again in all regions. This resulted in an increase in CPUE that is consistent with fishery-independent survey results, which showed increased egg laying activity in 2018 compared to 2017. However, total catch in 2018/2019 was notably higher again than the estimated maximum sustainable yield (MSY). In combination with egg survey results for 2019, which indicate reduced spawning activity, there is reason for concern that fishing mortality has been excessive and could cause the stock to become recruitment impaired.	
IMPORTANCE	Key
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch and CPUE trends



Sepioteuthis australis
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Shallow inshore water	Gomon et al. (2008)
Distribution	• Endemic to southern Australia and northern New Zealand	Gomon et al. (2008)
Diet	• Various crustaceans and fishes	Norman (2000)
Movement and stock structure	• Highly mobile, including migrations between feeding grounds and spawning grounds • Preliminary genetic studies revealed a minimum of 5 distinct stocks in Australia, with 98% of the Tasmanian population belonging to a single genetic stock that is also found in South Australia, New South Wales and Western Australia, suggesting some degree of connectivity	Triantafillos and Adams (2001) Triantafillos (2004) Smith et al. (2015b)

	• A more comprehensive genetic study revealed a single stock across southern Australia and that Tasmania is particularly important in terms of reproduction	
Natural mortality	• High • Embryo mortality rate between 5% and 25%	Steer et al. (2004)
Maximum age	• Short-lived (<1 year), with maximum recorded ages of 275 days for males and 263 days for females	Pecl et al. (2004) Pecl and Molt-schaniwsky 2006
Growth	• Rapid growth: 7–8% body weight (BW) per day (<100 days old) and 4–5% BW per day (>200 days old) • Growth for both males and females after recruitment (age *t* > 80 days) can be estimated based on the power function $L = 2e^{-6}t^{3.5332}$, where *L* is mantle length (mm) • Variability in growth explained partly by temperature and food availability (warmer seasons means faster growth), but there is also a likely genetic component • Length-weight relationship can be described as $W = 0.00081L^{2.427}$ where *W* is weight (g) and *L* is the dorsal mantel length (mm).	Pecl et al. (2004) Triantafillos (2004) Data from Pecl (2004)
Maturity	• Size-at-50% maturity estimated at 184.5 mm for females	Data from Pecl et al. (2006)
Spawning	• Major spawning period in spring/summer (September to February) in Tasmania, with low levels of spawning likely occurring all year round • Great Oyster Bay (east coast of Tasmania) is a known spawning ground • Multiple spawners reproductively active over several months (up to 3.5 months). • Females deposit eggs in collective egg masses, attaching capsules to substrate by small stalks	Moltschaniwskyj and Pecl (2003) Pecl et al. (2004) Pecl et al. (2006)
Early life history	• Incubation time estimated at 4 to 8 weeks, depending on water temperature • Hatchlings (2.4-7 mm) then swim to the surface and can be found near spawning grounds for 20–30 days • Habitat and ecology between 20–80 days is unknown • From 80–150 days, juveniles are found in deeper water adjacent to spawning ground • Individuals available to the fishery between 90–120 days of age	Steer et al. (2002) Pecl (2000) Pecl (2004)

Background

The commercial fishery for Southern Calamari in Tasmania started developing in the mid-1990s in Great Oyster Bay (GOB). It then expanded rapidly to the Southeast (including Mercury Passage, Maria Island and Tasman Peninsula) during the latter half of the 1990s. Annual catches rose from less than 20 t prior to 1995/96 to around 90 t in 1998/99. Since then, catches have fluctuated between 40 t and 110 t. The expansion of the fishery was accompanied by a substantial increase in effort, particularly using squid-jigs, which now represent the primary capture method. Southern Calamari are taken in lower quantities by purse seine, beach seine, spear and dipnet. Although some night fishing occurs, the species is targeted mainly during the day over shallow areas of seagrass and macro-algae while it aggregates to spawn.

FISHING METHODS	Squid jig (main), purse seine, beach seine, spear, dipnet.
MANAGEMENT METHODS	**Input control:** • Gear licence (scalefish fishing licence) • Species licence (Southern Calamari licence) for the Southeast region • Class seine licences • Temporal closures (mid-October to mid-November) of an area on the East coast • Temporal closure (October) of the entire North coast **Output control:** • Daily bag limit of 10 and possession limit of 20 individuals for recreational fishers • Trip limit of 10 individuals within a 24-hour period in Southeast waters for personal fishing licence holders (not for the holders/operators of a Calamari or Danish seine licence) • Trip limit of 15 individuals outside of Southeast coast waters for holders of a Rock Lobster fishing licence
MAIN MARKET	Local and interstate

Current assessment

Catch, effort and CPUE

The total commercial catch of Southern Calamari in 2018/19 was 107 t, which is a substantial increase from last year's decline back to historical peak levels of >100 t (Fig. 20.1A). While catch increases compared to last year were evident in all regions, the most significant increases occurred on the North coast (Fig. 20.1B). Current production levels for these areas are >30 t. In the Mercury Passage (MP) and in Great Oyster Bay (GOB) on the East coast, similarly high catches were recorded until 2004/05, but these have now dropped to <20 t (MP) and <10 t (GOB) (Fig. 20.2B and 20.3). Preliminary data for 2019/20 indicate that catches remained high up until the onset of the Coronavirus pandemic.

Increases in catch in 2018/19 were associated with increased effort in all areas. On the North coast, effort levels were still lower than during record highs documented in 2016/17 (Fig. 20.1C). On the East coast, effort matched peak levels recorded over the last 10+ years (Fig. 20.2C).

Shifts in catch and effort from the East coast to the North coast has been accompanied by a general trend of increasing catch rates in all areas, which are least obvious in the traditionally most heavily exploited Mercury Passage (Fig. 20.1D and 20.2D).

Recent estimates of recreational catches are 63.5 t in 2012/13 (Lyle et al. 2014b) and 31.4 t in 2017/18 (Lyle et al 2019), which represent between 50-100% of commercial landings during these two years. Thus, recreational harvest remains a significant component of fishing mortality.

In 2018, the Maximum Sustainable Yield (MSY) of Southern Calamari in Tasmania (state-wide and just for the North coast) was estimated using the catch-only approach of the *simpleSA* R package of Haddon and Punt (2018). The catch-only MSY uses a Schaefer production model to calculate annual biomass dynamics for a plausible set of growth (r) and carrying capacity (k) parameter values, which are drawn from a uniform prior distribution. The resulting MSY values estimated from commercial catch data were 75 t (95% CI = 64–84 t) for Tasmanian state waters and 33 t (95% CI = 23–48 t) for the North coast.

Ecological Risk Assessment

In 2012/13, an environmental risk assessment of the Tasmanian Scalefish Fishery considered the risks to bycatch, threatened, endangered and protected species and habitats from fishing for Southern Calamari using squid jigs as negligible. Changes to the ecosystem and community structure from fishing for Southern Calamari using squid jigs was considered a low risk as opposed to negligible, as they are an important predator whose exploitation could negatively affect the ecosystem and community structure (Bell et al. 2016). Given that total catches of Southern Calamari have continued to rise since 2012/13, and that the distribution of catch and effort has shifted to the North coast, it is likely that the overall environmental risk has increased.

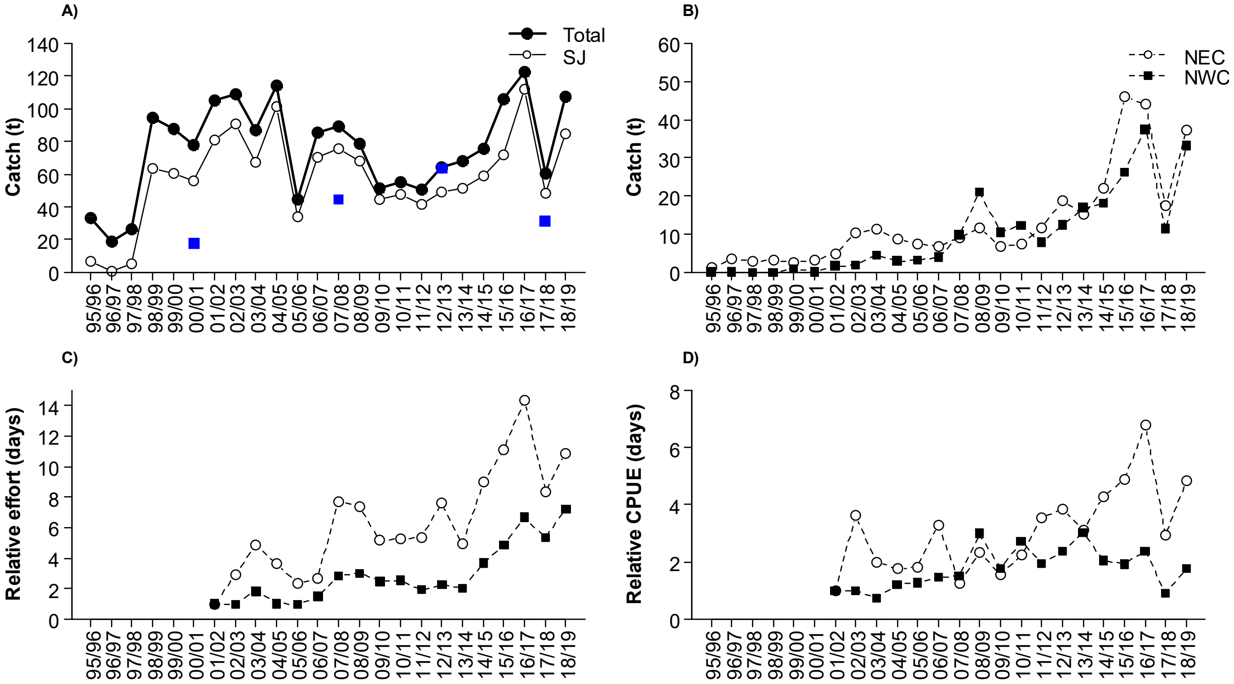


Figure 20.1 A) Annual commercial catch (t) by gear, including estimates of recreational catches in single blue squares. B) Annual commercial catch by region. C) Commercial squid-jig effort based on days fished relative to relative to 2001/02 for NEC and NWC. D) Commercial squid-jig catch per unit effort (CPUE) based on weight per day; SJ=squid jig, NWC=Northwest coast, NEC=Northeast coast.

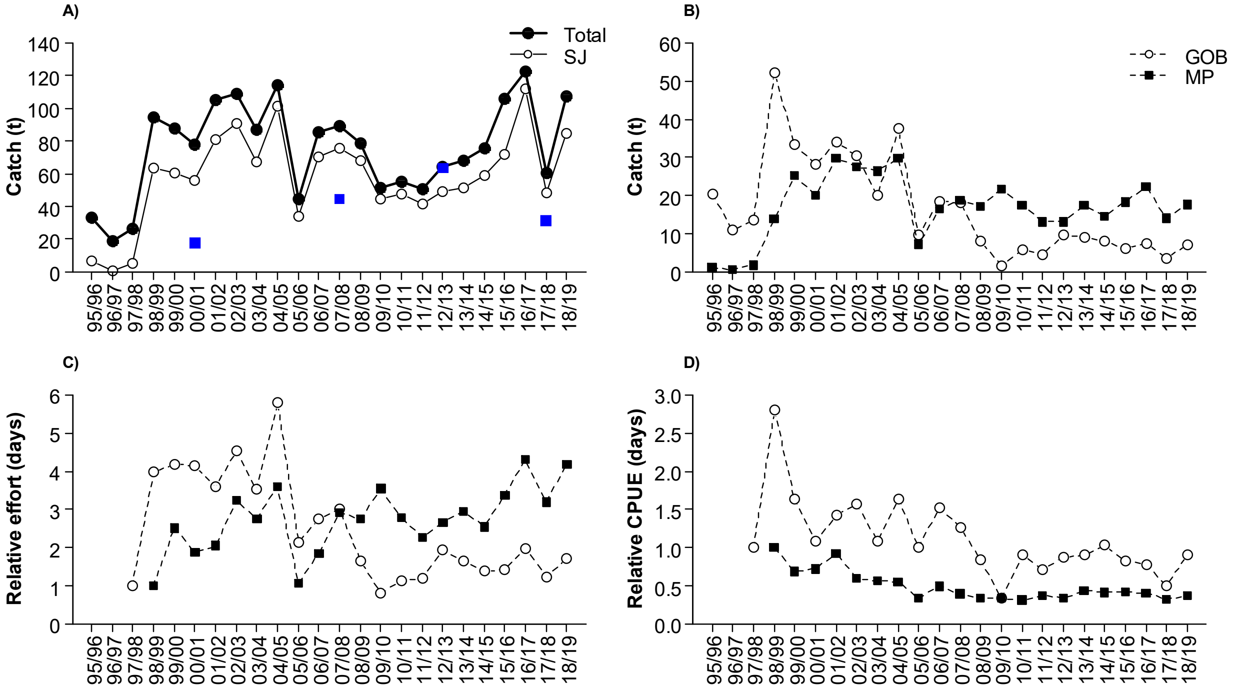
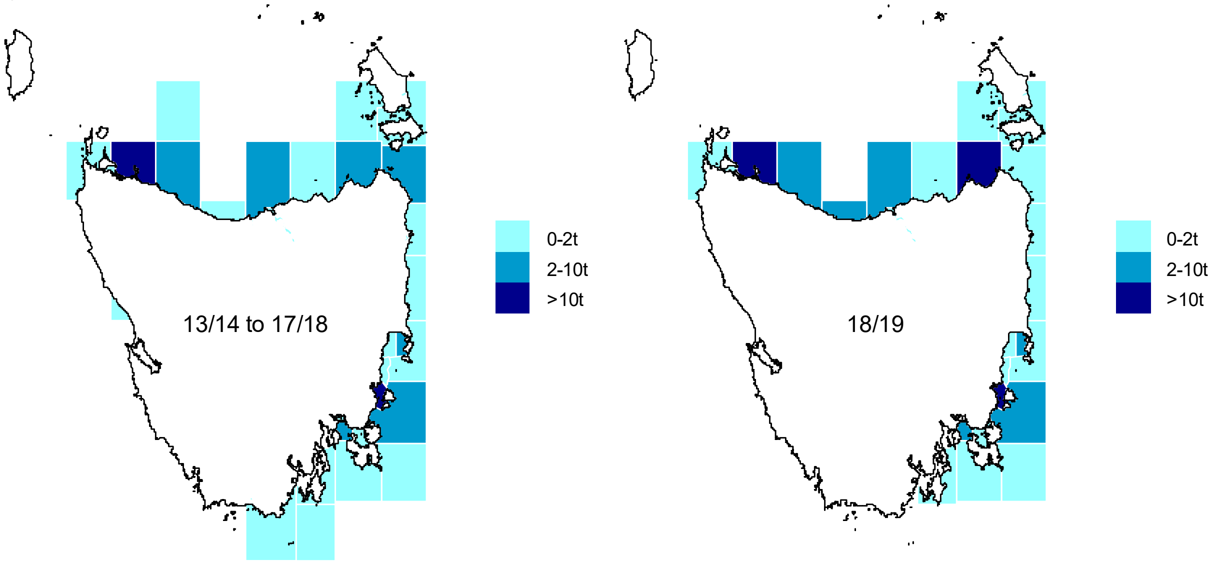


Figure 20.2 A) Annual commercial catch (t) by gear, including estimates of recreational catches in single blue squares. B) Annual commercial catch by region. C) Commercial squid-jig effort based on days fished relative to 1998/99 for MP and 1997/98 for GOB. D) Commercial squid-jig catch per unit effort (CPUE) based on weight per day. SJ=squid jig, GOB=Great Oyster Bay, MP=Mercury Passage.

A) Catch



B) Effort

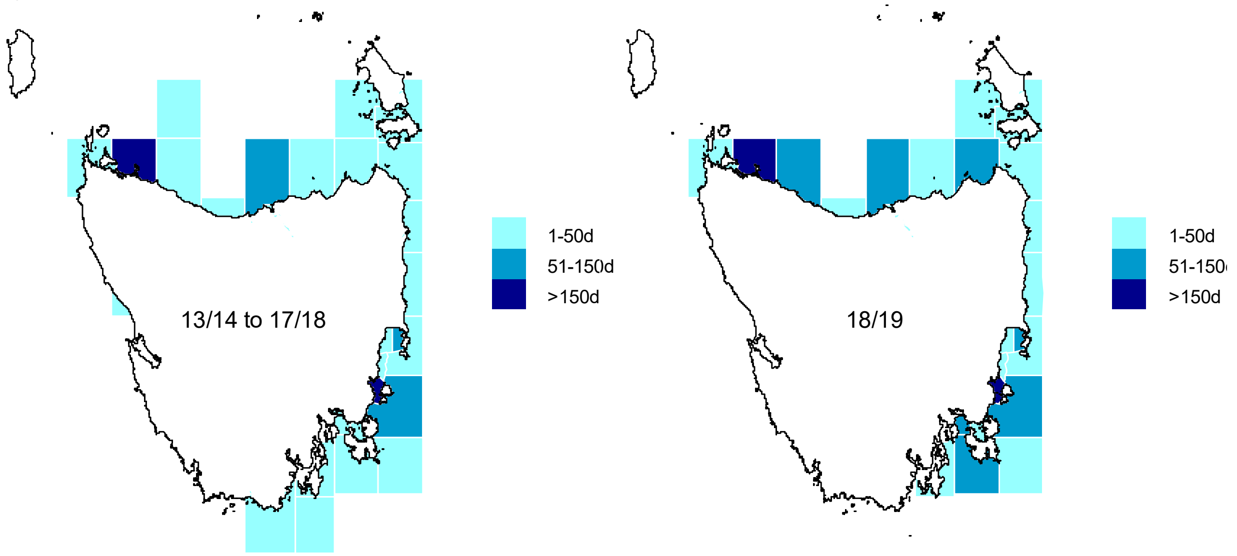


Figure 20.3 (A) Calamari catches (t) and (B) effort (days) for squid jig and purse seine by fishing blocks averaged over the last five assessment years (left) and in the current assessment year (right).

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (105.2 t)	Yes	↑ 2.2. t (+2.1%)
	• Catch < 3rd lowest catch value from the reference period (33.0 t)	No	
	• Catch variation from the previous year above the greatest inter-annual increase from the reference period (67.9 t)	No	
	• Catch variation from the previous year above the greatest inter-annual decrease from the reference period (-69.6 t)	No	
	• Latest recreational catch estimate > recreational catch estimate from the reference period (17.7 t)	Yes	Latest estimate (2017/18): 31.4 t (+77%)
	• Proportion of recreational catch to total catch > previous proportion estimate (51.3% in 2012/13)	No	
Biomass	• CPUE< 3rd lowest CPUE value from the reference period (0.0198 t/days fished)	No	
	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0030)	Yes	↓ 0.0009 t/day fished (29.9%)

Stock status

DEPLETING

Commercial catches fell markedly in 2017/18 relative to the preceding two fishing years when the commercial catch reference point was breached due to ongoing high landings of Southern Calamari from northern areas of the state. In line with this trend, the estimated recreational catch in 2017/18 was also substantially lower than for previous estimates. In 2018/19, however, commercial catches returned to historically highest levels and it is probable that recreational catches also increased, suggesting that the overall fishing pressure on Southern Calamari is likely to be at highest levels.

Vulnerability of Calamari to fishing pressure is unclear, but presumably high because individuals are targeted at spawning aggregations. Considering the species' annual or sub-annual life span, this situation renders the stock susceptible to recruitment failure. Moreover, catch rates for aggregation fisheries are unlikely to reflect abundance, which is phenomenon referred to as "hyperstability". Spatial and temporal closures have been implemented to address these challenges by reducing fishing pressure during the spawning period. With a regional species-specific fishing licence in place, commercial effort has effectively been capped in the traditional fishing grounds in Southeast Tasmanian (defined as waters between Whale Head to Lemon Rock for calamari management). However, fishing effort has subsequently shifted to the North coast, including a number of new entrants who did not qualify for a licence to fish in the South-East.

Sharp declines and increases in recent catch and effort raise concerns about the sustainability of current fishing levels, especially since fishing activities target the species during its peak spawning period. Egg surveys conducted from 2016 on the North coast confirm that commercial catches are closely correlated with spawning activity, and that historically highest catches in 2016/17 were followed by comparatively low abundance of eggs and thus spawning adults and catch in 2017/18 (IMAS unpublished data). Although the role of local environmental drivers of spawning activity is unclear, these current findings suggest that recruitment is sensitive to the number of individuals left to reproduce in any given spawning season.

Catches of more than 100 t in 2015/16, 2016/17 and 2018/19 exceed recent estimates of the state-wide maximum sustainable yield (MSY) of 75 t by more than 40%. The North coast region is of particular concern in this respect, given that recent catches in this area exceed the estimated regional MSY of 33 t by more than 100%. While uncertainty remains about the status of stocks, recent fishing mortality has been excessive and is likely to cause the stock to become recruitment impaired. On this basis, Southern Calamari in Tasmania is classified as a depleting stock.

21. Southern Garfish

Hyporhamphus melanochir

STOCK STATUS	**DEPLETED**
After strong declines in catches in 2006/07 and 2007/08, coupled with changes in population structure, management actions appeared to initiate recovery. However, both catches and catch rates showed significant declines over the last couple of years, which might be explained by recent estimates of consistently high fishing mortality. In consideration of the likely vulnerability of this species to overfishing, even currently low levels of fishing pressure may be too high to allow stocks to recover.	
IMPORTANCE	Key
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends; changes in size/age composition

Hyporhamphus melanochir
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Shallow inshore water (<20m depth) in association with seagrass beds	Gomon et al. (2008)
Distribution	• Endemic to Australia; from Eden (NSW) to Perth (Western Australia), including Bass Strait and Tasmania	Gomon et al. (2008)
Diet	• Predominantly herbivores (seagrass, algal filaments), but also consuming planktonic crustaceans, worms, diatoms and stray insects landing on the surface	Edgar (2008) Klumpp and Nichols (1983)
Movement and stock structure	• Schooling fish, highly mobile, near the surface at night and close to bottom during day • There are 4 genetically distinct populations distributed across Western Australia, western South Australia, eastern South Australia/Victoria and Tasmania • It is likely that at least two Garfish subpopulations exist in Tasmania, which is indicated by different size and age characteristics on the North vs East coasts	Grant (1991) St Hill (1996) Jones et al. (2002)
Natural mortality	• High (55% for adults of four years and over on the east coast)	Jones (1990)
Maximum age	• Up to 9 years	Jordan et al. (1998)

Growth	• From 6 month onwards, growth follows a von Bertalanffy growth function, with $L_\infty = 34.3, k = -0.54$ and $t_0 = 0.23$ • Length-weight relationship: $W = 0.0011L^{3.4403}$, where W is weight (g) and L is fork length (cm)	Jordan et al. (1998) Hartmann and Lyle (2011)
Maturity	• Size-at-50% maturity estimated at 19.9 cm for females and 17.1 cm for males • The relationship between batch fecundity and fork length is linear, with $F = 188.75L - 3585.8$, where F is fecundity (in number of eggs) and L is fork length (cm)	Hartmann and Lyle (2011)
Spawning	• Spawning is concentrated in shallow (<5 m deep) waters over beds of drift algae in eastern Tasmania, occurring over at least five months from October to February, with peak activity between October and December • Eggs are around 2.93 mm in diameter and negatively buoyant, sinking to the bottom after fertilisation and then becoming attached to drift algae	Jordan et al. (1998)
Early life history	• After an estimated incubation period of one month, large hatchlings (7.8-8.5mm) are assumed to stay in shallow sheltered waters as indicated by the presence of small juvenile (0+ cohort) in coastal waters off east Tasmania	Jordan et al. (1998)
Recruitment	• Variable (no-stock recruitment relationship established)	
Gillnet post release survival	• NA	

Background

Catches of the traditional winter beach seine fishery were centred off the Northeast coast, including Flinders Island. More recently, the fishery has extended to the East and Southeast coasts. Following the introduction of dip-nets, catches have also increasingly been taken over the summer months. Today, Garfish on the Northeast coast are caught mostly by beach seine while on the Southeast and East coasts they are caught mainly by dip-nets. A sharp and unexpected decline in catches in 2006/07 and 2007/08 initiated a size and age structure sampling program between 2008–2012 and again between 2017 and 2018 (Emery et al. 2015, Reid 2018).

Current assessment

Size and age composition

The sampling program revealed that the Tasmanian Garfish population is dominated by relatively few age classes (2-3 years), which indicated that any recruitment variability is likely to have a marked impact on population size. Up to 2011, there was evidence of a reduction in average fish size and a truncation of the age structure that was presumed to be indicative of heavy fishing pressure and possibly poor recruitment. After early signs of population recovery in 2012 (increasing size and age), which may have been linked in part to the implementation of spawning closures in 2009, both catch and catch rates declined again suggesting that any stock recovery was short-lived. A comprehensive presentation and interpretation of the biological sampling data is given in the last scalefish stock assessment report for 2017/18 (Moore et al. 2019).

FISHING METHODS	Mainly dip-net and beach seine
MANAGEMENT METHODS	**Input control**: - Temporal closure during spawning: mid-Nov to mid-Dec for southern waters, mid-Jan to mid-Feb for northern waters - Gear restriction: Scalefish fishing licence, Purse seine licence, Beach seine licence **Output control***:* - Legal size: 25 cm (upper jaw to end of tail) - Possession limit of 30 and bag limit of 15 individuals for recreational fishers
MAIN MARKET	- Local and interstate

Catch, effort and CPUE

At 7.4 t, the total commercial catch of Garfish for 2018/19 was the lowest on record and follows a trend of declining landings since 2009/10 (Fig. 21.4A). After many years of relative stability in Garfish catches of 80–90 t per annum, catches fell sharply in 2006/07 and 2007/08. Catches then recovered to around 60 t before the current general decline commenced. Catches were generally concentrated off the Northeast coast, but in contrast to the current year, commonly included some landings on the East coast (Fig. 21.5A).

Recreational Garfish catches are low compared to commercial catches, estimated at around 2 t in 2000/01, 2007/08 and 2012/13 (Henry and Lyle 2003, Lyle et al. 2009, Lyle et al. 2014a) and only 300 kg in 2017/18 (Lyle et al. 2019).

Effort of both major commercial gear types has been steadily decreasing and reached historic lows in the current year (Fig. 21.4B). Catch rates have fluctuated more substantially and with a notable peak in 2012/13 (Fig. 21.4C). This peak was followed by a strong declining trend until 2017/18, which substantiated concerns about the status of Southern Garfish stocks. In the current year, catch rates for dip-net remain close to the reference value, while those for beach seine are still reduced to about 50% of the reference value.

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian Scalefish Fishery, beach seining was considered a low risk activity with regard to Southern Garfish due to low catches and signs of population recovery at the time. Beach seining was also considered a low risk activity with regards to non-retained species given that bycatch is usually released alive. Beach seine was also considered a very low risk in regards to the general ecosystem (Bell et al. 2016).

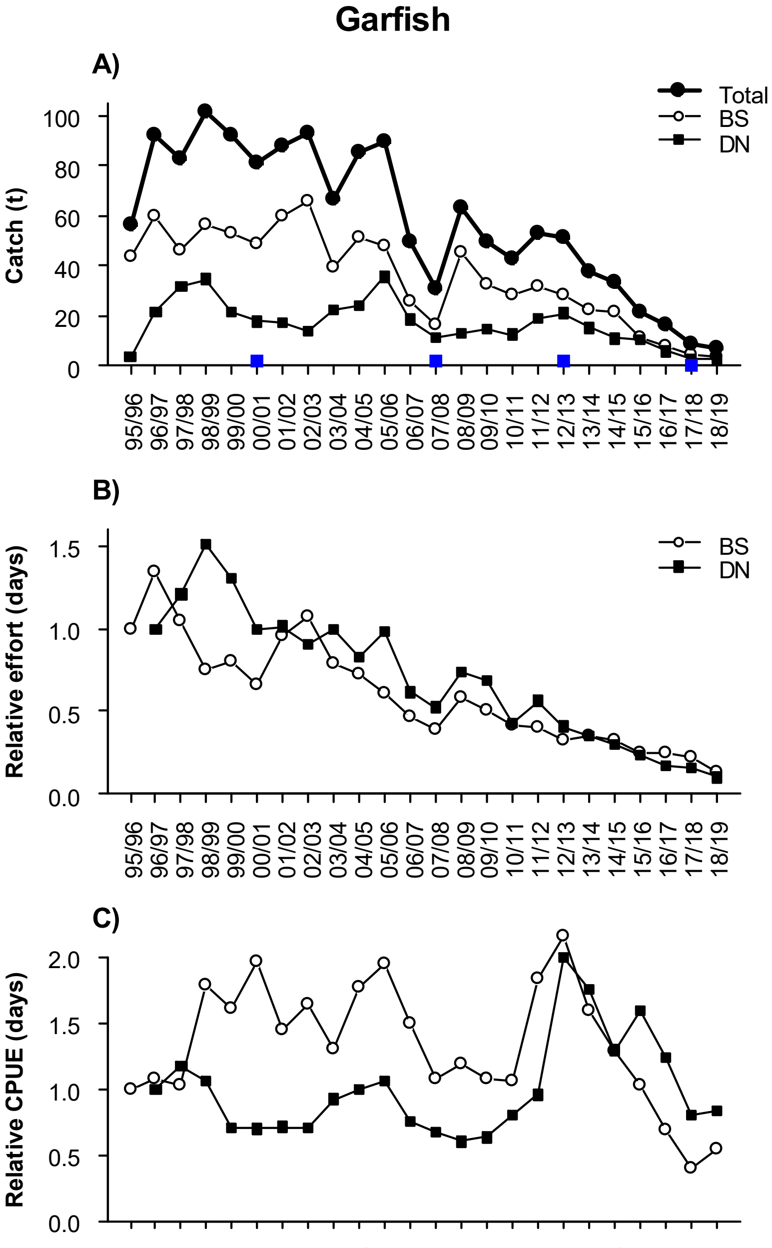
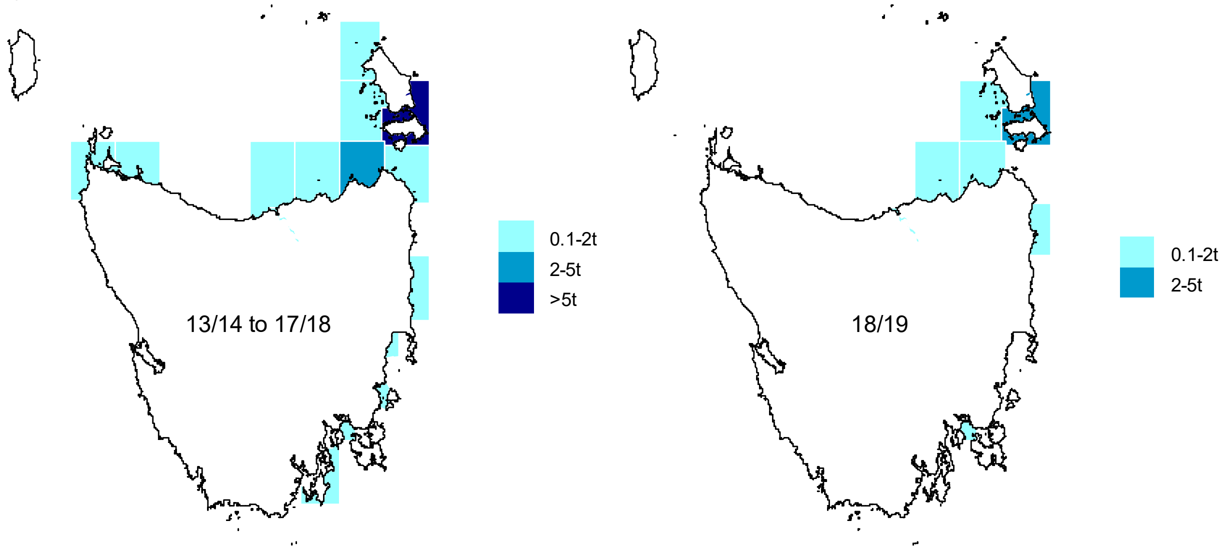


Figure 21.4 A) Annual commercial catch (t) by gear and best estimates of recreational catches (blue squares). B) Commercial effort by method based on day fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. BS=beach seine, DN=dip-net.

A) Catch



B) Effort

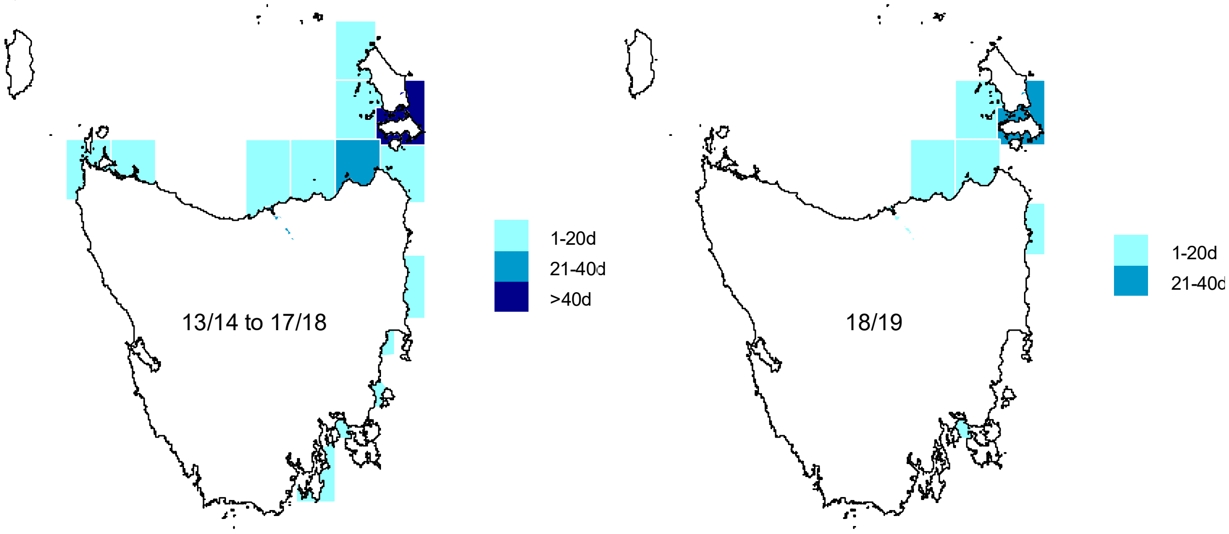


Figure 21.5 (A) Garfish catches (t) and (B) effort (days) for beach seine and dipnet by fishing blocks averaged over the last five assessment years (left) and in the current assessment year (right).

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (91.7 t)	No	
	• Catch < 3rd lowest catch value from the reference period (66.2 t)	Yes	↓ 58.9 t (-88.9%)
	• Catch variation from the previous year above the greatest inter-annual increase from the reference period (35.5 t)	No	
	• Catch variation from the previous year above the greatest inter-annual decrease from the reference period (-39.4 t)	No	
	• Latest recreational catch estimate > recreational catch estimate from the reference period (1.9 t)	No	
	• Proportion of recreational catch to total catch > previous proportion estimate (3.8% in 2012/13)	No	
Biomass	• CPUE< 3rd lowest CPUE value from the reference period (0.05 t/days fished)	Yes	↓ 0.0193 t (-38.3%)
	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0073)		

Stock status

DEPLETED

Spawning closures introduced in 2009 appear to have initiated population recovery (increasing size and age in 2012), but subsequent declines in catches and catch rates suggest that any such assumed recovery was short-lived. Current fishing mortality is likely to exceed values estimated for the late 2000s, when catches dropped sharply and the stock was assumed to be in a depleted state (Reid 2018), implying that stock biomass has remained at depleted levels.

In general, the vulnerability of Southern Garfish to fishing pressure is likely to be moderate or high, considering: (1) the schooling behaviour of the species, which means that individuals can be effectively targeted even if stocks are depleted and that catch rates are thus unlikely to reflect abundance (hyperstability); and (2) that the species is short-lived and its Tasmanian populations dominated by a few age classes, which makes them sensitive to recruitment variability. Based on the available evidence, Southern Garfish is therefore classified as depleted.

22. Striped Trumpeter

Latris lineata

STOCK STATUS	**RECOVERING**
Following evidence of recruitment in the last two years, population status and trends remain unclear. In 2018/19, reference points for low commercial catch, high recreational catch, and a high proportion of recreational catch were triggered. Commercial catches are at a historical low, but total levels of fishing pressure (commercial and recreational combined) could still be too high to allow for recovery, especially since the minimum size limit is below the estimated size at maturity.	
IMPORTANCE	Key
STOCK(S)	Tasmanian Scalefish Fishery, Commonwealth fisheries
INDICATOR(S)	Catch, effort and CPUE trends

Latris lineata
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	**Estimates**	**Source**
Habitat	• Exposed reefs and rocky bottom down to 300 m depth	Edgar et al. (2004) Gomon et al. (2008)
Distribution	• Sydney (New South Wales) to Albany (Western Australia), Tasmania, New Zealand, Amsterdam Islands (southern Indian Ocean) and most of the temperate Southern hemisphere (excl. South Africa and South America)	Edgar et al. (2004) Gomon et al. (2008)
Diet	• Small fish, cephalopods, crustaceans	Nichols et al. (1994)
Movement and stock structure	• Juveniles have limited movement, remaining around shallow reefs for several years before moving into deeper waters on offshore reefs • Adults have the capacity to undergo wide-scale movements (Tasmania to St Paul Island, Indian Ocean) • Uniform stock structure in Tasmanian waters (no significant genetic separation of populations)	Tracey and Lyle (2005) Lyle and Jordan (1999) Lyle and Murphy (2001) Tracey et al. (2007a)
Natural mortality	• Estimated at $M = 0.096$.	Tracey and Lyle (2005)

<table>
<tr><td>Maximum age</td><td>• Estimated at 43 years</td><td>Tracey and Lyle (2005)</td></tr>
<tr><td>Growth</td><td>• Maximum length: 1.2 m, maximum weight: 25 kg
• Rapid juvenile growth (mean fork length (FL) = 28 cm after 2 years, 42 cm after 4 years) and slower adult growth (large range of size-at-age over 50 cm FL)
• Growth for both sexes described by a two-phase van Bertalanffy growth function
$L = \left(1 - \int_{t=-t_0}^{+t^{\delta}} \frac{1}{\sigma\sqrt{2\pi}} e^{\left(\frac{-(t-t_{01})^2}{2\sigma^2}\right)}\right)\left(L_{\infty 1}\left(1 - e^{-k_{1(t-t_{01})}}\right) + \varepsilon\right) + \left(1 - \int_{t=t^{\delta}}^{+t_{max}} \frac{1}{\sigma\sqrt{2\pi}} e^{\left(\frac{-\left(t-t^{\delta}\right)^2}{2\sigma^2}\right)}\right)\left(L^{\delta} + \left(L_{\infty 2} - L^{\delta}\right)\left(1 - e^{-k_{2(t-t_{02})}}\right) + \varepsilon\right),$
where *L* is the length (mm), *t* is the age (years), $L_{\infty 1} and\ L_{\infty 2}$ are the average maximum length for the species for the 1st and 2nd growth phase, respectively, *k₁* and *k₂* are respective constants, *t₀₁* and *t₀₂* are the respective (theoretical) ages where lengths equal zero, $L^{\delta}$and t^{δ} are the length and age of transference from one growth phase to the next, t_{max} is the maximum age present in the sample, σ^2 is the standard deviation of cumulative density function with mean t^{δ}, and ε is an error term
Parameter estimates are:
<table><tr><th>$L_{\infty 1}$</th><th>k_1</th><th>t_{01}</th><th>L^{δ}</th><th>$L_{\infty 2}$</th><th>k_2</th><th>t_{02}</th><th>t^{δ}</th><th>σ^2</th></tr><tr><td>532.77</td><td>0.43</td><td>0.03</td><td>450.1</td><td>871.59</td><td>0.08</td><td>3.49</td><td>4.4</td><td>1.0</td></tr></table>
• Length-weight relationship for both sexes estimated at $W = 2E^{-5}L^{3.00}$, where *W* is weight (g) and *L* is fork length (mm)</td><td>Gomon et al. (2008)
Murphy and Lyle (1999)
Tracey and Lyle (2005)</td></tr>
<tr><td>Maturity</td><td>• Size at 50% maturity: 54 cm FL (62 cm TL; 6.8 years) for females and 53 cm FL (61 cm TL; 6.2 years) for males
• Batch fecundity: $4.15E^{-8}FL^{4.69}$</td><td>Tracey et al. (2007b)
IMAS unpublished data</td></tr>
<tr><td>Spawning</td><td>• July to early October depending on geographic location (early start and finish at lower latitudes)
• Multiple spawners, highly fecund (100,000 to 400,000 eggs for females weighing 3.2 kg and 5.2 kg respectively)
• Small pelagic eggs (1.3 mm diameter)</td><td>Ruwald et al. (1991)
Ruwald, 1992 (1992)
Hutchinson (1993)</td></tr>
<tr><td>Early life history</td><td>• Complex with extended larval phase of at least 9 months
• No information on size and timing of settlement
• Juveniles of around 18 cm FL (23 cm TL) have been caught on shallow reefs off southeast coast in January.</td><td>Ruwald et al. (1991)
Ruwald (1992)
Murphy and Lyle (1999)</td></tr>
<tr><td>Recruitment</td><td>• Highly variable
• No stock-recruitment relationship established</td><td>Murphy and Lyle (1999)</td></tr>
<tr><td>Gillnet post-release survival</td><td>• NA</td><td></td></tr>
</table>

Background

Striped Trumpeter has a long history of commercial exploitation in Tasmania being highly valued as a food fish. There is also a high level of interest in the species from recreational fishers and charter boat operators. The species is taken by a variety of fishing gears with handline and dropline representing the primary methods. Juvenile Striped Trumpeter are occasionally taken in gillnets in inshore waters and usually in depths <50 m, whereas adult fish are taken in deeper offshore waters by line methods and as by-product in large mesh gillnets (shark nets). Historically, catches have been concentrated off the east coast, including Flinders Island, as well as off the south and southwest coasts of Tasmania (André et al. 2015).

Responsibility for the management of Striped Trumpeter was passed to Tasmania in 1996 through an Offshore Constitutional Settlement (OCS) arrangement with the Commonwealth. A memorandum of understanding (MoU) accompanied the OCS, specifying trip limits for Commonwealth only fishers. As part of the Tasmanian Scalefish Fishery management plan, gear restrictions for all commercial scalefish fishers operating in state waters were introduced in 1998. This, however, enabled dual licensed operators (i.e. holders of a Tasmanian licence and a Commonwealth permit for Southern Shark or South East Non-Trawl fisheries) as well as rock lobster fishers to take unrestricted quantities of Striped Trumpeter in offshore waters using their gear allocations. In 2000, the Tasmanian Government introduced a combined trip limit of 250 kg for Striped Trumpeter, Yellowtail Kingfish and Snapper for all fishers (Commonwealth and state) in all waters to limit the potential for expansion of effort directed at these species. Over time, there have been additional management measures targeted at the species, including a spawning closure, a decrease in the recreational possession limit, introduction of a recreational boat limit and several increases in the minimum size limit for the species (currently 55 cm total length (TL), which is still below the size at maturity of 62 cm TL for females and 61 cm TL for males). Additionally, in 2013, the Commonwealth reduced their Striped Trumpeter trip limit component to 150 kg (it is still a part of the 250 kg combined species trip limit, but only a maximum of 150 kg can comprise Striped Trumpeter) year round.

FISHING METHODS	Mainly handline, also gillnet and dropline
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence, rock lobster licence) • Temporal closure (Sept–Oct – does not apply to Commonwealth operators) **Output control:** • Trip limit of 250 kg for Tasmanian commercial operators • Trip limit of 150 kg for Commonwealth operators • Bag limit of 4 fish for recreational fishers • Possession limit of 8 fish for recreational fishers • Boat limit of 20 fish for recreational vessels • Minimum size (550 mm TL)
MAIN MARKET	Mainly local

Current assessment

Biological characteristics

Length frequency composition

The length frequency distribution of Striped Trumpeter has been monitored since 1998/99. Sampling has been limited and opportunistic in some years, and consequently, some samples are unlikely to adequately represent population dynamics. Overall, there appears to have been a shortage of small fish (recruitment) up until 2009/10. In 2009/10, new recruits appear to have entered the fishery, which has clearly contracted the range and median of lengths. From 2012/13 onwards, length frequency distributions have started to flatten again. The stabilising trend indicates an ageing population similar to the years before 2019/10, albeit with evidence of recruitment of smaller individuals in recent years (Fig. 22.1).

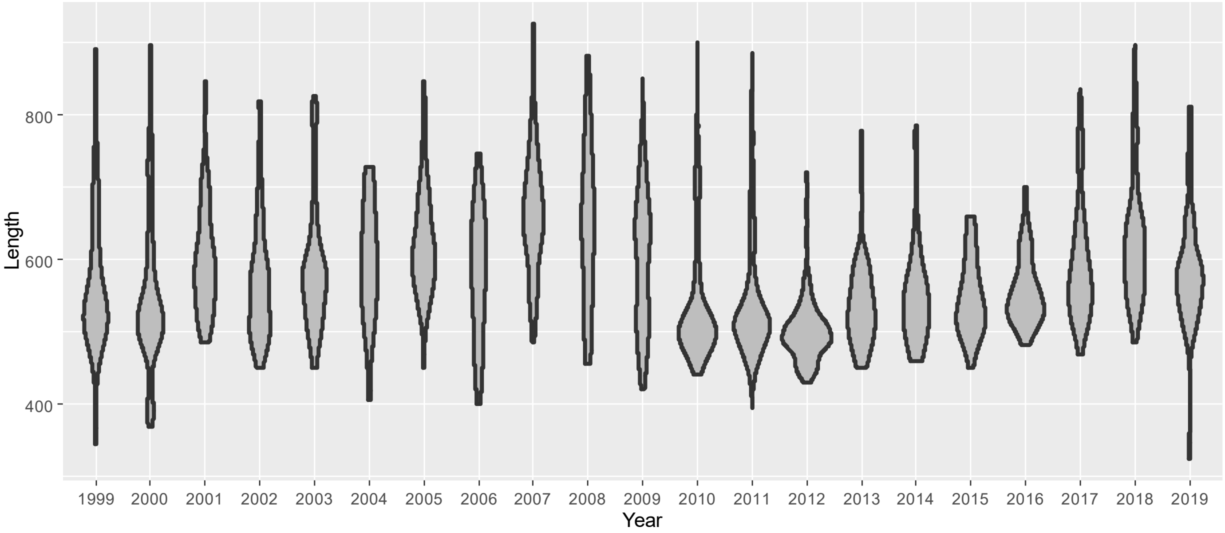


Figure 22.1 Striped Trumpeter length composition from 1998/99 (1999) to 2018/19 (2019) sampled from both commercial and recreational catches. Length is fork length in mm.

Age frequency composition

As expected, age data showed trends very similar to length data, revealing an increasing lack of young individuals (3–5 year olds) up until 2009/10. During this period, the population might have been sustained largely by strong year classes recruited during the 1990s. In 2009/10, new recruits appear to have contracted the age frequency distribution similar to what was observed in the 1990s. Samples up until 2015/16 were then dominated by 4–6 year olds, which is the age at which the species tends to recruit to the offshore hook fishery. However, the relative strength of cohorts in samples is unknown and the number of individuals sampled between 2012/13 and 2015/16 was low. Previous assessments suggested that the adult segment of the population is likely to remain in a depleted state due to continued fishing under a lack of recruitment over many years. Some young fish have entered the population in recent years, but there is an overall trend of an ageing population similar to that observed in the years before 2009/10 (Fig. 22.2).

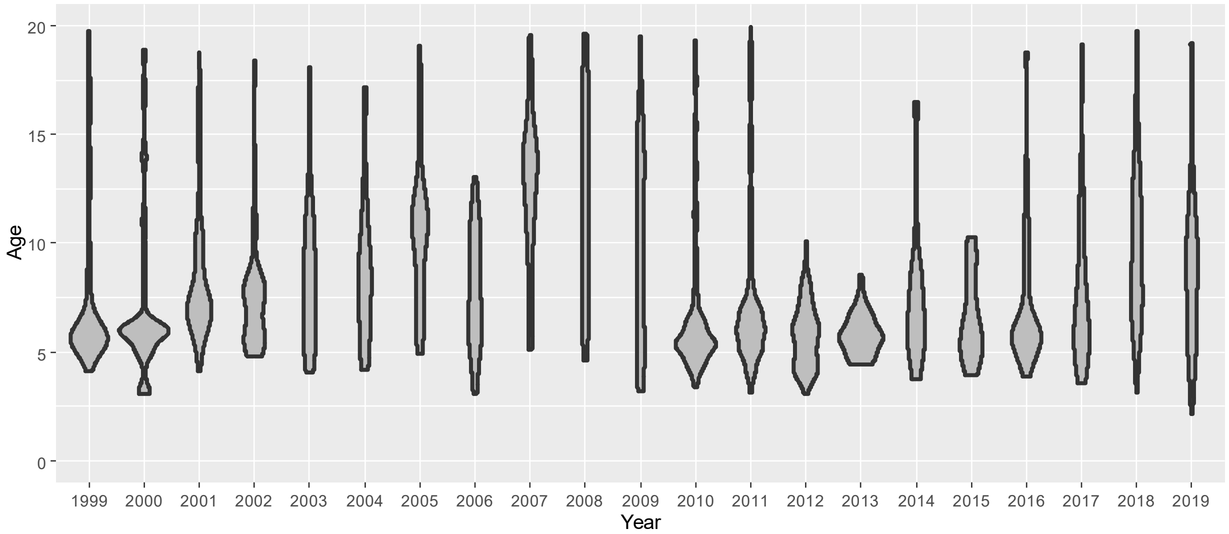


Figure 22.2 Striped Trumpeter age composition between 1998/99 (1999) and 2018/19 (2019) sampled from both commercial and recreational catches. Note that, for clarity, the graph excludes individuals older than 20 years of age, which accounted for 4.6% of all samples.

Using Poisson regression in R (‘fishmethods’ package) applied to age data for Striped Trumpeter, total mortality (*Z*) was estimated at 0.17, averaging 0.23 ± 0.20 (mean ± SD) across annual estimates. Assuming a maximum age of 43 years, natural mortality (*M*) was estimated at 0.096 (using the equation of Hoenig 1983; Tracey and Lyle 2005), which indicates that fishing mortality (*F* = *Z* -*M*) averaged approximately 1.33 × *M*. Temporal trends in *Z* indicate relatively stable mortality over the last four years with an estimated *F* between 0.6 and 0.9 × *M*.

Catch, effort and CPUE

The more recent catch history in waters south of latitude 39° 12’S (i.e. waters incorporated within the OCS agreement for Striped Trumpeter) shows significant catches by Victorian vessels, peaking at around 37 t in the early 1990s (Table 22.1). Since the mid-1990s, data from this sector have been unavailable, though it is assumed that subsequent catches have been reported in Commonwealth logbooks. Excepting years around 1999/2000, Commonwealth catches have been comparatively low with generally less than 5 t caught.

Total annual production was highest at over 110 t in the early 1990s when Victorian vessels accounting for 17–39% of this total, but then fluctuated between 70–80 t through the mid-1990s before increasing again to over 100 t by the late 1990s (Table 22.1). Catches almost halved in 2000/01 to less than 50 t and have remained low since that time. This trend was observed across fishing methods in Tasmania (Fig. 22.1A). In 2015/16, the total catch fell to a historic low of 7.1 t. After slight increases in the past two years, catch in the current season is at only 7.1 t again.

The Commonwealth catch reported in 2018/19 was only 2.6 t, but catches are believed to have been substantially underreported in the past. Coupled with limited information on recreational catches, this situation represents a major source of uncertainty in estimating mortality.

The recreational fishery has heavily targeted Striped Trumpeter in the past with an estimated 38 t caught in 2000/01 (Lyle 2005) and an uncertain combined catch of 19 t for both Striped and Bastard Trumpeter in 2007/08 (Lyle et al. 2009). The most recent estimates for Striped Trumpeter in 2011/12, 2012/13 and 2017/18 are 31.9 t, 15.2 t and 29.1 t, respectively, which all substantially exceeded the commercial catch of the species in these years (Fig. 22.1A). Notably, recreational catch estimates do not fully represent catches by charter boats.

Table 22.1 Annual commercial catches of Striped Trumpeter (t) south of latitude 39° 12'S. Data based on Tasmanian (General Fishing return), Victorian and Commonwealth catch returns.

	Catch (t)			
Year	Tasmania	Victoria	Commonwealth	Combined
1990/91	74.5	37.1		111.6
1991/92	58.2	36.8		95.0
1992/93	52.7	19.8		72.5
1993/94	56.5	16.0		72.5
1994/95	72.4	14.6		87.0
1995/96	60.3			60.3
1996/97	79.7		0.7	80.4
1997/98	75.4		5.7	81.1
1998/99	98.4		8.9	107.4
1999/2000	86.3		14.5	101.8
2000/01	41.2		7.5	49.6
2001/02	40.0		4.8	44.9
2002/03	36.8		3.2	40.0
2003/04	36.8		3.7	40.5
2004/05	24.0		2.2	26.2
2005/06	19.1		4.7	23.8
2006/07	18.8		3.5	22.3
2007/08	13.1		3.0	16.1
2008/09	10.5		2.8	13.3
2009/10	10.0		2.3	12.3
2010/11	15.0		4.8	19.8
2011/12	15.9		5.4	21.3
2012/13	12.3		5.1	17.4
2013/14	8.0		2.5	10.5
2014/15	9.6		3.4	13.0
2015/16	6.0		1.1	7.1
2016/17	8.3		4.0	12.3
2017/18	7.8		6.3	14.1
2018/19	4.5		2.6	7.1

Striped Trumpeter catches have been reported from all areas around the state. Fishing activity in 2018/19 was focused mainly on the Southeast and Southwest coasts (Fig. 22.2)

Catch trends appear to reflect the influence of strong year classes assumed to have entered the fishery before 1998/99. This was followed by a lack of recruitment and associated declines in catches in the early 2000s. Industry representatives suggest that the trip limit of 250 kg from 2000 provided a disincentive for operators to target the species, which might have contributed to the reduction in dropline and handline effort since 2000/01 (Fig. 22.1B).

Catch rates for handline and dropline, as the currently dominant gear types, have been variable, but with downward trend in recent years. Catch rates for handline are at a historic low point in 2018/19 (Fig. 22.1C).

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian Scalefish Fishery, handlining was considered a medium risk with regard to Striped Trumpeter due to evidence of the population being subject to heavy fishing pressure from combined fishing methods. Handlining for Striped Trumpeter was also considered a medium risk to by-product mixed fish species, such as Jackass Morwong and Ocean Perch, due to the uncertainty surrounding their population status. Impacts on communities and protected species were generally low or negligible (Bell et al. 2016). Post release survival is believed to be high in Striped Trumpeter even when captured from relatively deep water (Lyle et al. 2014b). This is a relevant risk factor considering that low bag and size limits trigger discards.

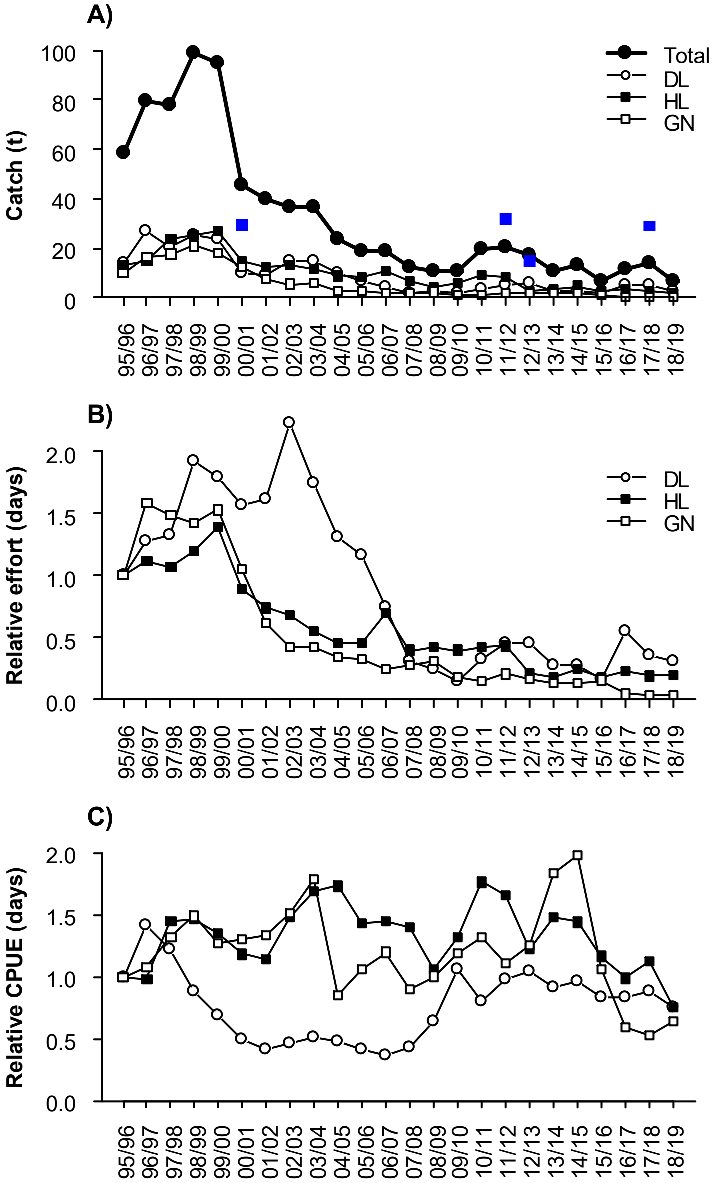
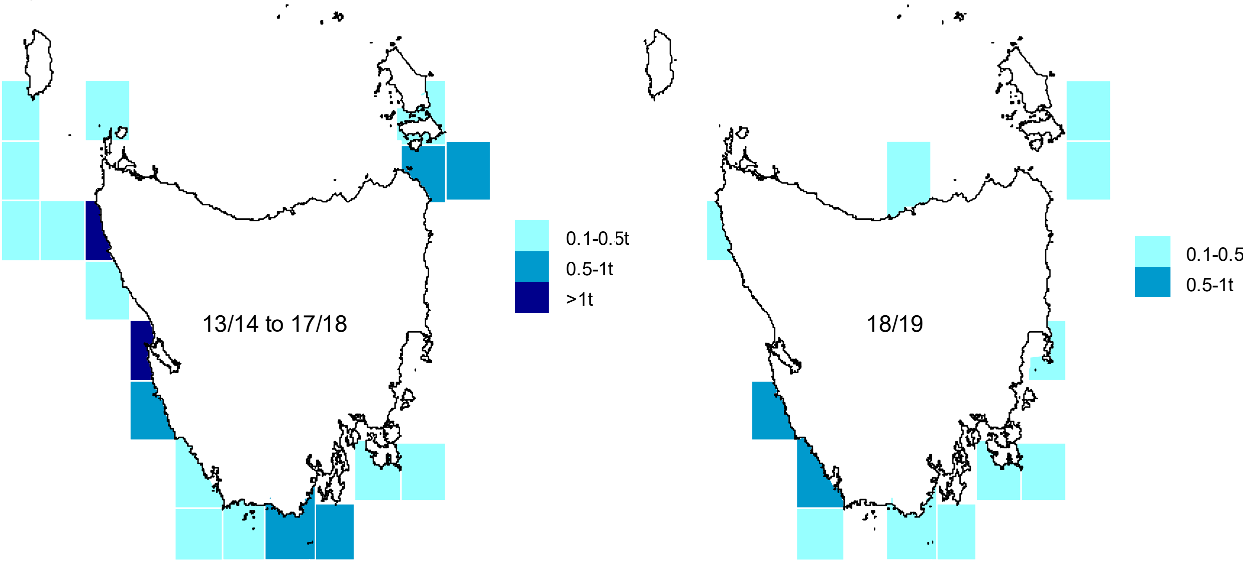


Figure 22.1 A) Annual commercial catch (t) by gear and best estimates of recreational catches (blue squares). B) Commercial effort by method based on day fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. HL=handline, GN=gillnet, DL=dropline. Data includes Australian Fisheries Management Authority (AFMA) catch in state waters.

A) Catch



B) Effort

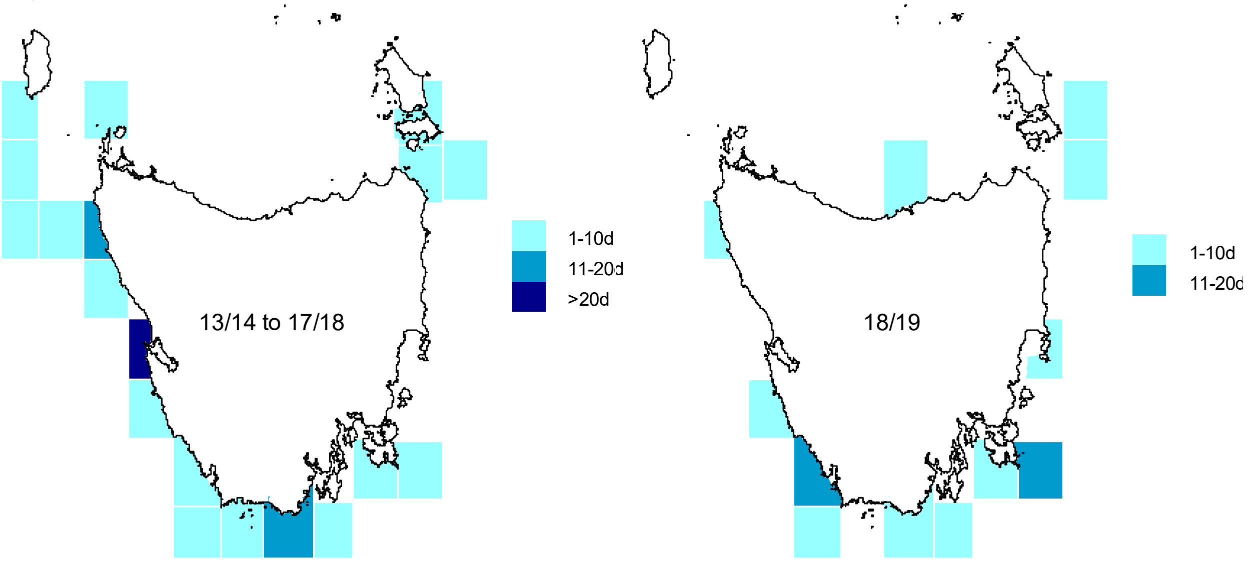


Figure 22.2 (A) Striped Trumpeter catches (t) and (B) effort (days) for dropline, handline and gillnet by fishing blocks averaged over the last five assessment years (left) and in the current assessment year (right). Data includes Australian Fisheries Management Authority (AFMA) catch in state waters.

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (79.4 t)	No	
	• Catch < 3rd lowest catch value from the reference period (23.9 t)	Yes	↓ 16.8 t (-70.4%)
	• Catch variation from the previous year above the greatest inter-annual increase from the reference period (21.1 t)	No	
	• Catch variation from the previous year above the greatest inter-annual decrease from the reference period (49.5 t)	No	
	• Latest recreational catch estimate > recreational catch estimate from the reference period (19.6 t)	Yes	Latest estimate (2017/18): 29.1 t (+48.5%)
	• Proportion of recreational catch to total catch > previous proportion estimate (61.1% in 2011/12%)	Yes	Latest estimate (2017/18): 67.4%
Biomass	• CPUE< 3rd lowest CPUE value from the reference period (0.0210 t/days fished)	No	
	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0034)	No	

Stock status	**RECOVERING**

Sharp declines in commercial catches since 2000/01 gave reason for concerns about the status of Striped Trumpeter stocks. Several management measures have since been implemented to address these concerns. For example, a spawning season closure during September and October (not recognised by the Commonwealth managed sector), when fish are particularly vulnerable to capture, was introduced in 2009. Additionally, a bag limit of four fish and a boat limit of 20 fish was implemented to help to constrain recreational harvest.

The 2017/18 assessment highlighted the presence of 4–6 year old individuals between 2010 and 2016, providing indication of population recovery after a prolonged period of limited or no recruitment. In addition, recent estimates of fishing mortality seem unlikely to cause the stock to become recruitment impaired. In combination, these considerations led to the stock status of Striped Trumpeter being revised from undefined to transitional-recovering to recovering.

In this assessment, which includes data from the latest recreational fishing survey for 2017/18, three reference points were breached (low catch, high recreational catch, high proportion of recreational catch).

Despite evidence for recent recruitment, there are no clear signs of population recovery, indicating that even current levels of presumably low fishing mortality could risk further depleting the spawning biomass and recruitment potential of the stock. The recreational sector is of particular concern in this respect, given that it represents an increasingly significant proportion of total fishing mortality (estimated at 67% for 2017/18). Options to reduce fishing pressure by the recreational sector include a higher minimum size limit. Research undertaken during 2010 highlights that the current minimum size limit (55 cm TL) is still below the estimated size at maturity (>60 cm TL), subjecting the population to potential growth overfishing. Aligning the size limit with the assumed size at maturity should allow more fish to spawn before they become vulnerable to capture, thus, likely increasing spawning biomass and recruitment potential. Increasing the minimum size limit should also help discourage high grading, which is likely to result in high discard mortality as fishers seek to maximise the weight of their catch under the reduced bag limit.

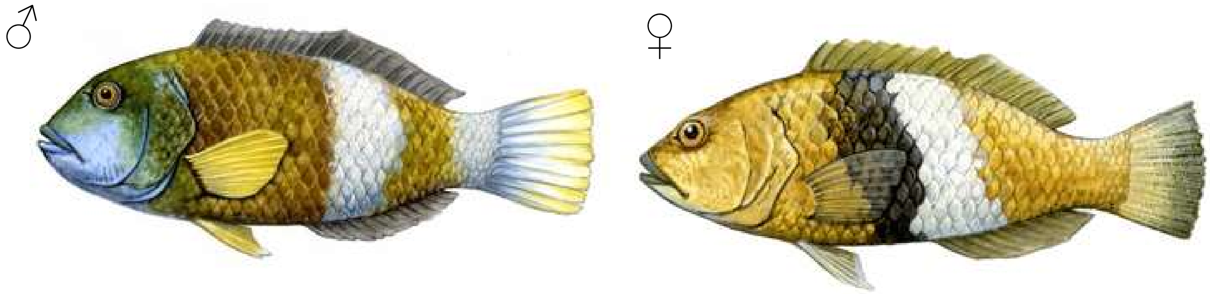
Recruitment, the relative strength of year classes and fishing mortality need be monitored more closely in the future to clarify the status of Striped Trumpeter.

23. Wrasse

Bluethroat Wrasse *Notolabrus tetricus*

Purple Wrasse *Notolabrus fuciola*

STOCK STATUS	**SUSTAINABLE**
Catches, effort and catch rates have remained relatively stable for almost a decade providing little reason for concern that recent fishing mortality is too high. Some uncertainty remains over the size of the catch taken by rock lobster fishers and used for bait.	
IMPORTANCE	Key
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends



Notolabrus tetricus
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Bluethroat Wrasse: Sheltered and exposed reefs, from 1 to 160 m depth • Purple Wrasse*:* Predominantly on exposed reefs up to 90 m depth	Edgar (2008)
Distribution	• Bluethroat Wrasse: from Sydney (New South Wales) to Ceduna (South Australia) • Purple Wrasse*:* New Zealand and Australian waters, from southern New South Wales to Kangaroo Island (South Australia)	Edgar (2008)
Diet	• Both species consume a range of molluscs and crustaceans	Shepherd and Clarkson (2001) Denny and Schiel (2001)
Movement and stock structure	• Bluethroat Wrasse: site-attached, with females showing overlapping home ranges and males being territorial, at least during the reproductive season • No apparent migration of individuals between reefs	Barrett (1995b)

	• Purple Wrasse: site-attached, with no evidence of territorial behaviour • Movements between reefs is limited and likely to be restricted to a small proportion of the population • No information on stock structure exists for either Bluethroat Wrasse or Purple Wrasse	
Natural mortality	• Low adult mortality for both species (estimated at M = 0.2 for Bluethroat Wrasse)	Smith et al. (2003) Barrett (1995a)
Maximum age	• Bluethroat Wrasse: 11 years • Purple Wrasse: up to 24 years	Barrett (1995a) Welsford (2003)
Growth	• Bluethroat Wrasse: From 6 months onwards, growth (males and females confounded) follows a van Bertalanffy growth function, with $L_{\infty} = 36.12, k = 0.2 \text{ and } t_0 = -0.35.$ • Length-weight relationship was estimated at $W = 0.0545L^{2.7157}$ (both sexes), where *W* is weight (g) and *L* is the fork length (cm) • Purple Wrasse: From 2 years onwards, growth (males and females confounded) follows a van Bertalanffy growth function with $L_{\infty} = 44.7, k = 0.085 \text{ and } t_0 = -3.23$ • Length-weight relationship (both sexes) was estimated at $W = 0.0161L^{3.0407}$ where *W* is weight (g) and *L* is the fork length (cm)	Welsford (2003) Barrett (1995a) Unpublished data
Maturity	• Bluethroat Wrasse: protogynous hermaphrodite (i.e. developing into female first before changing to male) with sex change happening between 27 and 32 cm in Tasmania • Not all individuals undergo a sex inversion • Size at 50% maturity reached at 29.89 cm for females (corresponding to around 8 years old) • Batch fecundity unknown • Purple Wrasse: gonochoristic species (i.e. sex is fixed at maturity) • Size at 50% maturity reached at 18.41 cm for females (corresponding to around 3 years old) • Batch fecundity is estimated at 74,500 ± 34,900 eggs/kg	Barrett (1995a) Hardwood and Lokman (2006) Unpublished data
Spawning	• Spawning season for both species from August to January	Barrett (1995a)
Early life history	• Bluethroat Wrasse: planktonic larval duration ranges from 44 to 66 days • Purple Wrasse: planktonic larval duration ranges from 40 to 87 days • Settlement on reefs at around 10.4mm for both species	Welsford (2003)

Background

Several species of Wrasse occur in Tasmanian waters. Purple Wrasse (*Notolabrus fucicola*) and Bluethroat Wrasse (*N. tetricus*) are the main species taken commercially. Wrasse are targeted for live fish markets, but also sold as dead product and utilised as bait for rock lobster. Bait usage is likely to be under-reported. Live fish market trade is recorded in the logbooks and has accounted for over 90% of the total reported catch since 2001/02. Thus, trends in the live-fish fishery will ultimately be reflected in overall production levels. The two species of Wrasse have only been distinguished in catch returns since 2007. While there is an apparent market preference for Bluethroat Wrasse, Purple Wrasse are more robust for live handling.

FISHING METHODS	Fish trap and handline.
MANAGEMENT METHODS	**Input control**: • Gear licence (Scalefish fishing licence) • Species licence (Wrasse licence) • Rock lobster licence (for bait only) **Output control*:*** • Minimum size: 30 cm • Possession limit of 10 and bag limit of 5 for recreational fishers • Limit of 30kg for landed dead wrasse without species licence
MAIN MARKET	• Interstate (live trade) and local (bait and food)

Current assessment

Catch, effort and CPUE

Wrasse catches fluctuated between approximately 75 t and 110 t from 1995/96 until 2007/08 and peaked at 113 t in 2006/07 (Fig. 23.1A). Along with notably decreasing catch rates, catches then fell to below 70 t in 2008/09 and have ranged around 80 t since then. Lower catches since the late 2000s were accompanied by a decline in the use of fish traps that resulted from the prohibition of abalone gut useage as bait. This prohibition was a response to the appearance of the abalone viral ganglioneuritis in Victoria and forced fishers to seek alternative, but less effective baits.

In 2018/19, total commercial landings of 81.4 t were recorded (comprising 62.4 t of Bluethroat Wrasse, 18.6 t of Purple Wrasse, and 0.5 t of unspecified Wrasse), which is very similar to recent years. For the above-mentioned reason, catch and effort for fish traps have been at low levels for over a decade. Fish trap catch rates have been relatively constant during this period, however, had slightly higher levels in recent years. In contrast, handline catch, effort and catch rates have been stable or slightly increasing over the last decade (Fig. 21A-C). Wrasse are targeted all around Tasmania with exception of the West coast (Fig. 23.2).

It is important to note that historically under-reported Wrasse caught and used as bait in rock lobster pots are not included in the catch data described above.

With Bluethroat Wrasse being more susceptible to line fishing methods and Purple Wrasse more vulnerable to trap capture, Bluethroat Wrasse are now taken in larger quantities in the live fishery. Gillnets account for the bulk of the remaining catch, but because survival in nets is poor, gillnet caught Wrasse are rarely marketed live.

Recreational catches were estimated at 13.6 t in 2000/01 (Lyle 2005), 10.3 t in 2007/08 (Lyle et al. 2009), 6.4 t in 2012/13 (Lyle et al. 2014b) and 9.6 t in 2017/18, representing around 10% of the total catch. Further, Bluethroat Wrasse are a reasonably common by-catch of recreational gillnet fishers with research showing that this species has a moderate to low post-release survival, particularly when gillnets are deployed for more than 4 hours (Lyle et al. 2014a).

It is important to note that state-wide analyses are insensitive to changes in abundance at the level of individual reefs at which the fishery impacts the stocks. Marked regional shifts of effort have occurred in the fishery over the years and may have masked localised depletions with fishers moving to new or lightly fished areas to maintain catches and catch rates.

Ecological Risk Assessment

In the 2012/13 ERA of the Tasmanian Scalefish Fishery, fish trapping was considered a low risk to Wrasse species, because fishing effort at the time had reduced due to the banning of the preferred bait for trap fishing (abalone guts). Risks to by-product species, such as Leatherjackets, were assumed to be very low due to small levels of catch and the risk to non-retained species and the general ecosystem assessed as either low or negligible (Bell et al. 2016).

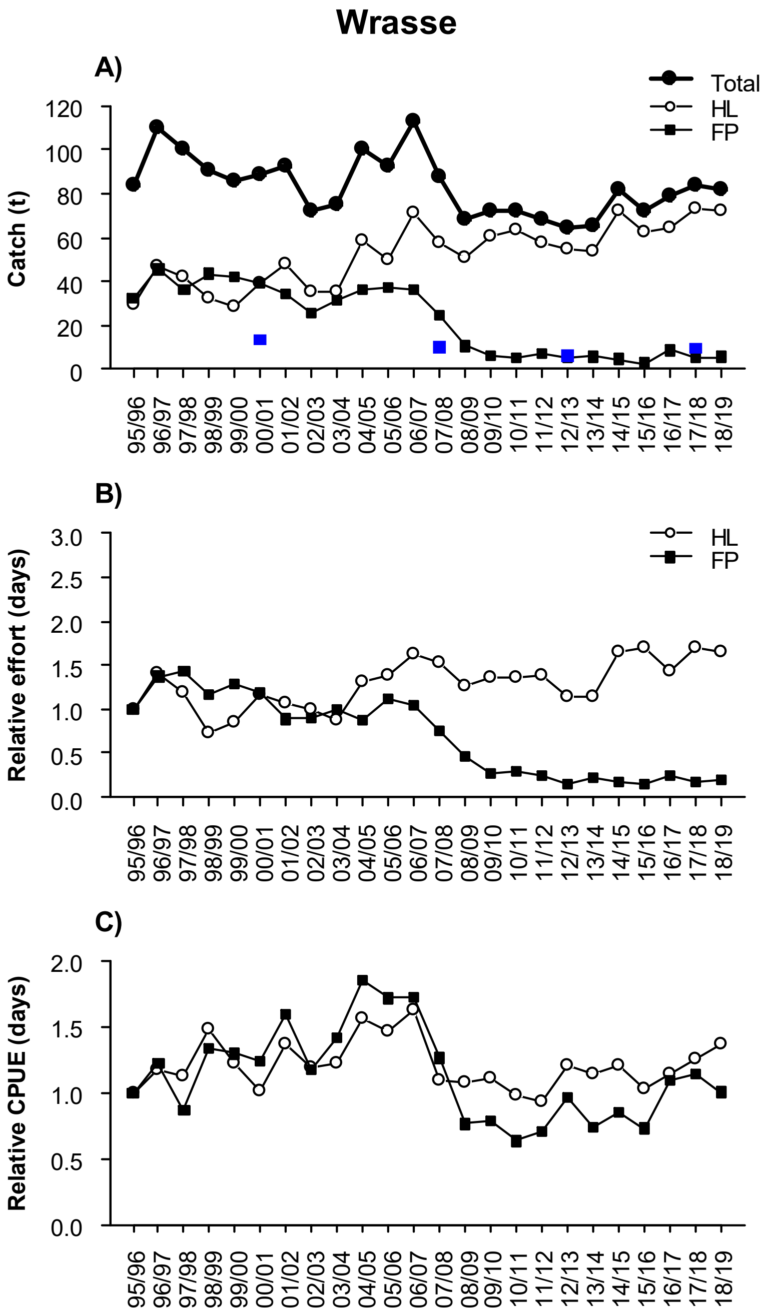


Figure 23.1 A) Annual commercial catch (t) by gear best estimates of recreational catches (blue squares). B) Commercial effort by method based on day fished relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per day fished relative to 1995/96. HL=handline, FP=fish trap.

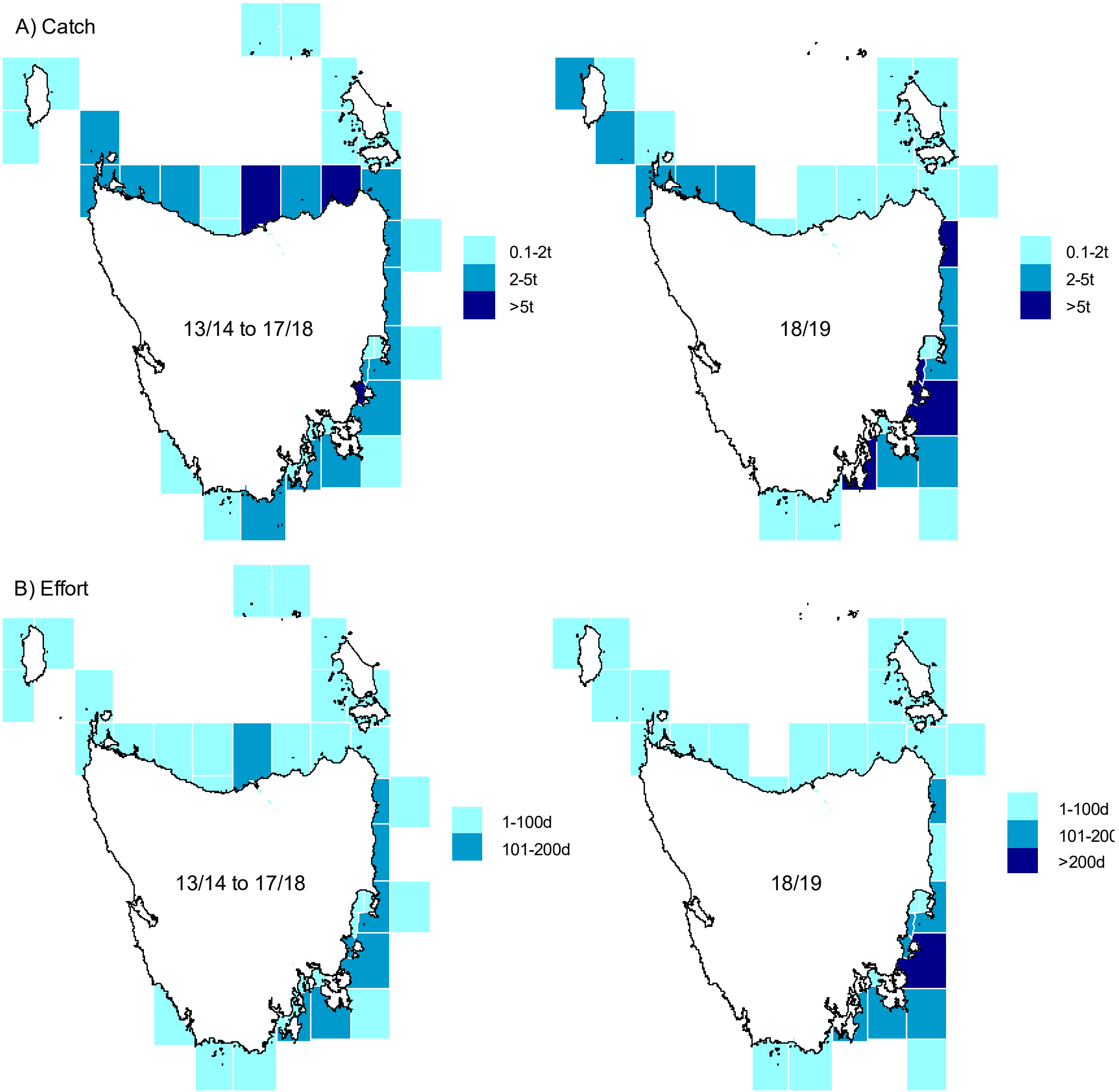


Figure 23.2 (A) Wrasse catches (t) and (B) effort (days) for fish trap, handline and by fishing blocks averaged over the last five assessment years (left) and in the current assessment year (right).

Reference points

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (94.1 t)	No	
	• Catch < 3rd lowest catch value from the reference period (83.4 t)	Yes	↓ 1.3 t (-1.6%)
	• Catch variation from the previous year above the greatest inter-annual increase from the reference period (26.7 t)	No	
	• Catch variation from the previous year above the greatest inter-annual decrease from the reference period (37.9 t)	No	
	• Latest recreational catch estimate > recreational catch estimate from the reference period (13.6 t)	No	
	• Proportion of recreational catch to total catch > previous proportion estimate (13.1% in 2007/08)	No	
Biomass	• CPUE< 3rd lowest CPUE value from the reference period (0.0135 t/days fished)	No	
	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0014)	No	

Stock status

SUSTAINABLE

The minimum size limit should provide protection for several years from reaching maturity for the spawning stock of Purple Wrasse and for female Bluethroat Wrasse. Male Bluethroat Wrasse, in contrast, develop from sex change typically after they have entered the fishery. This situation, along with the fact that male Wrasse are strongly site-attached and have a higher catchability (being more aggressive than females), suggests that males are vulnerable to fishing.

Underwater visual census revealed contrasting results about the abundance of Wrasse in accessible sites (e.g. areas near boat ramps) vs protected sites (Stuart-Smith et al. 2008, Walsh et al. 2017) highlighting the possibility that localised fishing pressure could deplete local populations and spawning potential. Previous assessments have shown that increasing catches up to 2006/07 reflected a strong interest in the species and was associated with concerns that fishing mortality might not be sustainable given notable declines in catch rates. With handline effort remaining at a historic high in 2018/19, close monitoring of potential localised depletions is mandatory, especially in areas where effort is known to be concentrated. However, state-wide catch rates have been stable or increasing over almost a decade, providing no indication that overall levels of fishing mortality are too high. Wrasse are therefore classified as sustainable.

References

AFMA. 2008. Blue warehou (*Seriolella brama*) stock rebuilding strategy: Southern and Eastern Scalefish and Shark Fishery (SESSF) - December 2008. Australian Fisheries Management Authority, Canberra.

AFMA. 2011. Blue warehou (*Seriolella brama*) stock rebuilding strategy: Southern and Eastern Scalefish and Shark Fishery (SESSF) - Revised July 2011. Australian Fisheries Management Authority, Canberra.

AFMA. 2012. Blue warehou (*Seriolella brama*) stock rebuilding strategy: Southern and Eastern Scalefish and Shark Fishery (SESSF) - Revised April 2012. Australian Fisheries Management Authority, Canberra.

AFMA. 2014. Blue warehou (*Seriolella brama*) Stock Rebuilding Strategy. Australian Fisheries Management Authority, Canberra, ACT.

Andrews J., J. Lyle, K. Hall, L. Maloney, and T. Emery. 2016. Eastern School Whiting *Sillago flindersi*. In: C. Stewardson, J. Andrews, C. Ashby, M. Haddon, K. Hartmann, P. Hone, P. Horvat, S. Mayfield, A. Roelofs, K. Sainsbury, T. Saunders, J. Stewart, I. Stobutzki and B. Wise (eds) 2016. Status of Australian fish stocks reports 2016, Fisheries Research and Development Corporation, Canberra.

Annala, J. H. 1994. Report from the Fishery Assessment Plenary, May 1994: stock assessments and yield estimates (unpublished). MAF Fisheries Greta Point library, Wellington

Ayling, G. M., K. C. Wilson, and D. A. Ratkowsky. 1975. Sand flathead (*Platycephalus bassensis*), an indicator species for mercury pollution in Tasmanian waters. Marine Pollution Bulletin 6:142–144.

Bani, A. 2005. Temporal and spatial variability of the life history characteristics of sand flathead, *Platycephalus bassensis*. University of Tasmania, Hobart.

Bani, A., and N. A. Moltschaniwsky. 2008. Spatio-temporal variability in reproductive ecology of sand flathead, *Platycephalus bassensis*, in three Tasmanian inshore habitats: potential implications for management. Journal of Applied Ichthyology 24:555–561.

Barnes, L. M., C. A. Gray, and J. E. Williamson. 2011. Divergence of the growth characteristics and longevity of coexisting Platycephalidae (Pisces). Marine and Freshwater Research 62:1308–1317.

Barrett, N. S. 1995a. Short- and long-term movement patterns of six temperate reef fishes (Families Labridae and Monacanthidae). Marine and Freshwater Research 46:853–860.

Barrett, N. S. 1995b. Aspects of the biology and ecology of six temperate reef fishes (Families: Labridae and Monacanthidae). University of Tasmania, Hobart.

Bell, J. D., J. Lyle, J. Andre, and K. Hartmann. 2016. Tasmanian scalefish fishery: ecological risk assessment. Institute for Marine and Antarctic Studies, Hobart, Australia.

Bertoni, M. 1995. The reproductive biology and feeding habits of the snook, *Sphyraena novaehollandiae*, in South Australian waters. Southern Fisheries 3:34–35.

Blackburn, M. 1960. A study of condition (weight for length) of Australian barracouta, *Thyrsites atun* (Auphrasen). Australian Journal of Marine and Freshwater Research 11:14–41.

Blackburn, M., and P. E. Gartner. 1954. Populations of barracouta, *Thyrsites atun* (Euphrasen), in Australian waters. Australian Journal of Marine and Freshwater Research 5:411–468.

Bruce, B. D., F. J. Neira, and R. W. Bradford. 2001a. Larval distribution and abundance of blue and spotted warehou (*Seriolella brama* and *S. punctata*: Centrolophidae) in southeastern Australia. Marine and Freshwater Research 52:631–639.

Bruce, B. D., K. Evans, C. A. Sutton, J. W. Young, and D. M. Furlani. 2001b. Influence of mesoscale oceanographic processes on larval distribution and stock structure in jackass morwong (*Nemadactylus macropterus*: Cheilodactylidae). ICES Journal of Marine Science 58:1072–1080.

Bulman, C., F. Althaus, X. He, N. J. Bax, and A. Williams. 2001. Diets and trophic guilds of demersal fishes of the south eastern Australian shelf. Marine and Freshwater Research 52:537–548.

Bulman, C., S. Condie, J. Findlay, B. Ward, and J. Young. 2008. Management zones from small pelagic fish species stock structure in southern Australian waters. FRDC report 2006/076. CSIRO, Hobart.

Burchmore, J. J., D. A. Pollard, M. J. Middleton, J. D. Bell, and B. C. Pease. 1988. Biology of four species of whiting (Pisces: *Sillaginidae*) in Botany Bay, New South Wales. Australian Journal of Marine and Freshwater Research 39: 709–727.

Butcher, A. R., and A. R. Hagedoorn. 2003. Age, growth and mortality estimates of stout whiting, *Sillago robusta* Stead (Sillaginidae), from Southern Queensland, Australia. Asian Fisheries Science 16: 215–228.

BWAG. 1998. Stock assessment report: Blue warehou 1998. Australian Fisheries Management Authority, Canberra.

Chubb, C. F., I. C. Potter, C. J. Grant, R. C. J. Lenanton, and J. Wallace. 1981. Age structure, growth rates and movements of sea mullet, *Mugil cephalus* L. and yellow-eye mullet, *Aldrichetta forsteri* (Valenciennes), in the Swan-Avon River System, Western Australia. Australian Journal of Marine and Freshwater Research 32:605–628.

Coleman, N., and M. Mobley. 1984. Diets of commercially exploited fish from Bass Strait and adjacent Victorian waters, South-eastern Australia. Australian Journal of Marine and Freshwater Research 35:549–560.

Crawford, C. M. 1984. An ecological study of Tasmanian flounder. University of Tasmania, Hobart.

Crawford, C. M. 1986. Development of eggs and larvae of the flounders *Rhombosolea tapirina* and *Ammotretis rostratus* (Pisces: Pleuronectidae). Journal of Fish Biology 29:325–334.

Curtis, T. D., and J. S. Shima. 2005. Geographic and sex specific variation in growth of yellow eyed mullet, *Aldrichetta forsteri*, from estuaries around New Zealand. New Zealand Journal of Marine and Freshwater Research 39:1277–1285.

Denny, C. M., and D. R. Schiel. 2001. Feeding ecology of the banded wrasse *Notolabrus fucicola* (Labridae) in southern New Zealand: prey items, seasonal differences, and ontogenetic variation. New Zealand Journal of Marine and Freshwater Research 35:925–933.

Dixon, P. I. 1987. Stock identification and discrimination of commercially important whitings in Australian waters using genetic (FIRTA 83/16): Final Report. University of New South Wales, Centre for Marine Science.

DPIF. 1998. Scalefish Fishery: Policy Document. Tasmanian Department of Primary Industry and Fisheries, Hobart.

DPIPWE. 2015. Framework to support developmental fishing program for Australian sardines. Department of Primary Industries, Parkes, Water & Environment, Tasmania.

Dunning, M. C. 1998. Zoogeography of arrow squids (Cephalopoda: Ommastrephidae) in the Coral and Tasman Seas, southwest Pacific. Pages 435-453 *in* N. A. Voss, M. Vecchione, R. B. Toll, and M. J. Sweeney, editors. Systematics and Biogeography of Cephalopods. Smithsonian Institution Press, Washington D.C.

Dunning, M. C., and E. C. Förch. 1998. A review of the systematics, distribution and biology of arrow squids of the genus *Nototodarus* Pfeffer, 1912 (Cephalopoda, Ommastrephidae). Pages 393–404 *in* N. A. Voss, M. Vecchione, R. B. Toll, and M. J. Sweeney, editors. Systematics and Biogeography of Cephalopods. Smithsonian Institution Press, Washington D.C.

Edgar, G. J. 1997. Australian marine life: the plants and animals of temperate waters. Reed Books, Melbourne.

Edgar, G. D. 2008. Australian marine life: the plants and animals of temperate waters. New Holland Publishers, Sydney.

Edgar, G. J., and N. S. Barrett. 1999. Effects of the declaration of marine reserves on Tasmanian reef fishes, invertebrates and plants. Journal of Experimental Marine Biology and Ecology 242:107–144.

Edgar, G. J., N. S. Barrett, and A. J. Morton. 2004. Patterns of fish movement on eastern Tasmanian rocky reefs. Environmental Biology of Fishes 70:273–284.

Elliott, N. G., and R. D. Ward. 1994. Enzyme variation in jackass morwong, *Nemadactylus macropterus* (Schneider 1801) (Teleostei: Cheilodactylidae) from Australian and New Zealand waters. Australian Journal of Marine and Freshwater Research 45:51–67.

Emery, T., Lyle, J. and Hartmann, K. 2016. Tasmanian Scalefish fishery assessment 2014/15. Institute for Marine and Antarctic Studies, Hobart.

Emery, T., Lyle, J. and Hartmann, K. 2017. Tasmanian Scalefish fishery assessment 2015/16. Institute for Marine and Antarctic Studies, Hobart.

Ewing, G., and J. Lyle. 2019. Low-cost monitoring regime to assess relative abundance and population characteristics of sand flathead 2019 update. Institute for Marine and Antarctic Studies, Hobart, Tasmania.

Fairbridge, W. S. 1951. The New South Wales tiger flathead, *Neoplatycephalus macrodon* (Ogilby). I. Biology and age determination. Australian Journal of Marine and Freshwater Research 2:117–178.

Ferguson, G. 2006. Fisheries biology of the greenback flounder *Rhombosolea tapirina* (Günther 1862) (Teleostei: Pleuronectidae) in South Australia. SARDI Aquatic Sciences Publication No. RD06/0008-1. South Australian Research and Development Institute (Aquatic Sciences), Adelaide.

FishBase. 2013. Monacanthidae. Accessed 30/09/2013.

Fletcher, W. J. (1995). Application of the otolith weight-age relationship for the pilchard *Sardinops sagax neopilchardus*. Canadian Journal of Fisheries and Aquatic Sciences 52:657–664.

Flood, M., I. Stobutzki, J. Andrews, G. Begg, R. Fletcher, C. Gardner, J. Kemp, A. Moore, A. O'Brien, R. Quinn, J. Roach, K. R. Rowling, K. Sainsbury, T. Saunders, T. Ward, and M. Winning. 2012. Status of key Australian fish stocks reports 2012. Fisheries Research and Development Corporation, Canberra.

Flood, M., I. Stobutzki, J. Andrews, C. Ashby, G. Begg, R. Fletcher, C. Gardner, L. Georgeson, S. Hansen, K. Hartmann, P. Hone, P. Horvat, L. Maloney, B. McDonald, A. Moore, A. Roelofs, K. Sainsbury, T. Saunders, T. Smith, C. Stewardson, J. Stewart, and B. Wise. 2014. Status of key Australian fish stocks reports 2014. Fisheries Research and Development Corporation, Canberra.

Francis, M. 2001. Coastal fishes of New Zealand. Reed Publishing, Auckland.

Frimodt, C. 1995. Multilingual illustrated guide to the world's commercial coldwater fish. Wiley- Blackwell, Oxford.

Gavrilov, G. M., and N. P. Markina. 1979. The feeding ecology of fishes of the genus *Seriolella* (fam. Nomeidae) on the New Zealand plateau. Journal of Ichthyology 19:128–135.

Godfriaux, B. L. 1974. Food of tarakihi in western Bay of Plenty and Tasman Bay, New Zealand. New Zealand Journal of Marine and Freshwater Research 8:111–153.

Goldworthy, S. D., C. Bulman, X. He, J. Larcombe, and C. Littnan. 2003. Trophic interactions between marine mammals and Australian fisheries: ecosystem approach. Pages 62–99 *in* N. Gales, M. Hindell, and R. Kirkwood, editors. Marine mammals: fisheries, tourism and management issues. CSIRO Publishing, Collingwood, Victoria.

Gomon, M., D. Bray, and R. Kuiter. 2008. Fishes of Australia's southern coast. Reed New Holland.

Gorman, T. B. S. 1962. Yellow-eyed mullet *Aldrichetta forster*i Cuvier and Valenciennes in Lake Ellesmere.

Grant, C. J., T. R. Cowper, and D. D. Reid. 1978. Age and growth of snoek, *Leionura atun* (Euphrasen), in south-eastern Australian waters. Australian Journal of Marine and Freshwater Research 29:435–444.

Grant, E. M. 1991. Grant's Fishes of Australia. E.M. Grant Pty. Ltd., Queensland.

Grewe, P. M., A. J. Smolenski, and R. D. Ward. 1994. Mitochondrial DNA variation in jackass morwong, *Nemadactylus macropterus* (Teleostei: Cheilodactylidae) from Australian and New Zealand waters. Canadian Journal of Fisheries and Aquatic Sciences 51:1101–1109.

Haddon, M., and A. Punt. 2018. simpleSA: A package containing functions to facilitate relatively simple stock assessments. R package version 0.1.10.

Hardwood, N. J., and M. P. Lokman. 2006. Fecundity of banded wrasse (*Notolabrus fucicola*) from Otago, Southern New Zealand. New Zealand Journal of Marine and Freshwater Research 40:467–476.

Harries, D. N., and R. L. Croome. 1989. A review of past and present inshore gill netting in Tasmania with particular reference to the bastard trumpeter, *Latridopsis forsteri* Castelnau. Papers and Proceedings of the Royal Society of Tasmania 123:97–110.

Harries, D. N., and P. S. Lake. 1985. Aspects of the biology of inshore populations of Bastard Trumpeter, *Latridopsis forsteri* (Castleneau, 1872) in Tasmanian waters. Tasmanian Fisheries Research 27:19–43.

Hartmann, K., and J. M. Lyle. 2011. Tasmanian Scalefish Fishery-2009/10. Tasmanian Aquaculture and Fisheries Institute, Hobart.

Henry, G. W., and J. M. Lyle. 2003. National recreational and indigenous fishing survey. Final report to FRDC. Project No 99/158. Canberra

Hobday, D. K., and J. W. J. Wankowski. 1987. School whiting *Sillago bassensis flindersi*: reproduction and fecundity in eastern Bass Strait, Australia. Internal Report 153. Victorian Department of Conservation, Forests and Lands. Fisheries Division.

Hoedt, F. E., and W. F. Dimmlich. 1995. Egg and larval abundance and spawning localities of the anchovy (*Engraulis australis*) and pilchard (*Sardinops neopilchardus*) near Phillip Island, Victoria. Marine and Freshwater Research 46:735–743.

Hoenig, J. M., and W. D. Lawing. 1982. Estimating the mortality rate using the maximum order statistic for age. ICES Journal of Marine Science 7: 13.

Hurst, R. J., S. L. Ballara, and D. MacGibbon. 2012. Fishery characterisation and standardised CPUE analyses for barracouta,*Thyrsites atun*, (Euphrasen, 1791) (Gempylidae),1989–90 to 2007–08. New Zealand Fisheries Assessment Report 2012/12 NIWA, Wellington.

Hutchinson, W. 1993. The reproductive biology and induced spawning of striped trumpeter, *Latris lineata*. University of Tasmania, Hobart.

Izzo, C., T. M. Ward, A. R. Ivey, I. M. Suthers, J. Stewart, S. C. Sexton, B. M. Gillanders. (2017). Integrated approach to determining stock structure: implications for fisheries management of sardine, *Sardinops sagax*, in Australian waters. Reviews in Fish Biology and Fisheries 27: 267–284.

Jackson, G. D., B. McGrath Steer, S. Wotherspoon, and A. J. Hobday. 2003. Variation in age, growth and maturity in the Australian arrow squid *Nototodarus gouldi* over time and space-what is the pattern? Marine Ecology Progress Series 264:57–71.

Jackson, G. D., R. K. O'Dor, and Y. Andrade. 2005a. First tests of hybrid acoustic/archival tags on squid and cuttlefish. Marine and Freshwater Research 56:425–430.

Jackson, G. D., S. Wotherspoon, and B. L. McGrath-Steer. 2005b. Temporal population dynamics in arrow squid *Nototodarus gouldi* in southern Australian waters. Marine Biology 146:975–983.

Jenkins, G. P. 1986. Composition, seasonality and distribution of ichthyoplankton in Port Phillip Bay, Victoria. Australian Journal of Marine and Freshwater Research 37:507–520.

Jones, G. K. 1990. Growth and mortality in a lightly fished population of garfish (*Hyporhamphus melanochir*), in Baird Bay, South Australia. Transactions of the Royal Society of South Australia 114:37–45.

Jones, G. K., Q. Ye, S. Ayvazian, and P. Coutin. 2002. Fisheries ecology and habitat ecology of southern sea garfish (*Hyporhampus melanochir*) in southern Australian waters. South Australian Research and Development Institute.

Jordan, A. R. 2001a. Reproductive biology, early life-history and settlement distribution of sand flathead (*Platycephalus bassensis*) in Tasmania. Marine and Freshwater Research 52:589–601.

Jordan, A. R. 2001b. Age, growth and spatial and interannual trends in age composition of jackass morwong, *Nemadactylus macropterus*, in Tasmania. Marine and Freshwater Research 52:641–660.

Jordan, A. R., D. M. Mills, G. Ewing, and J. M. Lyle. 1998. Assessment of inshore habitats around Tasmania for life-history stages of commercial finfish species. Tasmanian Aquaculture and Fisheries Institute, Hobart.

Kailola, P. J., M. J. Williams, P. C. Stewart, R. E. Reichelt, A. McNee, and C. Grieve. 1993. Australian fisheries resources. Bureau of Resource Sciences, Canberra.

Klaer, N. 2010. Tiger flathead (*Neoplatycephalus richardsoni*) stock assessment based on data up to 2009. CSIRO, Hobart.

Klumpp, D. W., and P. D. Nichols. 1983. Nutrition of the southern sea garfish (*Hyporhamhus melanochir*): gut passage rate and daily consumption of two food types and assimilation of seagrass components. Marine Ecology Progress Series 12:207–216.

Knuckey, I. A. 2006. Southern and Eastern Scalefish and Shark Fishery – Bycatch Utilisation Scoping Study. Department of Primary Industries Agribusiness Group, Victoria.

Knuckey, I. A., and K. P. Sivakumaran. 2001. Reproductive characteristics and per-recruit analyses of blue warehou (*Seriolella brama*): implications for the south-east fishery of Australia. Marine and Freshwater Research 52:575–587.

Last, P. R., E. O. G. Scott, and F. H. Talbot. 1983. Fishes of Tasmania. Tasmanian Fisheries Development Authority Hobart.

Lo, N. C. H., B. J. Macewicz, and D. A. Griffith. 2005. Spawning biomass of Pacific sardine (*Sardinops sagax*) from 1994–2004 off California. California Cooperative Oceanic Fisheries Investigations Reports 46:93–112.

Lyle, J. M. 1999. Licensed recreational fishing and an evaluation of recall biases in the estimation of recreational catch and effort. Final Report to the Marine Recreational Fishing Council Tasmanian Aquaculture and Fisheries Institute, Hobart.

Lyle, J. M. 2000. Assessment of the licensed recreational fishery of Tasmania (Phase 2). Final Report to FRDC. Project 96/161. Tasmanian Aquaculture and Fisheries Institute Hobart.

Lyle, J. M. 2005. 2000/01 survey of recreational fishing in Tasmania. Tasmanian Aquaculture and Fisheries Institute, Hobart.

Lyle, J. M., and W. B. Ford. 1993. Review of trawl research 1979–1987, with summaries of biological information for the major species, with summaries of biological information for the major species. Technical Report 46. Department of Sea Fisheries, Tasmania, Hobart.

Lyle, J. M., and A. R. Jordan. 1999. Tasmanian scalefish fishery assessment - 1998. Tasmanian Aquaculture and Fisheries Institute, Hobart.

Lyle, J. M., and R. Murphy. 2001. Long distance migration of striped trumpeter. Fishing Today 14:6.

Lyle, J. M., and S. R. Tracey. 2012. Recreational gillnetting in Tasmania – an evaluation of fishing practices and catch and effort. Report to FishWise. IMAS, Hobart.

Lyle, J. M., K. Krusic-Golub, and A. K. Morison. 2000. Age and growth of jack mackerel and the age structure of the jack mackerel purse seine catch. FRDC project no 1995/034. TAFI, Hobart.

Lyle, J. M., N. Moltschaniwskyj, A. J. Morton, I. W. Brown, and D. Mayer. 2007. Effects of hooking damage and hook type on post-release survival of sand flathead (*Platycephalus bassensis*). Marine and Freshwater Research 58:445–453.

Lyle, J. M., S. R. Tracey, K. E. Stark, and S. Wotherspoon. 2009. 2007-08 survey of recreational fishing in Tasmania. Tasmanian Aquaculture and Fisheries Institute, Hobart.

Lyle, J. M., K. E. Stark, and S. R. Tracey. 2014a. 2012-13 survey of recreational fishing in Tasmania. Institute for Marine and Antarctic Studies, Hobart, Tasmania.

Lyle, J. M., J. D. Bell, B. M. Chuwen, N. S. Barrett, S. R. Tracey, and C. D. Buxton. 2014b. Assessing the impacts of gillnetting in Tasmania: Implications for by-catch and biodiversity. Institute for Marine and Antarctic Studies, Hobart, Tasmania.

Lyle, J. M., K. E. Stark, G. P. Ewing, and S. R. Tracey 2019. 2017-18 Survey of recreational fishing in Tasmania. Institute for Marine and Antarctic Studies, Hobart, Tasmania.

Machida, S. 1983. A brief review of the squid survey by Hoyo Maru No. 67 in southeast Australian waters in 1979/80. Memoirs of the National Museum Victoria 44:291–295.

May, J. L., and J. G. H. Maxwell. 1986. Trawl fish from temperate waters of Australia. CSIRO Division of Fisheries Research, Hobart.

Millar, R. B. (2015). A better estimator of mortality rate from age-frequency data. Canadian Journal of Fisheries and Aquatic Sciences 72: 364–375.

Moltschaniwskyj, N. A., and G. T. Pecl. 2003. Small-scale spatial and temporal patterns of egg production by the temperate loliginid squid *Sepioteuthis australis*. Marine Biology 142:509–516.

Moore, B. R., J. M. Lyle, and K. Hartmann. 2019. Tasmanian Scalefish Fishery Assessment 2018/19. Institute for Marine and Antarctic Studies, Hobart.

Morison, A. K., I. A. Knuckey, C. A. Simpfendorfer, and R. C. Buckworth. 2012. 2011 Stock assessment summaries for the South East Scalefish and Shark Fishery. Southern and Eastern Scalefish and Shark Fishery Assessment Group, AFMA.

Murphy, R., and J. M. Lyle. 1999. Impact of gillnet fishing on inshore temperate reef fished, with particular reference to banded morwong. Final report to FRDC, project No. 95/145.Tasmanian Aquaculture and Fisheries Institute, Hobart.

Nakamura, I., and N. V. Parin. 1993. FAO Species Catalogue. Vol. 15. Snake mackerels and cutlassfishes of the world (families Gempylidae and Trichiuridae). An annotated and illustrated catalogue of the snake mackerels, snoeks, escolars, gemfishes, sackfishes, domine, oilfish, cutlassfishes, scabbardfishes, hairtails, and frostfishes known to date. FAO.

Neira, F. J., A. G. Miskiewicz, and T. Trnski. 1998. Larvae of temperate Australian fishes: laboratory guide for larval fish identification. University of Western Australia Press.

Neira, F. J., M. I. Sporcic, and A. R. Longmore. 1999. Biology and fishery of pilchard, *Sardinops sagax* (Clupeidae), within a large south-eastern Australian bay. Marine and Freshwater Research 50:43–55.

Nichols, D. S., D. Williams, G. A. Dunstan, P. D. Nichols, and J. K. Volkman. 1994. Fatty acid composition of Antarctic and temperate fish of commercial interest. Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology 107:357–363.

Noriega, R., J. Lyle, K. Hal, B. Moore. 2018. Status of Australian Fish Stocks (SAFS) Report: Gould's Squid. Fisheries Research and Development Corporation, Canberra.

Norman, M. 2000. Cephalopods, a world guide. ConchBooks, Hackenheim.

Norman, M., and A. Reid. 2000. A guide to squid, cuttlefish and octopuses of Australasia. CSIRO Publishing/The Gould League of Australia, Collingwood/Moorabbin

O'Shea, S., K. S. Bolstad, and P. A. Ritchie. 2004. First records of egg masses of *Nototodarus gouldi* McCoy, 1888 (Mollusca: Cephalopoda: Ommastrephidae), with comments on eggmass susceptibility to damage by fisheries trawl. New Zealand Journal of Zoology 31:161–166.

O'Sullivan, D., and J. M. Cullen. 1983. Food of the Squid *Nototodarus gouldi* in Bass Strait. Australian Journal of Marine and Freshwater Research 34:261–285.

Parker, S., and D. Fu. 2011. Age composition of the commercial tarakihi (*Nemadactylus macropterus*) catch in quota management area TAR 2 in fishery year 2009–2010. New Zealand Fisheries Assessment Report 2011/59.

Patterson, H., J. Woodhams, A. Williams and R. Curtotti. 2019. Fishery status reports 2019. Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

Paul, L. J. 2000. New Zealand fishes. Identification, natural history and fisheries. Reed Publishing, Auckland.

Paul, L. T., and P. R. Taylor. 1998. A summary of the biology, recreational and commercial landings, and stock assessment of yellow-eyed mullet, *Aldrichetta forsteri* (Cuvier and Valenciennes, 1836) (Mugiloidei: Mugilidae). New Zealand Fisheries Assessment Research Document 98/17, NIWA, Wellington.

Paxton, J. R., D. F. Hoese, G. R. Allen and J. E. Hanley. Pisces. Petromyzontidae to Carangidae. Zoological Catalogue of Australia, Vol. 7. Australian Government Publishing Service, Canberra, 665 p.

Pecl, G. T. 2000. Comparative life-history of tropical and temperate Sepioteuthis squids in Australian waters. PhD Thesis, James Cook University, Townsville.

Pecl, G. T. 2004. The *in situ* relationships between season of hatching, growth and condition in the southern calamary, *Sepioteuthis australis*. Marine and Freshwater Research 55:429–438.

Pecl, G. T., and N. A. Moltschaniwsky. 2006. Life history of a short-lived squid (*Sepioteuthis australis*): resource allocation as a function of size, growth, maturation, and hatching season. ICES Journal of Marine Science 63:995–1004.

Pecl, G. T., N. A. Moltschaniwskyj, S. R. Tracey, and A. R. Jordan. 2004. Inter-annual plasticity of squid life-history and population structure: ecological and management implications. Oecologia (Berlin) 139:515–524.

Pecl, G. T., S. R. Tracey, J. M. Semmens, and G. D. Jackson. 2006. Use of acoustic telemetry for spatial management of *Sepioteuthis australis*, a highly mobile inshore squid species. Marine Ecology Progress Series 328:1–15.

Reid J (2018). Decadal changes in the population dynamics and stock structure of southern sea garfish (*Hyporhamphus melanochir*) within Tasmania. Honours thesis, University of Tasmania.

Richardson, B. J. 1982. Geographical distribution of electrophoretically detected protein variation in Australian commercial fishes. II: Jackass morwong, *Cheilodactylus macropterus* (Bloch and Schneider). Australian Journal of Marine and Freshwater Research, 33: 927–931.

Robinson, N., A. Skinner, L. Sethuraman, H. McPartlan, N. Murray, I. Knuckey, D. C. Smith, J. Hindell, and S. Talman. 2008. Genetic stock structure of blue-eye trevalla (*Hyperoglyphe antarctica*) and warehous (*Seriolella brama* and *Seriolella punctata*) in south-eastern Australian waters. Marine and Freshwater Research 59:502–514.

Rowling, K. R. 1994. Tiger flathead, *Neoplatycephalus richardsoni*. Pages 124-136 *in* R. D. J. Tilzey, editor. The South East Fishery: a scientific review with reference to quota management. Bureau of Resource Sciences, Australian Government Print Service, Canberra.

Ruwald, F. P. 1992. Larval feeding trials with striped trumpeter, *Latris lineata*. In: D. A. Hancock, editor. Larval biology. Australian Society for Fish Biology Workshop, Hobart, 20 August 1991. Bureau of Rural Resources Proceedings, AGPS, Canberra.

Ruwald, F. P., L. D. Searle, and L. A. Oates. 1991. A preliminary investigation into the spawning and larval rearing of striped trumpeter, *Latris lineata*. Technical Report 44. Department of Primary Industries, Tasmania.

Sahlqvist, P., and M. Skirtun. 2011. Southern Squid Fishery. In: J. Woodhams, I. Stobutzki, S. Vieira, R. Curtotti, and G. Begg, editors. Fisheries Status Reports 2010: status of fish stocks and fisheries managed by the Australian Government. Australian Bureau of Agriculture and Resource Economics and Sciences, Canberra.

Scott, T. D., C. J. M. Glover, and R. V. Southcott. 1974. The marine and freshwater fishes of South Australia, 2nd ed. Government Printer, South Australia.

SFAC. 2015. Scalefish fishery advisory committee (SFAC) minutes No. 59, 26 November 2015. Page 38 Department of Primary Industries, Water and the Environment. Hobart.

Shepherd, S. A., and P. S. Clarkson. 2001. Diet, feeding behaviour, activity and predation of the temperate blue-throated wrasse, *Notolabrus tetricus*. Marine and Freshwater Research 52:311–322.

Smith, D. C. 1994. Blue warehou. Page 360 *in* R. D. J. Tilzey, editor. The South East Fishery: a scientific review with particular reference to quota management. Bureau of Resource Sciences, Parkes.

Smith, D. C., I. Montgomery, K. P. Sivakumaran, K. Krusic-Golub, K. Smith, and R. Hodge. 2003. The fisheries biology of bluethroat wrasse (*Notolabrus tetricus*) in Victorian waters. FRDC Report No. 97/128. Marine and Freshwater Institute, Victoria, Australia.

Smith, H. K. 1983. Fishery and Biology of *Nototodarus gouldi* (McCoy, 1888) in western Bass Strait. Memoirs of the National Museum Victoria 44:285–290.

Smith, A. D. M., T. M. Ward, F. Hurtado, N. Klaer, E. Fulton, and A. E. Punt. 2015a. Review and update of harvest strategy settings for the Commonwealth Small Pelagic Fishery: Single species and ecosystem considerations. FRDC Project No. 2013/028, Final report.

Smith, T. M., C. P. Green, and C. D. H. Sherman. 2015b. Patterns of connectivity and population structure of the southern calamary *Sepioteuthis australis* in southern Australia. Marine and Freshwater Research 66:942–947.

St Hill, J. L. 1996. Aspects of the biology of southern sea garfish, *Hyporhamphus malanochir*, in Tasmanian waters. University of Tasmania, Hobart.

Stacy, B., N. C. Krueck., K. Hartmann, and J. M. Lyle. 2019. Tasmanian Banded Morwong Fishery Assessment. 2018/19. Institute for Marine and Antarctic Studies, Hobart.

Stark, K. E. 2008. Ecology of the arrow squid (*Nototodarus gouldi*) in southeastern Australian waters: a multi-scale investigation of spatial and temporal variability. PhD Thesis, University of Tasmania, Hobart.

Steer, M. A., N. A. Moltschaniwskyj, and F. C. Gowland. 2002. Temporal variability in embryonic development and mortality in the southern calamary *Sepioteuthis australis*: a field assessment. Marine Ecology Progress Series 243:143–150.

Steer, M. A., N. A. Moltschaniwskyj, D. S. Nichols, and M. Miller. 2004. The role of temperature and maternal ration in embryo survival: using the dumpling squid *Euprymna tasmanica* as a model. Journal of Experimental Marine Biology and Ecology 307:73–89.

Stevens, J. D., and H. F. Hansfeld. 1982. Age determination and mortality estimates on an unexploited population of Jack mackerel *Trachurus declivis* (Jenyns, 1841) from southeast Australia. Report No 148, CSIRO Marine Laboratories, Cronulla.

Stewart, J., G. Ballinger, and D. Ferrell. 2010. Review of the biology and fishery for Australian sardines (*Sardinops sagax*) in New South Wales - 2010. Industry and Investment NSW-Fisheries Research Report Series No. 26.

Stewart, J., J. Hughes, J. McAllister, J. M. Lyle, and M. MacDonald. 2011. Australian salmon (*Arripis trutta*): population structure, reproduction, diet and composition of commercial and recreational catches. Fisheries Final Report Series No. 129. Industry & Investment NSW.

Stewart, J., A. Fowler, C. Green, J. Lyle, K. Smith, and B. Moore. 2018. Status of Australian Fish Stocks (SAFS) Report: Australian Salmons. Fisheries Research and Development Corporation, Canberra. (www.fish.gov.au/report/160-AUSTRALIAN-SALMONS-2018)

Stuart-Smith, R. D., N. S. Barrett, C. M. Crawford, S. D. Frusher, D. G. Stevenson, and G. J. Edgar. 2008. Spatial patterns in impacts of fishing on temperate rocky reefs: Are fish abundance and mean size related to proximity to fisher access points? Journal of Experimental Marine Biology and Ecology 365:116–125.

Sutton, C. P., D. J. MacGibbon, and D. W. Stevens. 2010. Age and growth of greenback flounder (*Rhombosolea tapirina*) from southern New Zealand. New Zealand Fisheries Assessment Report 2010/48. NIWA, Wellington.

Thresher, R. E., C. H. Proctor, J. S. Gunn, and I. R. Harrowfield. 1994. An evaluation of electronprobe microanalysis of otoliths for stock identification of nursery areas in a southern temperate groundfish, *Nemadactylus macropterus* (Cheilodactylidae). Fishery Bulletin 92:817–840.

Tilzey, R. D. J. 1994. The South East fishery: a scientific review with particular reference to quota management. Bureau of Resources Sciences, Australia.

Tilzey, R. D. J., M. Zann-Schuster, N. L. Klaer, and M. J. Williams. 1990. The South East Trawl Fishery: biological synopses and catch distributions for seven major commercial fish species.

Tracey, S. R., and J. M. Lyle. 2005. Age validation, growth modeling and mortality estimates for striped trumpeter (*Latris lineata*) from south-eastern Australia: making the most of patchy data. Fishery Bulletin 103:169–182.

Tracey, S. R., J. M. Lyle, G. Ewing, K. Hartmann, and A. Mapleston. 2013. Offshore recreational fishing in Tasmania 2011/12. Institute for Marine and Antarctic Studies, Hobart.

Tracey, S. R., A. J. Smolenski, and J. M. Lyle. 2007a. Genetic structuring of *Latris lineata* at localized and transoceanic scales. Marine Biology 152:119–128.

Tracey, S. R., J. M. Lyle, and M. Haddon. 2007b. Reproductive biology and per-recruit analyses of striped trumpeter (*Latris lineata*) from Tasmania, Australia: implications for management. Fisheries Research 84:358–367.

Triantafillos, L. 2004. Effects of genetic and environmental factors on growth of southern calamary, *Sepioteuthis australis*, from southern Australia and northern New Zealand. Marine and Freshwater Research 55:439–446.

Triantafillos, L., and M. Adams. 2001. Allozyme analysis reveals a complex population structure in the southern calamary *Sepioteuthis australis* from Australia and New Zealand. Marine Ecology Progress Series 212:193–209.

Triantafillos, L., G. D. Jackson, M. Adams, and B. McGrath Steer. 2004. An allozyme investigation of the stock structure of arrow squid *Nototodarus gouldi* (Cephalopoda: Ommastrephidae) from Australia. ICES Journal of Marine Science 61:829–835.

Uozumi, Y. 1998. Fishery biology of arrow squids, *Nototodarus gouldi* and *N. sloanii* in New Zealand Waters. Bulletin of the National Research Institute of Far Seas Fisheries 35:1–111.

van den Enden, T., R. W. G. White, and N. G. Elliott. 2000. Genetic variation in the greenback flounder *Rhombosolea tapirina* Günther (Teleostei, Pleuronectidae) and the implications for aquaculture. Marine and Freshwater Research 51:23–33.

Ward, T. M., and Grammer, G. L. 2016. Commonwealth Small Pelagic Fishery Assessment Report 2015. Report to the Australian Fisheries Management Authority. SARDI publication F2010/000270–7, SARDI Research Report Series 900, South Australian Research and Development Institute (Aquatic Sciences), Adelaide.

Ward, T. M., O. Burnell, A. Ivey, J. Carroll, J. Keane, J. Lyle, and S. Sexton. 2015. Summer spawning patterns and preliminary Daily Egg Production Method survey of Jack Mackerel and Australian Sardine off the East Coast. South Australian Research and Development Institute (Aquatic Sciences).

Ward. T., N. Marton, K. Hall, J. Norriss, J. Stewart. 2018. Status of Australian Fish Stocks (SAFS) Report: Australian Sardine. Fisheries Research and Development Corporation, Canberra. (https://www.fish.gov.au/api/sitecore/FishGovReport/downloadreport?id=186)

Walsh, A. T., Barrett, N., and Hill, N. 2017. Efficacy of baited remote underwater video systems and bait type in the cool-temperature zone for monitoring 'no-take' marine reserves. Marine and Freshwater Research 68: 568–580.

Wayte, S. E. 2013. Management implications of including a climate-induced recruitment shift in the stock assessment for jackass morwong (*Nemadactylus macropterus*) in southeastern Australia. Fisheries Research 142:47–55.

Webb, B. F. 1976. Aspects of the biology of jack mackerel *Trachurus declivis* (Jenyns) from south east Australian waters. Tasmanian Fisheries Research 10:1–17.

Welsford, D. C. 2003. Early life-history, settlement dynamics and growth of the temperate wrasse, *Notolabrus fucicola* (Richardson 1840), on the east coast of Tasmania. PhD thesis. University of Tasmania, Hobart.

Williams, H., and G. Pullen. 1986. A synopsis of biological data on the jack mackerel *Trachurus declivis* Jenyns. Tasmanian Department of Sea Fisheries Technical Report 10. 34 p.

Woodhams, J., S. Vieira, and I. Stobutzki. 2013. Fishery status reports 2012. Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

Ziegler, P. E. 2012. Fishing tactics and fleet structure of the small-scale coastal scalefish fishery in Tasmania, Australia. Fisheries Research 134-136:52–63.

Zwolinski, J. P., and D. A. Derner. 2013. Measurements of natural mortality for Pacific sardine (*Sardinops sagax*). ICES Journal of Marine Science 70:1408–1415.

Appendix 1: Common and scientific names of species

Common name	Scientific name	Common name	Scientific name
Alfonsino	*Beryx* spp.	Pilchard	Fam. Clupeidae
Anchovy	Fam. Engraulidae	Rays bream	Fam. Bramidae
Atlantic salmon	*Salmo salar*	Redbait	*Emmelichthys nitidus*
Australian Salmon	*Arripis* spp.	Red fish	Fam. Berycidae
Barracouta	*Thyrsites atun*	Red Mullet	*Upeneichthys* spp.
Boarfish	Fam. Pentacerotidae	Silverfish	Fam. Atherinidae
Bream	*Acanthopagrus butcheri*	Snapper	*Pagrus auratus*
Butterfish	Spp unknown	Stargazer	Fam. Uranoscopidae
Cardinal fish	Fam Apogonidae	Sweep	*Scorpis spp*
Cod deep sea	*Mora moro*	Tailor	*Pomatomus saltatrix*
Cod, bearded rock	*Pseudophycis barbata*	Thetis fish	*Neosebastes thetidis*
Cod, red	*Pseudophycis bachus*	Trevalla, white	*Seriolella caerulea*
Cod, unspec.	Fam. Moridae	Trevally, silver	*Pseudocaranx dentax*
Dory, john	*Zeus faber*	Trout, rainbow	*Oncorhynchus mykiss*
Dory, king	*Cyttus traversi*	Trumpeter, bastard	*Latridopsis forsteri*
Dory, mirror	*Zenopsis nebulosus*	Trumpeter, striped	*Latris lineata*
Dory, silver	*Cyttus australis*	Trumpeter, unspec.	Fam. Latridae
Dory, unspec.	Fam. Zeidae	Warehou, blue	*Seriolella brama*
Eel	*Conger* spp.	Warehou, spotted	*Seriolella punctata*
Flathead	Fam Plactycephalidae	Whiptail	Fam. Macrouridae
Flounder	Fam. Pleuronectidae	Whiting	Fam. Sillaginidae
Garfish	*Hyporhamphus melanochir*	Whiting, King George	*Sillaginoides punctata*
Gurnard	Fam. Triglidae & Fam. Scorpaenidae	Wrasse	*Notolabrus* spp.
Gurnard perch	*Neosebastes scorpaenoides*	**'Commonwealth' spp**	
Gurnard, red	*Chelidonichthys kumu*	Blue grenadier	*Macruronus novaezelandiae*
Hardyheads	Fam. Atherinidae	Gemfish	*Rexea solandri*
Herring cale	*Odax cyanomelas*	Hapuka	*Polyprion oxygeneios*
Kingfish, yellowtail	*Seriola lalandi*	Oreo	Fam. Oreosomatidae
Knifejaw	*Oplegnathus woodwardi*	Trevalla, blue eye	*Hyperoglyphe antartica*
Latchet	*Pterygotrigla polyommata*	Tunas	
Leatherjacket	Fam. Monocanthidae	Albacore	*Thunnus alalunga*
Ling	*Genypterus* spp.	Skipjack	*Katsuwonus pelamis*
Luderick	*Girella tricuspidata*	Southern bluefin	*Thunnus maccoyii*
Mackerel, blue	*Scomber australasicus*	Tuna, unspec.	Fam. Scombridae
Mackerel, jack	*Trachurus declivis*	**Sharks**	
Marblefish	*Aplodactylus arctidens*	Shark, angel	*Squatina australis*
Morwong, banded	*Cheilodactylus spectabilis*	Shark, blue whaler	*Prionace glauca*
Morwong, blue	*Nemadactylus valenciennesi*	Shark, bronze whaler	*Carcharhinus brachyurus*
Morwong, dusky	Fam. Cheilodactylidae	Shark, elephant	*Callorhynchus milii*
Morwong, grey	*Nemadactylus douglasii*	Shark, gummy	*Mustelus antarcticus*
Morwong, jackass	*Nemadactylus macropterus*	Shark, saw	*Pristophorus spp.*
Morwong, red	Fam. Cheilodactylidae	Shark, school	*Galeorhinus galeus*
Morwong, unspec.	Fam. Cheilodactylidae	Shark, seven-gilled	*Notorynchus cepedianus*
Mullet	Fam. Mugilidae	Shark, spurdog	Fam. Squalidae
Nannygai	*Centroberyx affinis*	**Cephalopods**	
Perch, magpie	*Cheilodactylus nigripes*	Calamari	*Sepioteuthis australis*
Perch, ocean	*Helicolenus* spp.	Cuttlefish	*Sepia* spp.
Pike, long-finned	*Dinolestes lewini*	Octopus	*Octopus* spp.
Snook	*Sphyraena novaehollandiae*	Squid, Gould's	*Nototodarus gouldi*

Appendix 2: Data restrictions and quality control

There have been a number of administrative changes that have affected the collection of catch and effort data from the fishery. The following restrictions and adjustments have been applied when analysing the data as an attempt to ensure comparability between years, especially when examining trends over time.

Tasmanian logbook data

i) Correction of old logbook landed catch weights

Prior to 1995, catch returns were reported as monthly summaries of landings. With the introduction of a revised logbook in 1995, catch and effort was recorded on a daily basis for each method used. Since catch data reported in the old general fishing return represent landed catch, it has been assumed to represent processed weights. For example, where a fish is gilled and gutted, the reported landed weight will be the gilled and gutted and not the whole weight. In contrast, in the revised logbook all catches are reported in terms of weight and product form (whole, gilled and gutted, trunk, fillet, bait or live). If the catch of a species is reported as gilled and gutted, then the equivalent whole weight can be estimated based on a conversion factor[3].

Without correcting for product form, old logbook and revised logbook catch weights are not strictly compatible. In an attempt to correct for this issue and provide a 'best estimate', a correction factor was calculated using catch data from the revised logbook and applied to catches reported in the old logbook. A species-based ratio of the sum of estimated whole weights (adjusted for product form) to the sum of reported catch weights was used as the correction factor (Lennon 1998).

ii) Effort Problems

Records of effort (based on gear units, Table 2.1) of zero or null, or appearing to be recorded incorrectly (implausible), were flagged. While catch can then still be included in catch summaries, such records need to be excluded from calculations of gear unit effort and associated catch rate calculations. However, all records of effort can be considered in calculating daily catch rates.

iii) Vessel restrictions

In all analyses of catch and effort, past catches from six vessels (four Victorian based and two Tasmanian based) have been excluded. These vessels were known to have fished consistently in Commonwealth waters and their catches of species, such as Blue Warehou and Ling tended to significantly distort catch trends. In fact, all four Victorian vessels and one of the Tasmanian vessels ceased reporting on the General Fishing Returns in 1994. With the introduction of the South East Fishery Non-Trawl logbook (GN01) in 1997, the remaining Tasmanian vessel ceased reporting fishing activity in the Tasmanian logbook.

Commonwealth logbook data:

Commonwealth logbook data from Australian Fisheries Management Authority was included in the analyses so that the assessment of individual species reflected all catches from Tasmanian waters.

(i) Area restrictions

Commonwealth logbook records were only included if the catch was taken in fishing blocks adjacent to Tasmania and the maximum depth of the fishing operation was less than 200 m.

---

[3] Conversion factors to whole weights are 1.00 for whole, live or bait; 2.50 for fillet; 1.50 for trunk; and 1.18 for gilled and gutted.

These conditions were applied to all records except where Striped or Bastard Trumpeter were caught. All records that included catches of these species were included for analysis, because these species are managed under Tasmanian jurisdiction in all waters adjacent to Tasmania.

Fishing blocks adjacent to land and used in the analyses (refer Fig. A1) include:

3C2, 3D1, 3F1, 3F2, 3G1, 3G2, 3C4, 3D3, 3F4, 3G3, 3G4, 3H3, 3H4, 4C2, 4D1, 4D2, 4E1, 4G2, 4H1, 4H2, 4D4, 4E3, 4E4, 4F4, 4G3, 4G4, 4H3, 4H4, 5D2, 5E2, 5F1, 5F2, 5H1, 5D4, 5E3, 5H3, 6E1, 6H1, 6E3, 6G4, 6H3, 7E1, 7E2, 7G1, 7G2, 7H1, 7E4, 7F3, 7F4, 7G3.

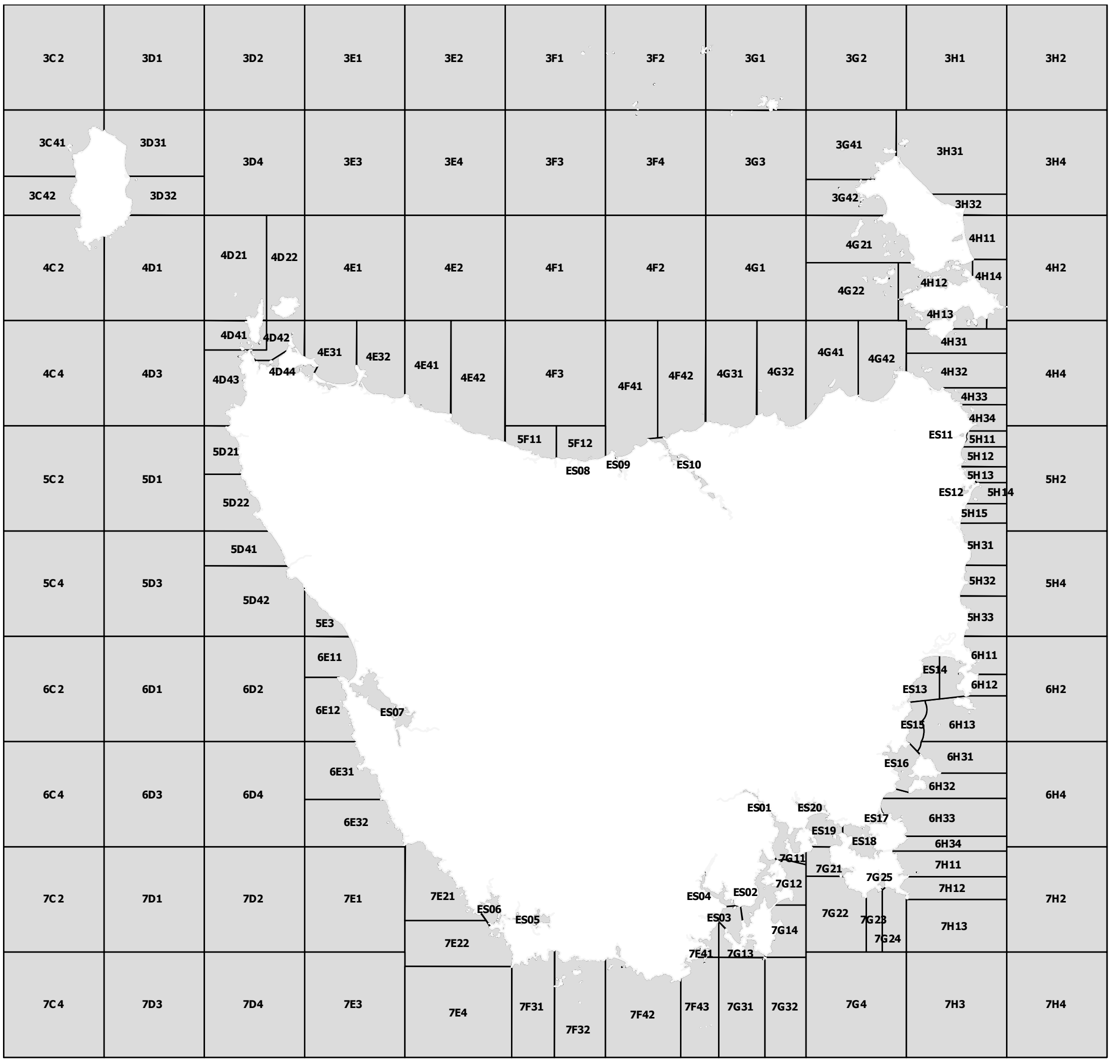


Fig. A1 Numbers for fishing blocks used in calculation of catch figures.

(ii) Duplicate records

A number of records in Commonwealth logbooks had matching records (fisher, date, gear type) in the Tasmanian database. Such records were examined individually and decisions made as to whether it was more appropriate to keep the Tasmanian record, the Commonwealth record or both. In most situations, the Tasmanian logbook entry was kept and the Commonwealth record excluded. The only exceptions were records with extra information in the Commonwealth record, e.g. catch of a Commonwealth species that was not recorded in the Tasmanian logbook.

Appendix 3: Annual Tasmanian Scalefish Fishery production

Table A.1. Catch (tonnes) of selected species and species groups classified as finfish, small pelagics, cephalopods and sharks.

Species	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
Selected finfish species (excl. small pelagics)																								
Australian Salmon	413.2	287.3	475.7	384.7	363.7	485.0	462.1	407.2	167.2	336.5	254.2	115.0	256.1	338.8	372.3	203.5	189.4	331.3	65.6	42.2	89.3	18.9	76.1	38.7
Barracouta	19.3	53.8	65.2	27.6	25.0	15.1	136.0	67.5	87.5	101.0	60.1	26.6	13.3	13.3	7.6	5.0	4.0	1.1	1.1	1.7	0.4	1.4	0.9	1.1
Boarfish	7.3	10.0	6.2	3.2	2.5	3.6	5.5	3.6	4.3	3.6	5.0	5.2	4.7	2.6	2.7	1.9	3.4	2.1	1.0	0.6	0.7	0.7	1.1	0.9
Cod	18.6	12.8	9.4	9.6	8.8	3.7	3.0	2.3	2.1	1.6	2.0	2.6	2.3	3.3	2.6	2.8	2.4	2.0	2.0	2.0	1.5	1.3	0.9	0.3
Flathead, sand	13.7	12.7	13.0	10.1	12.5	8.2	13.1	10.8	10.6	13.9	12.6	12.0	11.5	13.0	9.2	6.7	7.5	5.5	6.8	8.1	2.7	6.4	3.5	2.8
Flathead, tiger	34.1	31.3	44.5	37.1	44.4	53.0	35.9	27.2	17.9	58.8	75.7	44.8	62.0	37.8	66.3	47.6	52.7	31.2	20.2	23.5	64.4	74.0	39.4	16.8
Flounder	33.4	29.4	29.7	25.2	18.6	12.3	13.0	10.9	14.9	14.7	10.9	13.0	7.8	5.1	5.2	5.2	4.0	2.0	2.1	1.5	1.0	3.3	3.9	2.2
Garfish	56.2	91.6	83.0	101.7	91.7	81.4	87.8	92.5	66.2	85.5	89.3	50.0	31.0	63.0	49.3	43.2	53.0	51.5	37.9	33.8	21.9	16.4	8.9	7.4
Gurnard	13.5	10.4	9.1	7.0	9.6	7.4	5.3	9.7	6.8	6.1	5.1	5.7	4.7	2.6	1.5	2.1	1.2	1.1	0.6	1.9	2.1	2.7	1.8	1.0
Leatherjacket	14.5	12.6	13.3	12.9	16.6	16.7	16.6	13.7	14.8	10.4	8.5	8.8	5.3	5.5	3.0	2.9	2.2	2.4	2.9	2.1	1.3	2.6	2.6	4.3
Ling	15.0	13.3	8.3	4.3	1.8	1.2	0.9	0.4	0.8	0.7	0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.1	1.2	0.0	0.1	0.1	0.1	0.1
Marblefish	3.5	5.6	3.0	2.6	4.2	4.0	4.4	3.1	0.6	1.1	0.5	2.2	2.3	1.1	0.5	0.2	0.2	0.3	0.2	0.3	0.3	0.3	0.0	0.1
Morwong, banded	85.8	78.0	72.6	42.4	34.2	39.0	53.7	56.0	46.4	45.6	54.4	50.3	52.6	37.1	44.6	40.9	40.3	37.9	34.1	30.1	32.9	34.0	30.3	36.0
Morwong, jackass	27.1	18.7	33.2	17.5	15.9	13.1	14.8	14.7	16.6	17.5	13.1	11.7	4.6	5.3	5.9	3.2	3.1	1.5	1.0	0.8	3.2	1.6	3.3	2.6
Morwong, other	5.4	7.4	7.4	6.3	1.4	0.6	1.4	1.9	1.2	1.8	1.3	1.3	2.5	1.4	1.2	0.9	0.7	0.7	0.6	0.7	0.3	0.6	0.3	0.4
Mullet	1.0	1.7	1.7	2.2	4.9	4.8	2.5	4.0	4.3	2.4	3.2	2.0	0.1	1.4	1.8	2.1	0.5	4.4	0.5	0.8	2.4	0.4	0.3	0.2
Snook	13.7	15.2	17.7	3.2	4.1	5.9	6.6	6.6	3.7	2.2	2.9	6.7	7.0	8.7	7.9	7.5	6.7	6.3	9.1	9.0	2.6	9.4	5.9	2.7
Trevally	8.4	6.0	5.4	6.5	2.7	1.6	4.7	5.9	3.4	3.7	6.3	3.6	8.8	4.5	3.8	1.9	2.1	5.4	4.3	5.7	2.8	3.6	3.3	3.7
Trumpeter, bastard	60.1	51.8	40.7	47.7	36.4	26.1	23.9	21.0	23.2	18.5	23.4	21.3	19.1	16.7	10.5	9.8	9.6	9.5	8.3	6.5	8.4	6.4	4.2	2.7
Trumpeter, striped	58.3	79.4	78.1	99.0	95.0	45.5	39.9	36.6	36.9	23.9	19.0	18.7	12.2	10.7	10.8	19.7	20.9	17.3	10.5	13.0	7.1	12.1	14.1	7.1
Trumpeter, unspec.	0.0	0.1	0.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.3	0.2	0.0	0.0	0.0
Warehou, blue	82.3	128.4	187.6	272.2	187.1	34.2	66.4	49.3	27.6	19.1	20.0	29.3	25.3	26.8	37.5	10.7	3.8	8.5	5.8	2.8	7.4	7.6	12.6	1.8
Warehou, other	14.6	15.6	4.2	1.0	0.0	0.0	0.1	0.2	0.1	0.8	0.1	0.0	0.1	0.6	0.2	0.0	0.0	0.2	0.0	0.1	0.3	0.4	1.2	0.5
Whiting	1.4	0.1	0.0	23.3	9.6	36.5	39.6	35.9	50.9	31.6	2.3	38.1	31.4	32.5	26.7	34.2	15.5	13.8	36.6	1.9	20.7	26.0	16.1	41.5
Wrasse	83.4	110.1	100.0	90.7	85.5	88.4	92.3	72.0	75.1	100.1	92.9	112.9	87.6	68.1	72.0	72.7	68.0	64.2	65.1	81.8	72.7	79.1	83.8	82.1
Total	**1084**	**1083**	**1310**	**1241**	**1076**	**987**	**1130**	**953**	**683**	**901**	**763**	**582**	**653**	**700**	**743**	**525**	**491**	**600**	**318**	**271**	**347**	**309**	**315**	**257**

Table A.1 Continued. Whole weight in tonnes by financial year

Species	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
Small pelagics																								
Australian sardine	6.6	4.3	15.4	2.8	1.7	3.2	0.7	0.0	0.3	0.8	0.0	0.0	13.2	14.5	0.4	0.0	0.0	0.0	0.1	0.0	0.0	33.3	0.1	0.0
Mackerel, jack	26.2	19.3	19.7	59.8	14.7	9.1	19.4	19.4	41.1	12.8	6.8	2.6	202.8	919.7	910.2	35.7	56.4	0.2	0.4	5.5	1.0	0.1	2.0	0.2
Mackerel, other	2.0	1.3	1.0	0.5	2.1	0.1	0.0	0.1	0.0	0.5	0.5	0.2	10.3	0.2	0.3	0.8	0.1	1.9	4.2	1.1	0.2	2.8	0.5	0.2
Redbait	0.1	0.0	0.0	4.0	0.0	0.0	0.0	0.0	3.4	1.0	1.4	0.3	300.1	521.4	121.6	15.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Total	**34.9**	**24.9**	**36.1**	**67.1**	**18.5**	**12.4**	**20.1**	**19.5**	**44.8**	**15.1**	**8.7**	**3.1**	**526.4**	**1456**	**1033**	**51.5**	**56.6**	**2.2**	**4.7**	**6.6**	**1.2**	**36.2**	**2.6**	**0.4**
Cephalopods																								
Calamari, southern	33.0	19.0	26.6	94.4	87.4	78.0	105.2	108.8	86.8	114.2	44.6	85.4	89.0	78.6	51.1	54.9	50.8	63.9	67.8	75.9	106.2	122.6	60.6	107.4
Cuttlefish	0.2	0.3	0.2	0.0	0.0	0.0	0.7	2.4	1.0	0.2	0.4	0.1	0.3	0.3	0.1	0.1	0.1	0.2	0.1	0.1	0.5	0.3	0.2	0.1
Octopus													3.0	2.2	2.1	5.9	3.8	4.5	8.3	4.7	7.5	19.2	6.7	1.1
Squid, Gould’s	5.7	7.8	12.9	79.7	481.3	39.7	2.4	1.9	2.1	2.6	1.8	687.7	45.9	45.5	121.3	131.2	516.6	1071.8	0.0	31.4	416.8	175.6	528.0	23.9
Total	**38.9**	**27.1**	**39.7**	**174.1**	**568.7**	**117.7**	**108.3**	**113.1**	**89.9**	**117**	**46.8**	**773.2**	**138.2**	**126.6**	**174.6**	**192.1**	**571.3**	**1140.4**	**76.2**	**112.1**	**531**	**317.7**	**595.5**	**132.5**
Sharks[4]																								
Elephant shark	58.0	48.9	21.4	14.7	17.0	16.7	18.4	16.5	10.2	7.6	5.7	9.0	1.9	1.5	2.4	1.3	2.7	1.9	1.4	0.6	0.2	1.8	1.2	0.8
Gummy shark	750.5	543.8	348.6	113.4	109.7	53.9	23.5	14.2	24.7	41.6	12.4	13.6	13.8	9.8	9.8	9.3	7.5	7.9	6.0	7.6	8.2	11.1	9.1	7.7
Draughtboard shark	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.7	1.0	0.8	1.3	1.2	0.4	0.3	0.2	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Sawshark	127.4	74.4	29.2	6.8	3.4	12.3	21.4	20.4	20.6	23.5	5.9	3.4	0.3	0.1	0.1	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
School shark	252.1	171.5	71.7	31.5	11.3	1.7	2.2	1.4	7.0	2.6	0.6	1.8	1.0	0.7	1.8	1.4	1.9	2.1	1.1	1.4	1.1	1.7	2.0	1.4
Seven-gilled shark	6.1	4.9	6.1	1.9	10.3	16.3	18.8	7.4	11.5	8.4	3.8	3.9	0.5	2.3	1.1	1.4	1.1	0.8	0.7	1.0	1.1	0.4	0.2	0.3
Other shark	26.4	16.1	11.3	6.8	6.5	4.8	5.8	3.6	3.2	1.1	0.6	2.3	0.9	0.7	0.3	0.9	0.6	0.6	0.7	0.9	0.8	0.9	1.8	2.8
Total sharks	**1221**	**859.6**	**488.3**	**175.1**	**158.2**	**105.7**	**91.8**	**64.2**	**78.2**	**85.6**	**30.3**	**35.2**	**18.8**	**15.4**	**15.7**	**14.7**	**14.2**	**13.4**	**9.9**	**11.5**	**11.4**	**15.9**	**14.3**	**13.0**

---

[4] Since 2001/02, shark catches have been reported in Commonwealth logbooks. Tasmania has jurisdiction of all shark species inside 3 nm except gummy and school shark, and fishers are on bycatch possession limits for all species.