TASMANIAN SCALEFISH FISHERY ASSESSMENT 2010/12

Jessica André, Jeremy Lyle and Klaas Hartmann

March 2014

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This assessment of the Tasmanian Scalefish Fishery is produced by the Institute for Marine and Antarctic Studies (IMAS) and uses input from the Scalefish Fishery Assessment Working Group (SFAWG). SFAWG met on the 26 July 2013 to consider the draft assessment report and provide input into the assessments. The Working Group participants were:

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Executive Summary

The Tasmanian scalefish fishery is a multi-species fishery operating in State fishing waters and encompassing a wide variety of capture methods. The Scalefish Management Plan (renewed in 2004 and revised in 2009), provides the legislative rules and thus management framework for the fishery. Performance indicators and reference points set out in policy provide the framework to monitor the performance of the fishery in relation to catch and effort, and provide reference points against which the status of fish stocks can be assessed.

Fishery assessment

Since the early 1990's, annual commercial catches of the major species have generally been declining. Total scalefish production (excluding small pelagics) declined from over 2 000 tonnes in the early 1990's to around 500 tonnes in recent years. Only automated squid jig, drop line, small mesh nets and purse seine effort have risen in 2011/12 from the previous year. Effort levels for all other methods are either stable or declining.

There has been a continuous decline in the number of vessels participating in the scalefish fishery and in the number of scalefish fishing licences since 2000. Although effort performance indicators were not triggered for any fishing method, there are on-going concerns regarding the level of latent capacity within the fishery from licence holders who are currently either participating at low levels or not active (only 20-50% of licences are active depending on the type).

Catch and effort information are not routinely available for the recreational fishery but surveys have demonstrated that the recreational catch represents a significant component of the total Tasmanian harvest for many species such as Sand Flathead, Striped Trumpeter, Bastard Trumpeter, Blue Warehou, Flounder, Mullet, Barracouta, Jackass Morwong, Cod, Leatherjacket, and Silver Trevally.

Species assessment

The scalefish management plan and policy documents are currently undergoing a review, including a review of performance indicators and reference points. For this assessment, a hierarchical approach based on the available information for individual species is applied in determining proposed reference points. Both existing and proposed reference points are, however, presented for each species.

The current assessment report should be viewed as transitional, both in terms of the development and implementation of reference points and the adoption of stock status reporting based on a recently implemented national stock status reporting framework.

Species/Species group	Status	Comment	Page
Australian Salmon *Arripis trutta*	SUSTAINABLE	Species has a long history of exploitation. Commercial landings are driven by market demand not abundance.	42
Banded Morwong *Cheilodactylus spectabilis*	TRANSITIONAL DEPLETING	Unusual combination of high longevity, fast growth and early maturity. The commercial fishery has been managed using Total Allowable Commercial Catch since 2008 and is closely monitored.	48
Barracouta *Thyrsites atun*	**NOT ASSESSED**	Large fishery for Barracouta in the 1960's but little market for the species nowadays.	62

Bastard Trumpeter *Latridopsis forsteri*	**NOT ASSESSED**	This species is a by-product for the commercial fishery rather than target species, and the recreational catch substantially exceeds commercial landings.	67
Blue Warehou *Seriolella brama*	**OVERFISHED**	Commonwealth-managed species. Sporadically occurs in Tasmania. Despite a reduction in Total Allowable Catch (TAC) for the Commonwealth fishery, and not being actively targeted by the trawl industry, stocks have shown little signs of recovery.	73
Flathead *Platycephalus richardsoni* (Tiger Flathead) *Platycephalus bassensis* (Sand Flathead)	**SUSTAINABLE** **NOT ASSESSED**	Tiger Flathead is targeted commercially while Sand Flathead is predominantly a recreational species.	79
Flounder *Pleuronectidae* family	**NOT ASSESSED**	Greenback Flounder (*Rhombosolea tapirina*) constitute the majority of the commercial catches.	86
Gould's Squid *Nototodarus gouldi*	**SUSTAINABLE**	High inter-annual variability in abundance. Commonwealth fishery operating in Bass Strait. Dual endorsed vessels fish in Tasmanian waters especially in years of peak abundance.	91
Jack Mackerel *Trachurus declivis*	**SUSTAINABLE**	Shared stock with Commonwealth fishery.	95
Jackass Morwong *Nemadactylus macropterus*	**NOT ASSESSED**	Commonwealth managed fishery.	101
Leatherjacket *Monacanthidae* family	**UNDEFINED**	Leatherjackets are a by-product species and are not actively targeted. There is little biological information available for most species.	106
Longsnout Boarfish *Pentaceropsis recurvirostris*	**NOT ASSESSED**	Little information is available for this species. Very low levels of allowable catch.	111
Mullet *Aldrichetta forsteri*	**NOT ASSESSED**	Recreational and commercial catches are similar and both minor.	116
Pike *Dinolestes lewini* (Longfin Pike) *Sphyraena novaehollandiae* (Shortfin Pike)	**NOT ASSESSED**	The main species targeted is the shortfin Pike. Little information is available on either of the species.	121
School Whiting *Sillago flindersi*	**NOT ASSESSED**	Fishery currently based on one part time operator.	126
Southern Calamari *Sepioteuthis australis*	**UNDEFINED**	Vulnerability of calamari to fishing pressure is unclear but probably high. High recreational interest in the species.	131
Southern Garfish *Hyporhamphus melanochir*	**NOT ASSESSED**	After a strong decline in catches from 2006/07 coupled with changes in population structure, which prompted management actions, the species is showing early signs of recovery.	138
Striped Trumpeter *Latris lineata*	**TRANSITIONAL RECOVERING**	After a lack of recruitment for over a decade, Striped Trumpeter is showing signs of recovery in the last 3 years. However, the stock currently relies exclusively on recent recruits.	147

Wrasse *Notolabrus tetricus* (Blue-throated Wrasse) *Notolabrus fuciola* (Purple Wrasse)	**NOT ASSESSED**	Both species are targeted as part as a live fishery. Recent ban on the preferred bait type in fish traps has led to a decline in the participation in this fishery.	158

1. Fisheries Assessment

Management objectives and strategies

The Scalefish Management Plan was first introduced in 1998 (DPIF 1998) and was renewed in 2004 with reviews in 2001and 2009. The management plan provides the regulatory framework for the fishery, which covers commercial and recreational components. The policy documents contain the following objectives, strategies and performance indicators.

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 recreational 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 fishing capacity by restricting the number of commercial fishing licences available to operate in the fishery;
- Define allowable fishing methods and amounts of gear that can be used in the scalefish fishery;
- 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.

The fishery

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

In many respects the scalefish fishery is dynamic, with fishers readily adapting and changing their operations in response to changes in fish availability and in response to market requirements and opportunities. As a consequence, only a small proportion of the fleet has specialised in a single activity or targeting a primary species (Ziegler 2012). For many operators, scalefish represent an adjunct to other activities—for instance rock lobster fishing.

This report covers the assessment of selected scalefish and cephalopod fisheries under Tasmanian jurisdiction, as well as selected species under Commonwealth jurisdiction. These were included due to the importance of catch levels in Tasmanian logbooks. Formal assessments of species under Commonwealth jurisdiction (e.g. Tiger Flathead, Blue Warehou, Jackass Morwong, Ocean Perch, Blue-eye Trevalla, Blue Grenadier, School and Gummy Shark) are undertaken by the Southern and Eastern Scalefish and Shark Fishery Resource Assessment Group (SESSFRAG, e.g. Morison et al. 2012) and are summarised in fishery status reports produced by the Bureau of Rural Sciences (e.g. Woodhams et al. 2012).

Data sources

Commercial catch and effort data are collected through compulsory Tasmanian General Fishing Returns, now known as Commercial Catch, Effort and Disposal Records, 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 are not routinely collected for the recreational sector.

Tasmanian Commercial Catch, Effort and Disposal Records

The Commercial Catch, Effort and Disposal Records have been amended several times (1995, 1999, 2007,2010 and 2013) in an effort to provide finer spatial scales and greater operational details. While the outer 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). In analysing Catch, Effort and Disposal Records some data manipulation has been undertaken, details of which are provided in Appendix 2.

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 of 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 manipulations 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 logbook. This should have removed the necessity to include subsequent Commonwealth catch and effort data into analyses but it has become apparent that there was 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 Tasmania 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 July 1995 to June 2012.

A fishing year from 1st July to 30th June in the following year has been adopted for annual reporting. This better reflects the seasonality of the fisheries for most species than reporting based on calendar year, with catch (and effort) generally concentrated between late spring and early autumn. In addition, it better encompasses the biological processes of recruitment and growth for most species.

Unless stated otherwise, catches have been analysed State-wide and by region. Five broad assessment regions are used: south-east coast (SEC), east coast (EC), north-east coast including Flinders Island (NEC), north-west coast including King Island (NWC), and west coast (WC) (Fig. 1.1).

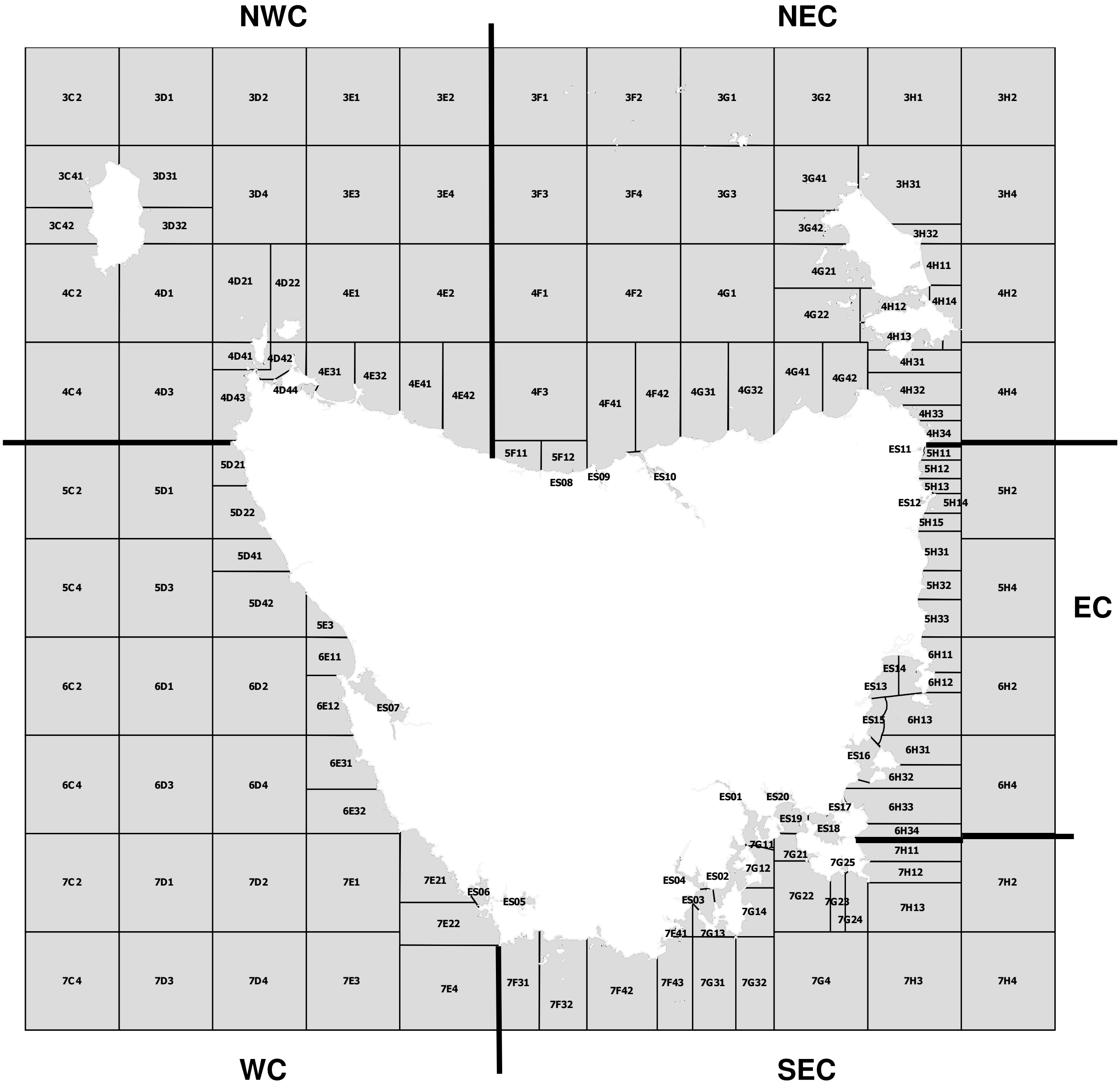

Figure 1.1 Map of Tasmania with the fishing blocks and the assessment regions. SEC is south-east coast, EC is east coast, NEC is north-east coast, NWC is north-west coast, and WC is west coast.

Table 1.1 Table of effort gear units by fishing method

Method	Effort gear units
Beach seine/purse seine	No. of shots
Graball/small mesh net	100 m net hours
Dropline	100 hook lifts
Handline	Line hours
Fish trap	No. trap or pot lifts
Squid jig	Jig hours
Automatic squid jig	Jig-machine hours
Spear	Fisher hours
Dip net	Dip net hours

Catch returns for which *effort* information was incomplete or unrealistically high or low (either due to data entry error or misinterpretation of information requirements by fishers) were flagged and excluded when calculating effort levels based on gear units or catch rates based on catch per unit of gear. Only a small number of fishing records for 2011/12 needed to be excluded in this manner. All records were, however, included for reporting catch, days fished and catch per day.

In generating catch rate statistics, the geometric mean rather than the arithmetic mean of all valid individual daily catch records has been calculated, since catch rate data are typically log-normally distributed. The geometric mean is calculated as the nth root of the product of the individual 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:

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

It should be noted that catch rates calculated in this manner may differ slightly from the more simplistic approach of dividing total catch by total effort or using the arithmetic mean. The geometric mean has the advantage of being less affected by the few observations that are skewed very high, as often happens with log-normally distributed data.

Recreational fishery

Information on recreational fisheries in Tasmania is relatively sparse. Detailed analyses of the Tasmanian recreational fishery available are based on the 2000/01 National Survey (Lyle 2005) and the 2007/08 state-wide fishing survey (Lyle et al. 2009). Additional data are provided by recreational net licence numbers.

Current assessment categories

In the absence of more quantitatively rigorous stock assessments, Scalefish Fishery Policy identifies a number of performance indicators that are used to define ranges between which the fishery, both in general and for particular species, is deemed to be performing acceptably (DPIF 1998). If the observed value of a performance indicator falls outside the acceptable range the reference point is said to have been exceeded and this is taken to imply that some management action may be required. Analysis of fishery performance under this (initial) strategy is measured by reference to:

- variations in the total catch from year to year, or between seasons, regions and sectors;
- trends in effort;
- trends in catch rates;
- changes in biological characteristics, such as a changes in size or age structure; and
- other indicators of fish stock stress, for example disease outbreaks.

As part of this strategy, reference or trigger points, or acceptable ranges, have been defined as levels of, or rates of change, that are considered to be outside the normal variation of the stock(s) and the fishery. The trigger points provide a framework against which the performance of the fishery can be assessed and (if necessary) flag the need for management action. Currently, reference points for a species are exceeded when one or more of the following criteria are met:

Performance indicators	Reference points
Catch	• Total catch outside the 1990/91 to 1997/98 range • Total catch declines or increases by > 30% from previous year
Effort trend	• Effort (related to species) >10% of highest level from 1995/96 to 1997/98 • Effort (related to gear) >10% of highest level from 1995/96 to 1997/98
Catch rates trends	• Catch rate < 80% of lowest levels from 1995/96 to 1997/98
Change in biological characteristics	• Significant change in the size composition of commercial catches • Significant change in the abundance of a year class (or year classes) from size/age structure monitoring, with particular importance on pre-recruit year classes from
Change in catch composition	• Change in the catch of non-commercial fish relative to 1995/96 to 1997/98 • Unacceptably high incidental mortality of non-commercial species or undersized commercial species
Stress	• Significant numbers of fish landed in a diseased or clearly unhealthy condition • Occurrence of a pollution event that may produce risks to fish stocks, the health of fish habitats or to human health • Any other indication of fish stock stress

Banded Morwong is the only scalefish species where management includes the use of a Total Allowable Catch (TAC), and has therefore its own set of performance indicators and reference points (see Banded Morwong section).

The fishery has also been assessed against an alternative set of performance indicators and reference points which account for recent developments in the fishery. These alternative assessment categories (presented below) are expected to be further refined and are expected to replace the existing indicators over the next few years as the performance indicators and reference points are determined and agreed upon across each species.

Proposed assessment categories

The proposed assessment categories take in account the species' importance and the amount of data available to inform the appropriate reference points for each species, with the intention to assign a stock status to each species based on the presented criteria.

Species' importance

There are over 90 species reported in commercial catches. Harvested species in Tasmania are associated to a range of social and economic values, meaning that all species cannot be given the same priority for assessment. In assessing the importance of a species, a combination of factors was taken into account, which includes:

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

Species are consequently classified as "Key species" or "Minor species". The remaining species reported in commercial catches are considered of minor significance and are not included in the assessment.

Reporting levels definitions

Each species in the assessment is associated with a level of reporting (Full, Medium or Minor), which stems from the available data for the species/species group. The long term aim is, in time, to have full reporting for all key species and medium reporting for all minor species. The attributes of the reporting categories are defined in Table 1.2. Table 1.3 summarises the species selected for the assessment, their importance and level of reporting.

Table 1.2. 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 (Tasmanian) 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-Tasmanian) information for growth, mortality, selectivity and maturity		●	●
Complex of related species		●	●

Table 1.3. Summary of Importance and Reporting level for all retained species.

Species/Species group	Importance	Reporting level
Banded Morwong	Key	Full
Australian Salmon	Key	Medium
Bastard Trumpeter	Key	Medium
Blue Warehou	Key	Medium
Flathead	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

Stock status definitions

In order to assess the fisheries in a manner consistent with the national approach (and other jurisdictions) we have adopted the national stock status categories (Flood et al. 2012). These categories define the assessed state of the stock in terms of recruitment overfishing, which is often treated as a limit reference point. Recruitment overfishing occurs when the mature adult (spawning biomass) population is depleted to a level where it no longer has the reproductive capacity to replenish itself. Hence, recruitment overfished stocks are not collapsed but they do have reduced productivity. This is different to growth overfishing where fish are harvested at an average size that is smaller than the size that would produce the maximum yield per recruit. Fisheries are ideally also managed towards targets that maximise benefits from the harvesting, such as economic yield or provision of food. The scheme used here does not attempt to assess the fishery against any target outcomes.

Stock status	Description	Potential implications for management of the stock
SUSTAINABLE	Stock for which biomass (or biomass proxy) is at a level sufficient to ensure that, on average, future levels of recruitment are adequate (i.e. not recruitment overfished) and for which fishing pressure is adequately controlled to avoid the stock becoming recruitment overfished	Appropriate management is in place
TRANSITIONAL-RECOVERING ↑	Recovering stock—biomass is recruitment overfished, but management measures are in place to promote stock recovery, and recovery is occurring	Appropriate management is in place, and the stock biomass is recovering
TRANSITIONAL-DEPLETING ↓	Deteriorating stock—biomass is not yet recruitment overfished, but fishing pressure is too high and moving the stock in the direction of becoming recruitment overfished	Management is needed to reduce fishing pressure and ensure that the biomass does not deplete to an overfished state
OVERFISHED	Stock is recruitment overfished, and 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

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 the commercial catch and effort data, which are assessed by calculating fishery performance indicators and comparing them with reference points.

The proposed performance indicators are 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. These are compared to a reference period (1995/96[1] 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. Reference points are illustrated in Fig. 1.2.

Reporting	Performance indicators	Reference points
Full	Fishing mortality	• Maintain an appropriate spatial distribution of catch
	Biomass	• High probability of staying above a certain level of mature 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

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[1] 1995/96 was selected as the reference period as it corresponds to the introduction of daily catch and effort reporting in the Tasmanian General Fishing Returns.

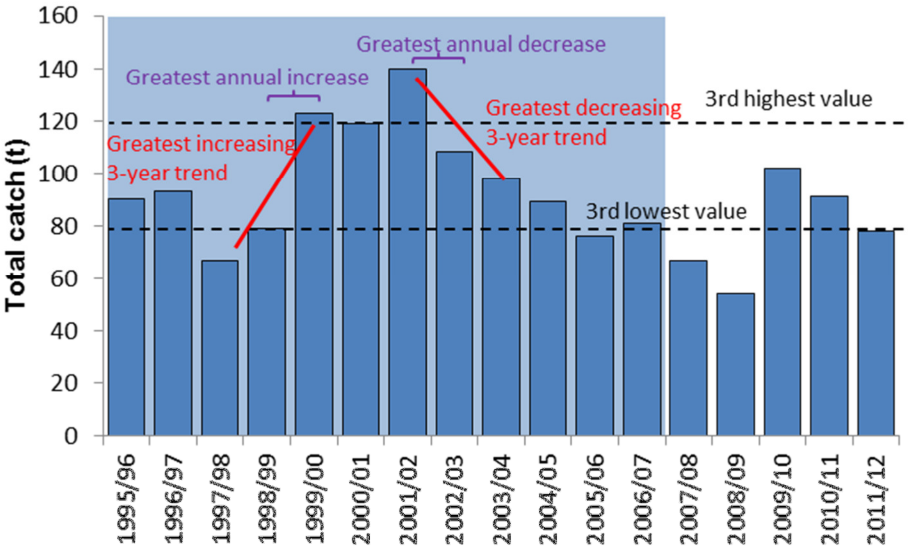

Figure 1.2 Schematic illustration of the application of fishing mortality reference points for medium and minor reporting based on trends in catch. The shaded blue area represents the reference period.

As per the current assessment categories, other measures are also taken into consideration in the determination of stock status, such as changes in biological characteristics of the stock, indicators of stock stress, significant changes in the catch of non-commercial species or undersize commercial species, and significant external factors related to fishing activity.

Reporting	Performance indicators	Reference points
All	Stock stress	• Significant change in the size/age composition of commercial catches • Significant numbers of unhealthy fish landed

This report being a transitional report, stock status was only assessed for a few species (Australian Salmon, Banded Morwong, Southern Calamari and Blue Warehou) based on the current reference points. The proposed reference points are also presented for each species for comparison.

2. General fishing trends

Commercial fishing licences

The number of scalefish licences A, B and C has slowly declined since 2000 to 309 total licences in 2011, of which 139 were active (Table 2.1). The decline was mainly due to a reduction in scalefish C fishing licences (which are non-transferable), while the numbers of scalefish A and B licences have remained reasonably stable. Scalefish C licences were also the licence type that was least often fished, with just 20% of all C licences active in 2011 (down from 35% in 2000). The proportion of actively fished scalefish A and B licences has also dropped in the last four years, from around 70% up to 2007 to only around 55% in 2011.

In addition to the general scalefish licences, separate fishing licences allow the use of beach seine (a total of 50 licences in two categories A and B) and small mesh gillnet (10 licences). Fishers with a rock lobster licence (but without scalefish A or B licence) are also allowed to take scalefish with a limited amount of fishing gear.

Table 2.1 Number of active and total fishing licences (FL) by licence type (A, B or C) since 2000 (licence years from March to February of the following year)

No of active licences	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
FLA	50	44	51	48	46	38	43	47	37	33	33	38
FLB	109	104	111	110	109	101	105	105	93	88	91	84
FLC	79	62	63	52	47	34	36	33	23	16	18	17
Total	238	210	225	210	202	173	184	185	153	137	142	139

No of total licences	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
FLA	69	67	70	70	70	66	66	66	66	65	65	65
FLB	166	165	164	165	165	162	162	160	159	159	158	158
FLC	226	214	205	185	173	152	137	129	120	112	92	86
Total	461	446	439	420	408	380	365	355	345	336	315	309

Commercial catch trends

General production

Since the early 1990's, annual commercial catch of the major species has generally been declining (Fig. 2.1). Overall, total scalefish production (excluding small pelagics) declined from over 2000 tonnes in the early 1990's to around 500 tonnes in recent years (Appendix 3, Table A1). Recent fluctuations in total catches have been mainly driven by variability in landings of Australian Salmon.

The scalefish catch decreased slightly from 530 t in 2010/11 to 515 t in 2011/12 (-15 t). Increases in catches of Flathead (+6 t), garfish (+12 t), Striped Trumpeter (+1.5 t) did not offset decreases across most other species.

When assessing trends within the scalefish fishery it is important to recognise that some species occur seasonally in Tasmanian waters and that availability can differ markedly between years. Such variability does not, therefore, necessarily reflect changes in stock status. Species in this category include Blue Warehou, Barracouta and Gould's Squid. By contrast, species such as Banded Morwong, Garfish, Wrasse, Striped Trumpeter, Bastard Trumpeter, Southern Calamari and octopus are resident species, and variability in catches can reflect a combination of factors, including market forces, management intervention, stock status and intrinsic variability in life history.

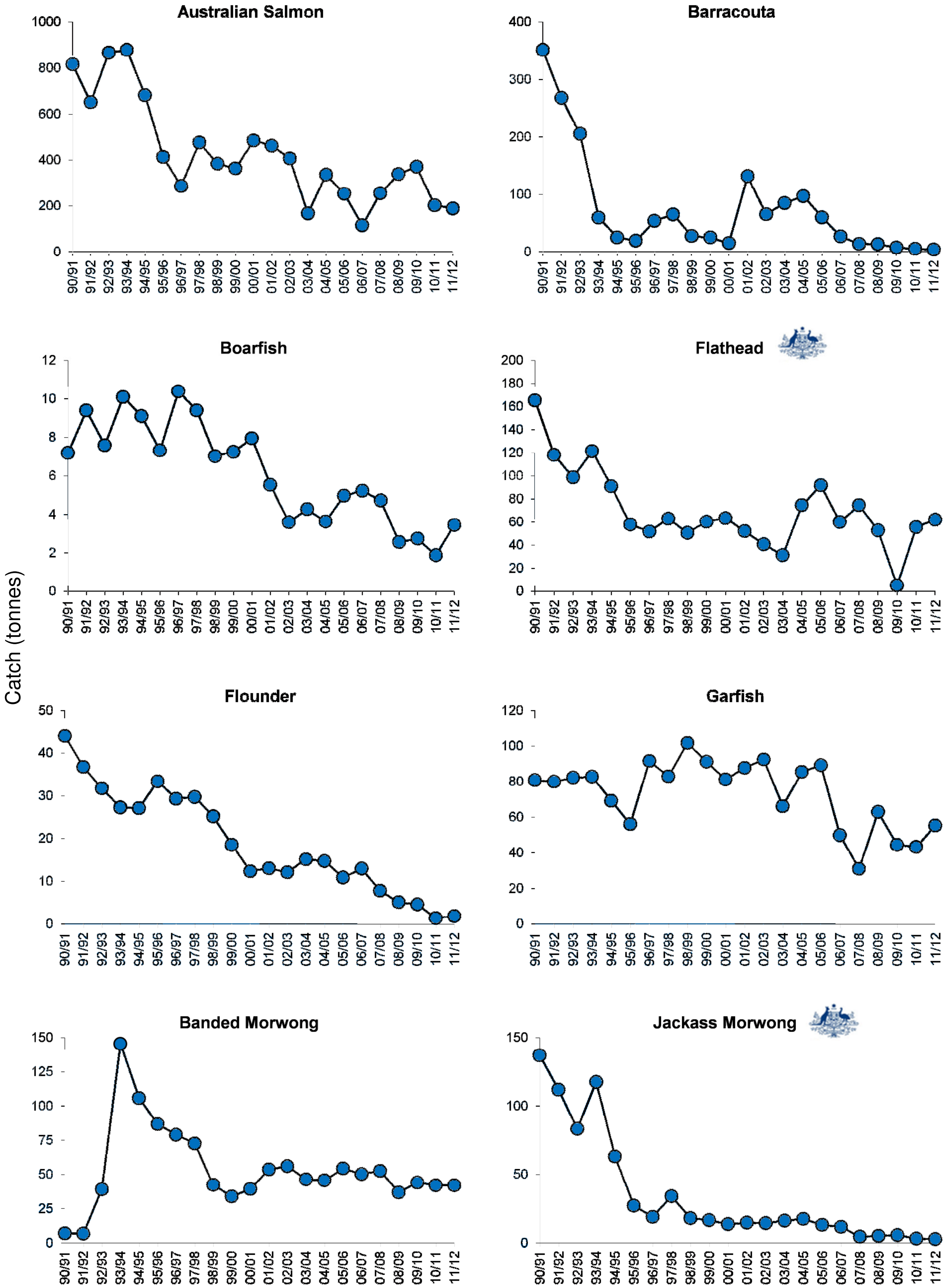

Figure 2.1 Annual catches (tonnes) for selected scalefish species since 1990/91.
= Commonwealth-managed fisheries

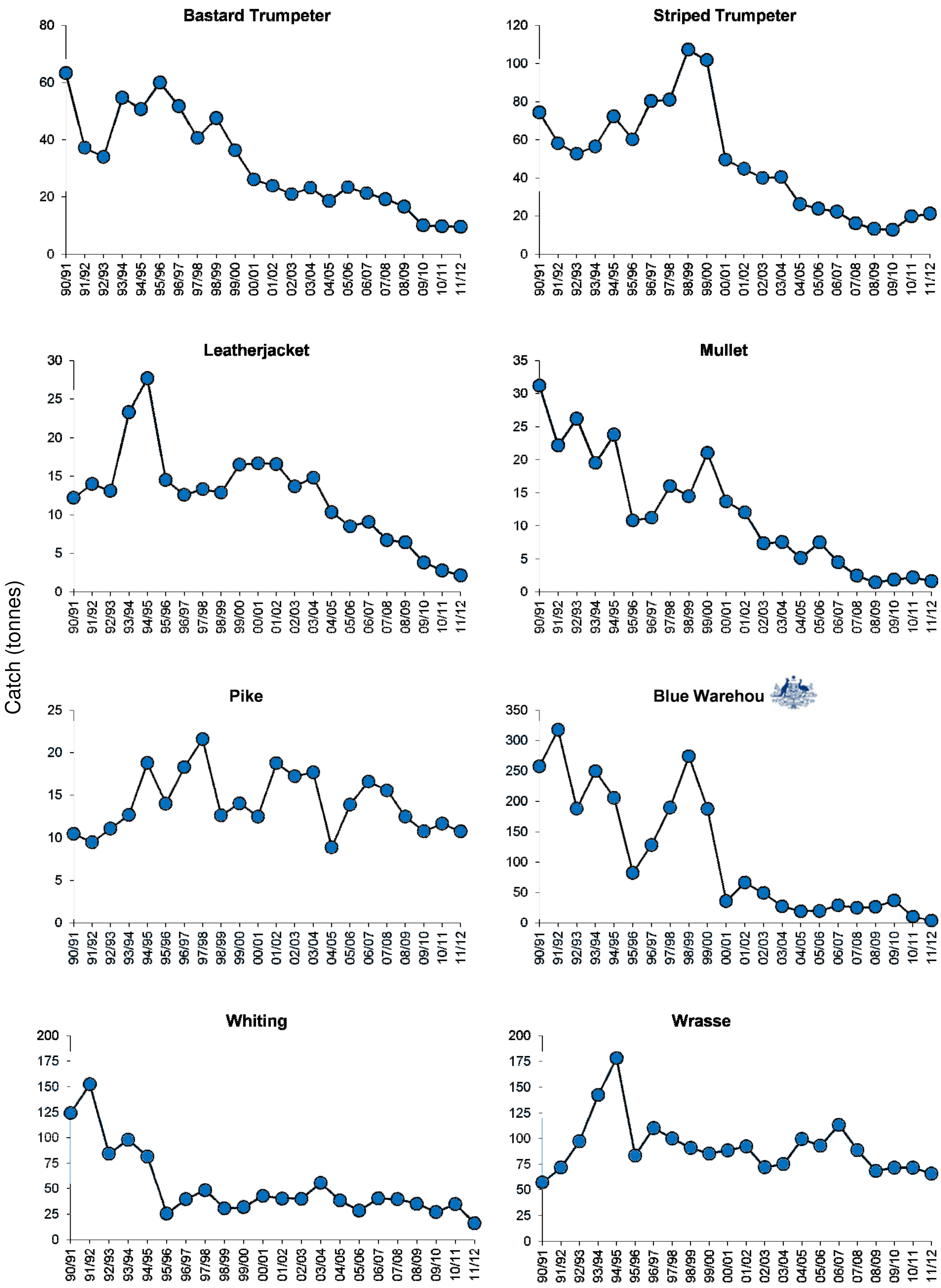

Figure 2.1 Continued.

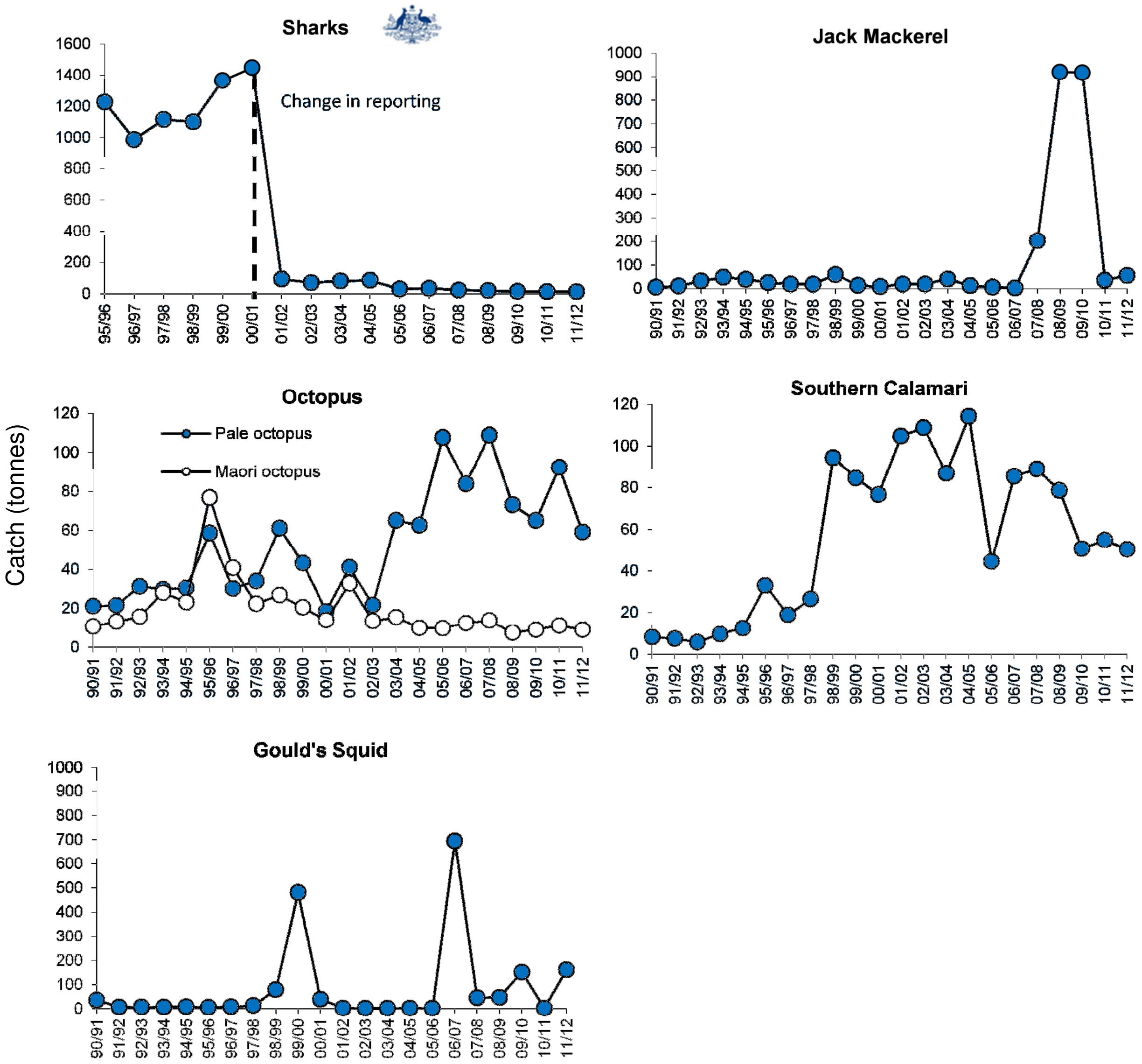

Figure 2.1 Continued.

Estuarine production

Estuarine production (a subset of the whole general fishery) totalled 44.2 tonnes in 2011/12, which is down from the previous years (Table 2.2). Catches came mainly from the southern estuaries of the Derwent River (ES1), Blackman Bay (ES17), Norfolk Bay (ES18), Frederick Henry Bay (ES19), and from the Tamar River (ES10). Whiting, Southern Calamari, Garfish, Flathead and Flounder were the main species. Port Davey (ES06), and Mersey River (ES08) are restricted to hand line fishing, which accounts for the very low production. Taking of scalefish for commercial purposes is not permitted in the D'Entrecasteaux Channel (ES02 and ES03) since 1998, Georges Bay (ES12) since 2003 and Ansons Bay (ES11) since 2009. Commercial scalefish fishing in the Derwent (ES01) is restricted by endorsement to a single Danish Seine operator who primarily targets whiting.

Table 2.2 Total commercial catches (in tonnes) in estuaries around Tasmania (a) by fishing year and (b) by species in 2011/12

a) By fishing year	**ES01**	**ES06**	**ES07**	**ES08**	**ES09**	**ES10**	**ES11**	**ES12**	**ES17**	**ES18**	**ES19**	**ES20**	**Total**
95/96	30.8	0.8	4.4	0.2	0.7	11.4		0.4	2.9	26.4	16.1	3.2	97.3
96/97	37.7	0.3	2.6		0.6	16.6		0.9	6.4	12.3	7.0	1.8	86.2
97/98	59.5	0.2	1.4	<0.05	1.0	18.9		2.5	13.4	20.9	15.2	1.4	134.4
98/99	20.4		1.4		1.2	22.3		1.6	11.0	36.5	23.5	4.9	122.8
99/00	11.4		1.0		0.5	16.6	0.1	1.9	21.5	28.5	16.8	2.8	101.1
00/01	20.4		0.2		0.1	18.0	<0.05	1.2	16.0	28.0	28.4	1.9	114.2
01/02	14.0		2.2		0.2	81.9		1.2	9.2	64.6	32.6	2.0	207.9
02/03	30.4		8.1		0.2	29.8	0.5	0.8	14.6	35.4	23.4	1.6	144.8
03/04	44.0		6.2		1.0	26.3			5.6	59.5	21.8	0.8	165.2
04/05	29.9		4.9		1.8	35.9		<0.05	9.6	25.9	23.1	0.7	131.8
05/06	4.1	0.1	23.2		0.9	34.2	1.3		8.4	14.4	19.6	0.8	107
06/07	31.0	0.3	9.9		2.0	26.3	0.2		8.7	20.3	19.7	1.4	119.8
07/08	38.8		3.2			17.9		<0.05	13.0	26.9	12.3	0.9	113
08/09	33.7		1.1		0.2	22.2		<0.05	8.4	15.7	10.5	2.1	93.9
09/10	26.9		0.7		0.5	17.5	<0.05	<0.05	3.9	15.6	4.4	2.1	71.6
10/11	27.8	0.1	0.4		0.6	11.1			6.3	5.4	13.7	1.7	67.2
11/12	13.9		0.3			8.1			6.1	7.2	6.7	1.9	44.2

b) By species	**ES01**	**ES06**	**ES07**	**ES08**	**ES09**	**ES10**	**ES11**	**ES12**	**ES17**	**ES18**	**ES19**	**ES20**	**Total**
Australian Salmon						1.4			0.3				1.7
Blue Warehou													
Calamari						1.8			1.3	0.8	5.5		9.4
Flathead						0.1			<0.05	3.4	0.1	0.05	3.7
Flounder			0.1			0.4			0.5	0.8	0.1	1.6	3.5
Garfish						2.3			2.5	0.1	0.5		5.4
Jack Mackerel						<0.05							<0.05
Mullet						0.4			1.2	0.3	<0.05		1.9
Octopus									<0.05	1.6	<0.05		1.6
Other			0.2			1.4			0.1	0.2	0.1	<0.05	2
Pilchard/Anchovy									0.1				0.1
Redbait													
Trevally						0.1			0.1	<0.05			0.2
Whiting	13.9												13.9
Wrasse						0.8			<0.05	0.1	0.4	0.2	1.5
Total	13.9		0.3			8.1			6.1	7.2	6.7	1.9	44.2

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

Recreational fishery

Catch and effort

Catch and effort information are not routinely available for the recreational fishery. Surveys of the recreational fishery conducted in 2000/01 and 2007/08 provide the only comprehensive snapshots of the Tasmanian recreational fishery (Henry and Lyle 2003, Lyle 2005, Lyle et al. 2009, Lyle and Tracey 2012). A statewide survey of recreational fishing conducted in 2012/13 will be incorporated in subsequent fishery assessments. In addition there have been surveys of recreational gillnetting (Lyle 1999, Lyle and Tracey 2012) and offshore boat fishing (Tracey et al. 2013).

Recreational fishing surveys have demonstrated that the recreational catch represents a significant component of the total harvest for many species, either as a proportion of the total harvest or in absolute quantities taken (Table 2.3). For instance, recreational catches exceeded commercial catches for Flathead, black bream[2], Mullet, Bastard Trumpeter (in 2000/01), Barracouta (in 2000/01), Jackass Morwong, cod, Flounder and Silver Trevally. By contrast, the commercial sector dominated the catches of Australian Salmon, Wrasse, Garfish, Whiting, Southern Calamari, and Gould's Squid. In 2007/08, the relatively high level of statistical uncertainty associated with Bastard Trumpeter and Striped Trumpeter catch estimates meant that the species were grouped for reporting purposes.

The most conspicuous differences between years were the decline in the recreational catch of Australian Salmon (possibly linked with a decline in overall shore-based fishing effort, refer Lyle et al. 2009), and increases in the recreational catch of Southern Calamari and Gould's Squid. Increased popularity of Southern Calamari has contributed to this increase, while increased availability of Gould's Squid was a factor in the catch of that species.

Table 2.3 Estimated recreational harvest (numbers and weight) for key scalefish species taken by Tasmanian residents, commercial landings (weight) and proportion of the total (recreational plus commercial) catch represented by the recreational harvest (refer to Lyle et al. 2009). Note: the survey periods do not correspond with fishing years; 2000/01 represented the period May 2000 to Apr 2001, and 2007/08 represented the period Dec 2007 to Nov 2008.* estimated from the 2011/12 offshore recreational fishing (Tracey et al. 2013) ** estimated from the 2010 recreational gillnetting survey (Lyle and Tracey 2012).

	2000/01				**2007/08**			
	Rec harvest		**Com.**	**Rec.**	**Rec harvest**		**Com.**	**Rec.**
Species	**No.**	**(t)**	**(t)**	**%**	**No.**	**(t)**	**(t)**	**%**
Flathead	1,236,675	321.5	63.4	*83.5*	1,066,293	292.6	73.2	*80.0*
Australian Salmon	300,456	105.2	485.0	*17.8*	110,312	48.1	299.8	*13.8*
Mullet	111,025	30.0	13.7	*68.6*	24,152	6.6	2.4	*73.3*
Flounder	50,582	15.2	10.5	*59.1*	32,436	10.1	7.8	*56.3*
Cod	65,115	30.6	4.0	*88.4*	14,263	8.2	2.5	*76.7*
Jackass Morwong	27,041	31.9	13.7	*70.0*	9,979	6.8	3.8	*64.2*
Garfish	15,669	1.9	81.4	*2.3*	14,568	2.0	51.0	*3.7*
Whiting	7,480	0.8	42.5	*1.9*	14,992	3.4	35.4	*8.7*
Black bream	34,336	22.0	0	*100*	13,134	11.4	-	*100*
Barracouta	24,320	46.9	15.1	*75.7*	11,577	10.8	13.9	*43.8*
Wrasse	23,083	13.6	88.4	*13.3*	11,640	10.3	68.5	*13.1*
Blue Warehou	16,359	14.6	36.3	*28.6*	8,723	7.0	26.6	*20.8*
Jack Mackerel	15,770	3.2	8.6	*26.8*	5,216	1.0	225.7	*0.4*
Striped Trumpeter	13,450	29.6	49.6	*37.4*	***7,274****	***31.9****	19.8	*61.7*
Bastard Trumpeter	29,130	37.0	26.2	*58.5*	***27,527*****	***27.3*****	10.5	*72.2*
Leatherjackets	18,706	8.2	16.7	*33.0*	7,619	2.6	4.2	*38.0*
Silver trevally	16,812	4.7	1.6	*74.6*	10,636	4.2	2.0	*67.9*
Southern Calamari	29,473	17.7	76.6	*18.8*	40,525	44.6	102.6	*30.3*
Gould's Squid	9,903	5.0	39.7	*11.1*	73,236	36.6	45.8	*44.4*

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[2] It is illegal to retain black bream for commercial sale.

The 2010 recreational gillnet survey revealed that almost 65% of the catch (all species by number) was kept (Lyle and Tracey 2012). Bastard Trumpeter and Blue Warehou together represented 45% of the total retained catch, Atlantic salmon contributed a further 10%, with Australian Salmon, Jackass Morwong, Mullet and Wrasse of secondary importance. Wrasse was the most significant by-catch. Recreational gillnet catches of Bastard Trumpeter, Mullet, Jackass Morwong, Leatherjacket and cod were higher when compared to the commercial catches, while Blue Warehou catches were similar between the two sectors. There has been a reduction in overall gillnet effort over time. This decline is accentuated by a fall in catch rates, from an average over 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 Blue Warehou), changes in fishing practices (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.), including a general reduction in the number and frequency of Atlantic salmon escapes due to improved fish farming techniques have also been contributing factors.

Recreational net licences

The use of recreational nets in Tasmania has been subject to licensing since 1995, with fishers able to licence up to two graball nets 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. From a recent survey, only 73% of recreational licences were used during 2010 (Lyle and Tracey 2012).

The number of recreational net licences issued rose rapidly from around 8 900 in 1995 to over 11 000 in 1999/00, licence numbers then stabilised at between 8 000-9 000 for several years. Licence numbers climbed again to around 10 000 in 2007/08 before scaling back to around 9000 by 2011/12 (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 gillnet 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 discernable 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).

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**	**06/07**	**07/08**	**08/09**	**09/10**	**10/11**	**11/12**
Graball 1	5615	6290	6685	6709	7477	7401	6960	7695	7313	7408	8054	8677	9185	9172	8960	8162	8248
Graball 2	2612	2678	2683	2426	2652	2515	1841	na	na	na	na	na	na	na	na	na	na
Mullet Net	656	684	738	739	879	845	608	754	753	754	816	877	995	1080	922	886	888
Total	**8883**	**9652**	**10106**	**9874**	**11008**	**10761**	**9409**	**8449**	**8066**	**8162**	**8870**	**9554**	**10180**	**10252**	**9882**	**9048**	**9136**

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 of the 2007 administrative changes relating to the reporting of catches may have, nonetheless, exerted some influence on observed catch and effort trends.

Other uncertainties 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. Since the General Fishing Return was designed to accommodate a diverse range of fishing activities, compromises have been necessary, with data collection on a daily rather than operational (set or shot) basis.

It has also become apparent that some fishers have experienced problems in correctly interpreting or complying with reporting requirements, especially in terms of how effort information is reported. The introduction of new logbooks in 2007 and 2010 has helped to clarify reporting, but there continues to be an on-going need to educate fishers in this regard. Further, the lack of catch verification remains a major issue in relation to data quality. Anecdotal reports suggest that some catch and effort data may be unreliable, particularly prior to the implementation of the management plan in 1998. Recent industry workshops have identified the need to improve the quality of catch reporting, including provision for catch verification. A restructuration of the logbook in August 2013, which now includes a record of catch disposal, should further improve the accuracy of catch reporting and data collection.

Catch and effort are influenced by a combination of factors which include fishers matching their fishing operations to changing market requirements and/or 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 uncertainty and is especially significant in the scalefish assessment given the scale of recreational catches relative to commercial catches for some species. While the 2000/01 and 2007/08 surveys represent important baseline information about this sector, there is a need for an on-going monitoring program for the recreational fishery. Without such information attempts to assess the status of those species with significant recreational catches may be compromised.

Fish mortality due to predation and fishery interactions with Australian and New Zealand fur seals is largely unknown but represents another source of uncertainty. Seals can cause substantial mortality to some of the fish species assessed in this report as well as causing gear damage and influencing the fisher behaviour, factors that impact on catches and catch rates. This tends to be caused predominantly by individual ‘rogue’ seals which learn to target particular fisheries or fishing methods (e.g. the Banded Morwong gillnet fishery), while the typical diet of seals includes mainly pelagic fish species (Goldworthy et al. 2003).

3. Gear Types in the commercial fishery

There are 14 main gear types used in the commercial Tasmanian Scalefish Fishery. Catch and effort by gear types are presented in Table A2 in Appendix 4. Since a variety of gear types are represented, it has been necessary to express effort in units appropriate to each specific fishing method (Table 1.1). Effort has also been 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. This problem has been further exacerbated with the introduction of the new logbook in 2007. Days fished overcomes any uncertainty about the reporting of effort units.

For the purpose of analysis, shark net and bottom longline catch and effort have been excluded since these methods relate specifically to the shark fishery, now managed by the Commonwealth.

General effort trends

Following the introduction of the new management arrangements in November 1998, effort based on beach seine, purse seine, graball and hand line all fell whereas effort based on dropline, squid jig and dipnet all increased sharply. While a range of factors, including availability of target species and market developments, have had an influence, there is little doubt that management changes have had a direct impact on effort levels. Specifically, methods for which gear allocations or access became more regulated (beach seine, purse seine and gillnets) demonstrated declines in effort whereas there was an initial shift to or increase in effort for less regulated methods (hooks, jigs and dipnets; i.e. gear that is equally available to all licence-holders).

Since the early 2000's effort levels for most gear types have declined through time, except for handline which has remained relatively stable and automatic squid-jig which has peaked sporadically with the periodic occurrence of Gould's Squid in Tasmanian waters. Effort levels during 2011/12 were generally similar to or lower than in 2010/11 for most gear types, except for dip net, squid jig and Danish seine (Table A2, Appendix 4). The effort performance indicator of 110% from the highest of the 1995 to 1997 levels was not exceeded for any gear type. Notwithstanding this, there are continuing concerns, regarding the level of latent effort from licence holders who are currently either not active in the fishery or participating at low levels but with access to gear such as gillnets, hooks, dipnets and jigs. The 2004 management plan review has attempted to address this issue through several strategies including non-transferability of C-class licences.

The following section presents an overview of the catch composition, as well as the overall catch, effort, and number of active vessels for each gear type.

Automatic squid jig

Automatic squid jig users targets exclusively Gould's Squid, and have practically no by catch. While commercial scalefish fishers can use up to four automatic squid jig machines without the need for an Automatic squid jig licence, few Scalefish licence holders currently have the capacity to use jig machines on their vessels. The data below therefore reflects Automatic squid jig license holders only.

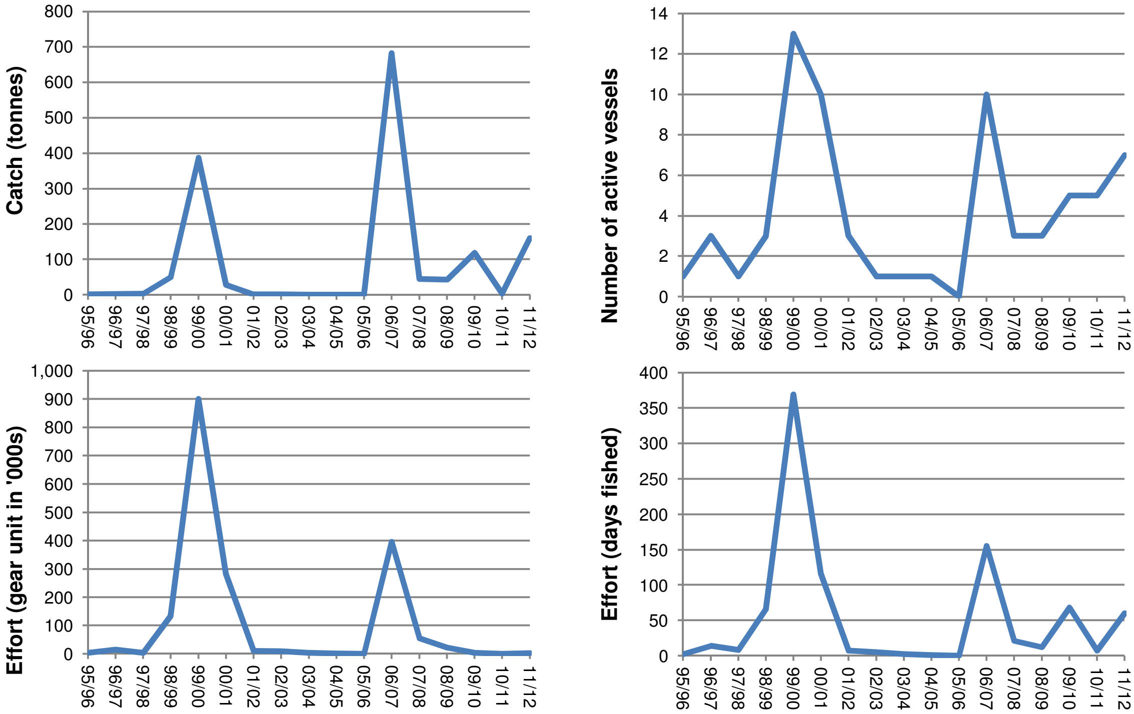


Figure 3.1 Overall catch, number of active vessels using the gear, and effort (in gear unit and days fished) for automatic squid jig. No vessel using automatic squid jig was active in Tasmanian waters in 2005/06.

Beach seine

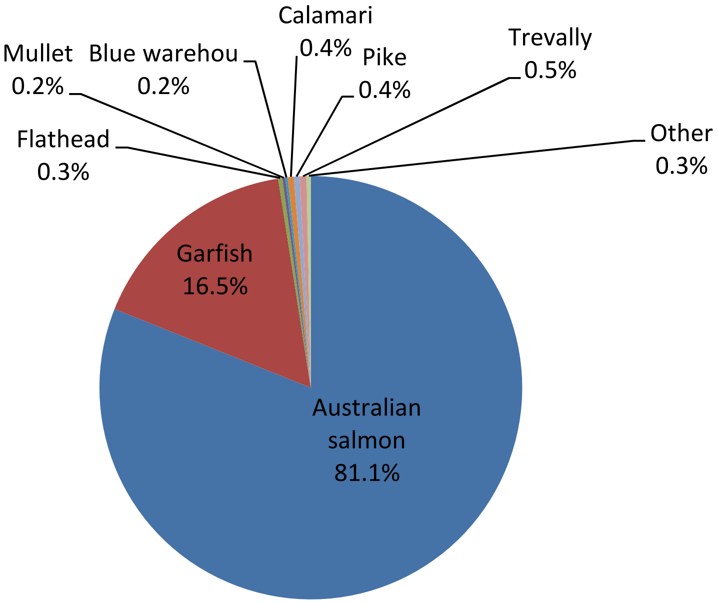


Figure 3.2 Beach seine catch composition for 2011/12. The vast majority of the trevally catch is Silver Trevally.

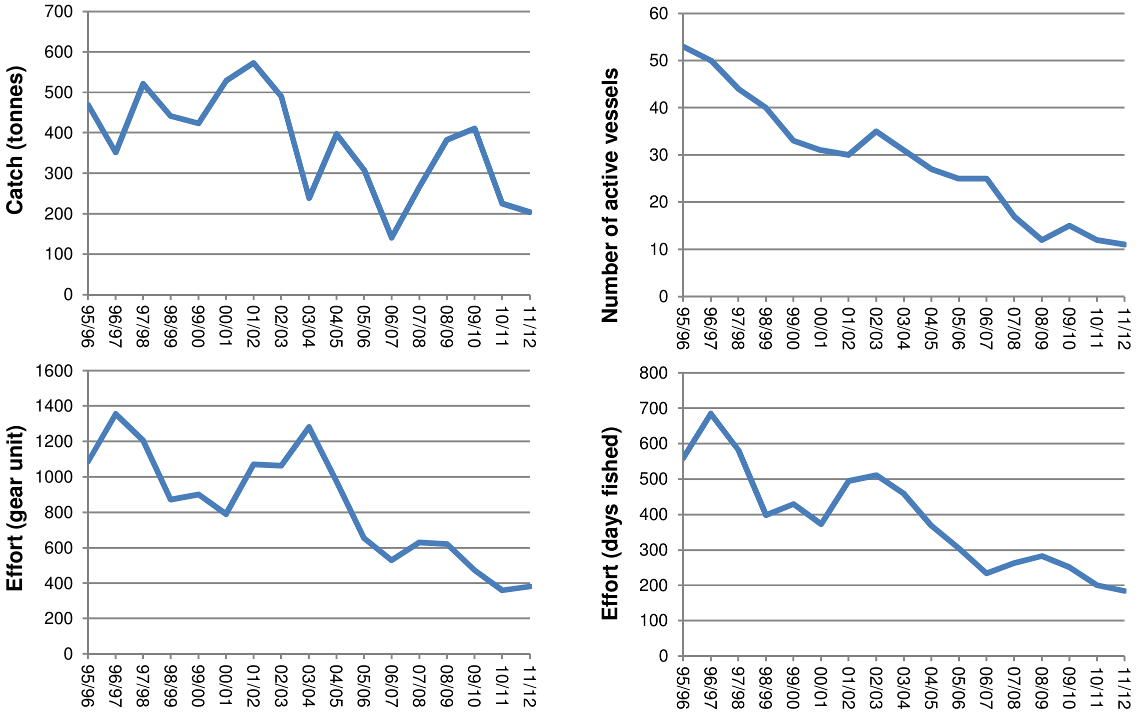


Figure 3.3 Overall catch (tonnes), number of active vessels using the gear, and effort (in gear unit and days fished) for beach seine.

Drop line

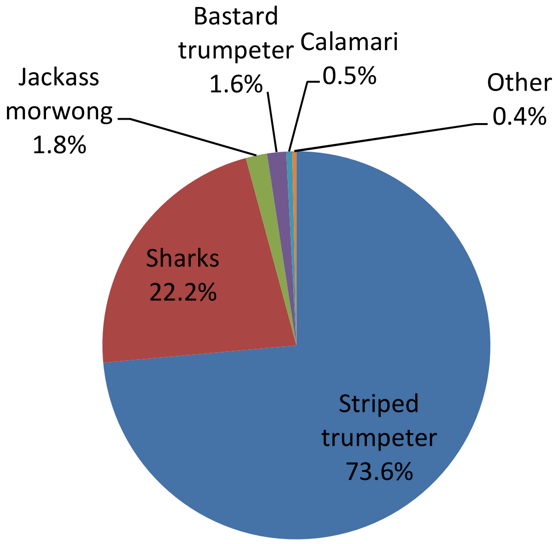


Figure 3.4 Drop line catch composition for 2011/12.

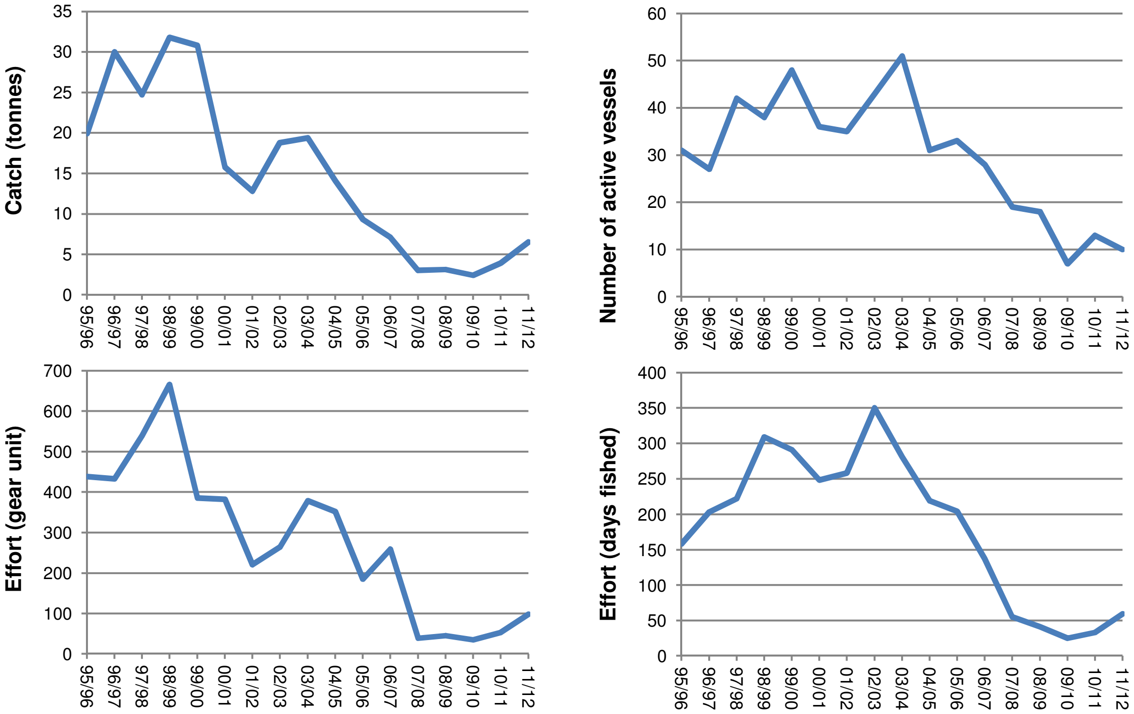


Figure 3.5 Overall catch (tonnes), number of active vessels using the gear, and effort (in gear unit and days fished) for drop line. For the purpose of analysis, drop line catch and effort up to 1998 was restricted to records that indicated a fishing depth of less than 200 m. This restriction effectively excluded reports of drop line fishing for blue-eye trevalla (since 1998 fishing for blue-eye has been covered in Commonwealth catch returns) but effectively encompassed the target fishery for Striped Trumpeter (less than 1% of the Striped Trumpeter catch has been reported from depths greater than 200 m).

Dip net

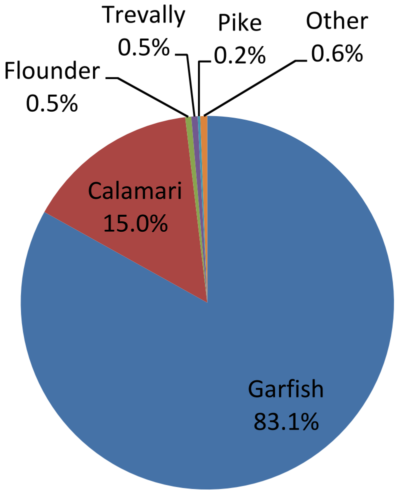


Figure 3.6 Dip net catch composition for 2011/12. The vast majority of the trevally catch is Silver Trevally.

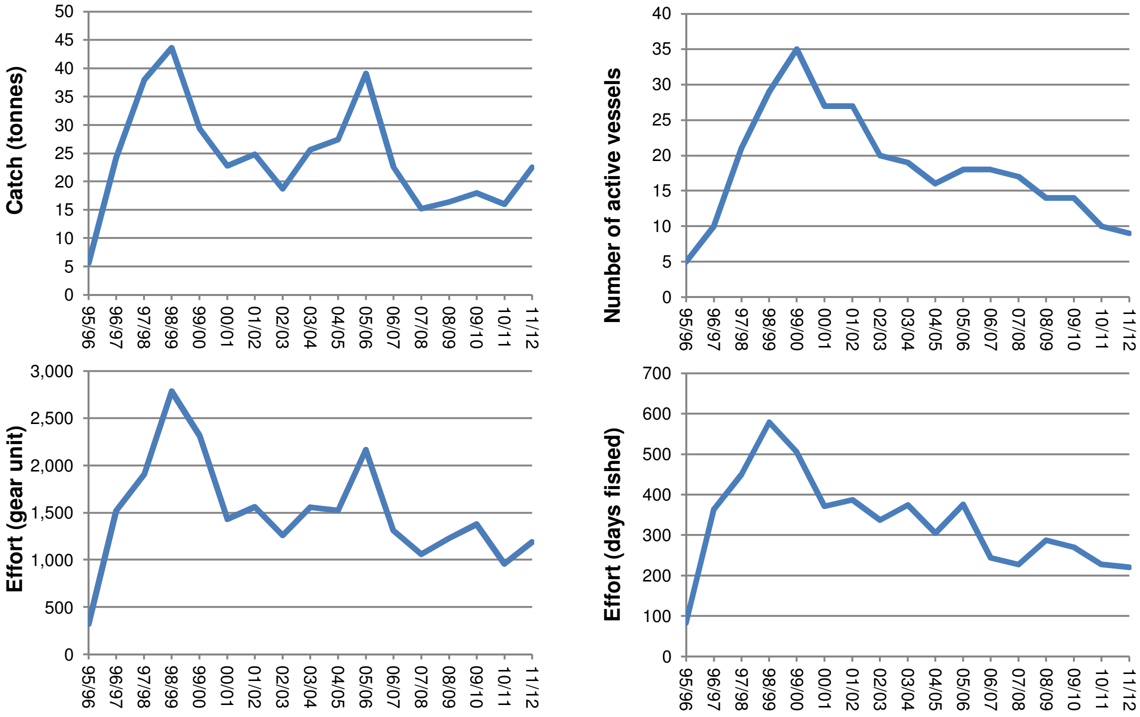


Figure 3.7 Overall catch (tonnes), number of active vessels using the gear, and effort (in gear unit and days fished) for dip net.

Danish seine

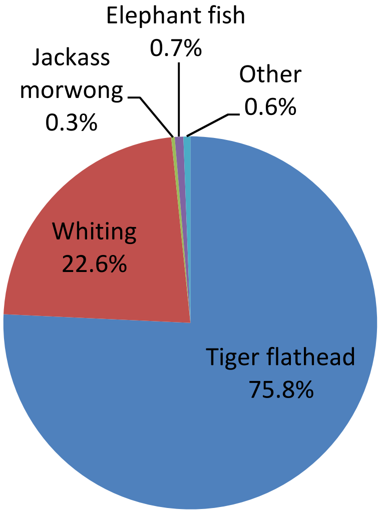


Figure 3.8 Danish seine catch composition for 2011/12.

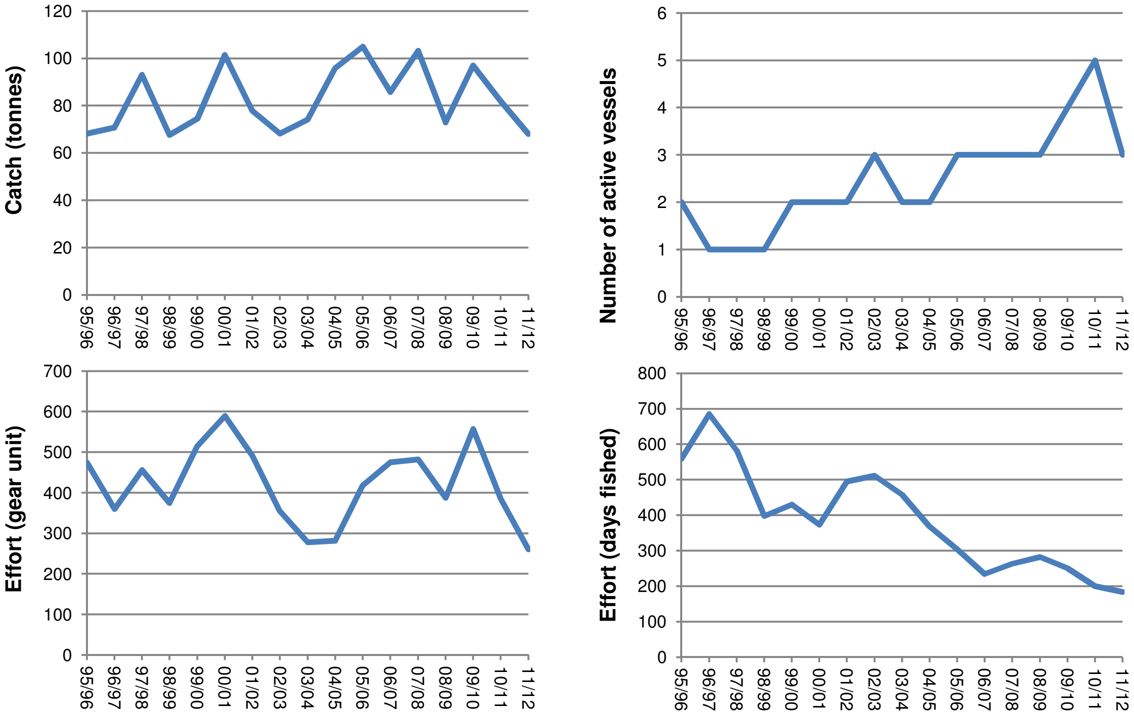


Figure 3.9 Overall catch (tonnes), number of active vessels using the gear, and effort (in gear unit and days fished) for Danish seine.

Fish trap

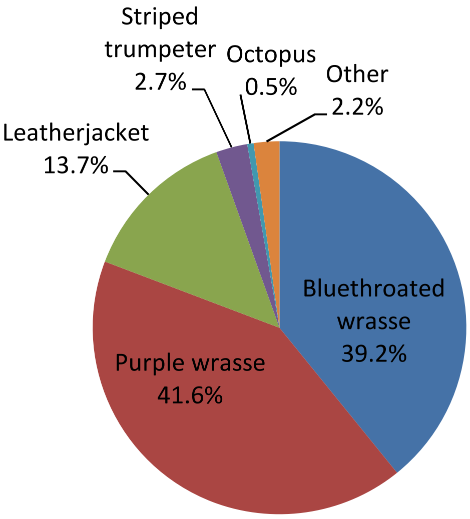


Figure 3.10 Fish trap catch composition for 2011/12.

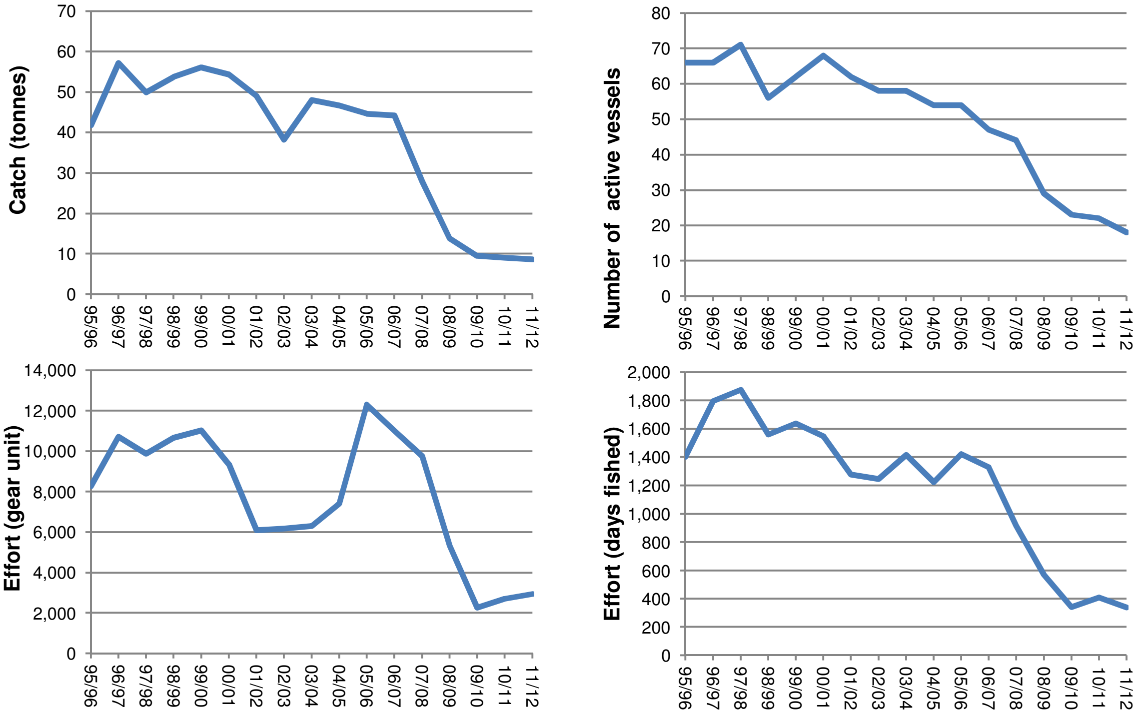


Figure 3.11 Overall catch (tonnes), number of active vessels using the gear, and effort (in gear unit and days fished) for fish trap.

Graball net

Graball nets in this analysis include both the traditional graball net (110 mm mesh size) and the Banded Morwong net (140 mm mesh size). The vast majority of the trevally catch is Silver Trevally.

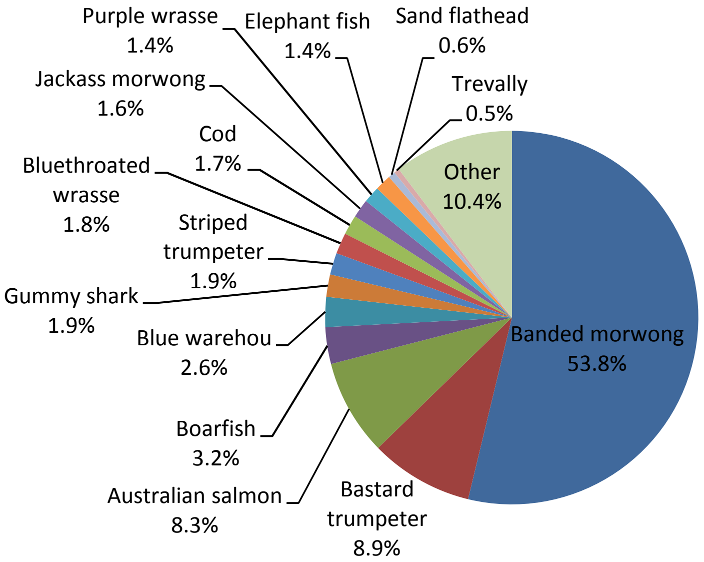


Figure 3.12 Graball net catch composition for 2011/12.

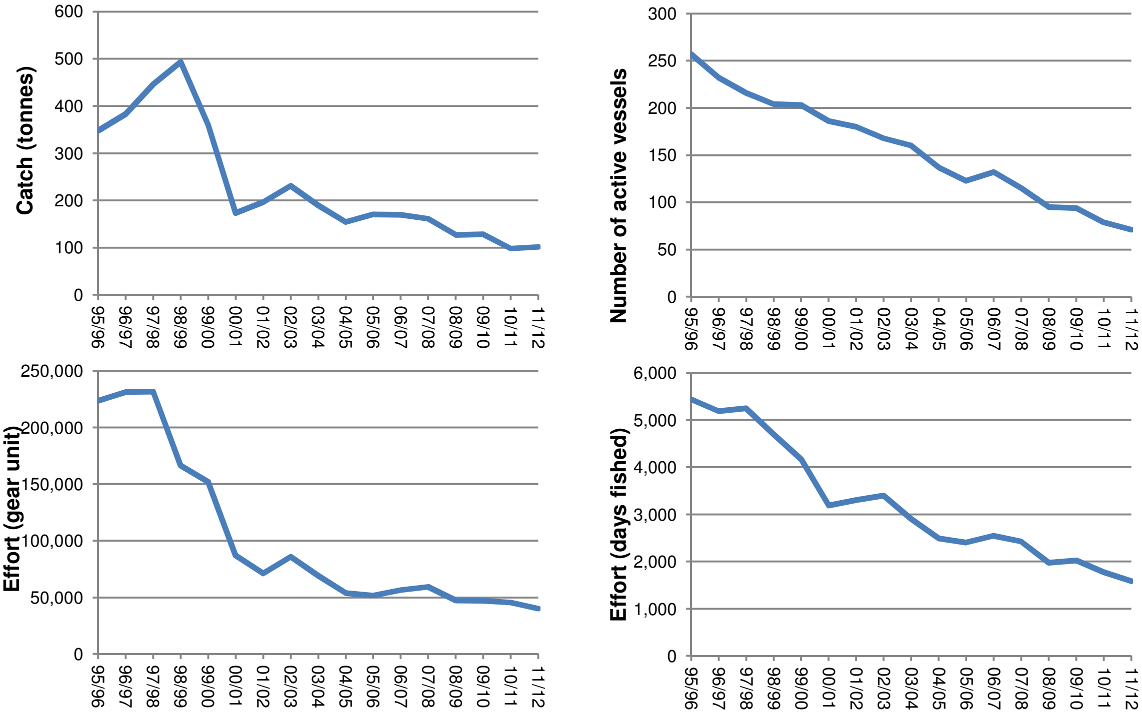


Figure 3.13 Overall catch (tonnes), number of active vessels using the gear, and effort (in gear unit and days fished) for graball net.

Hand line

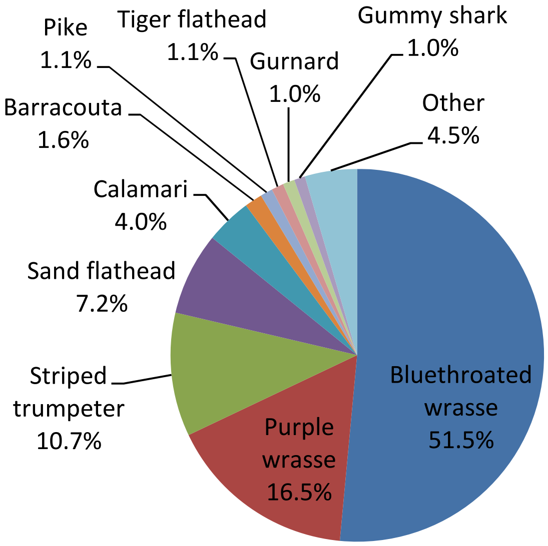


Figure 3.14 Hand line catch composition for 2011/12.

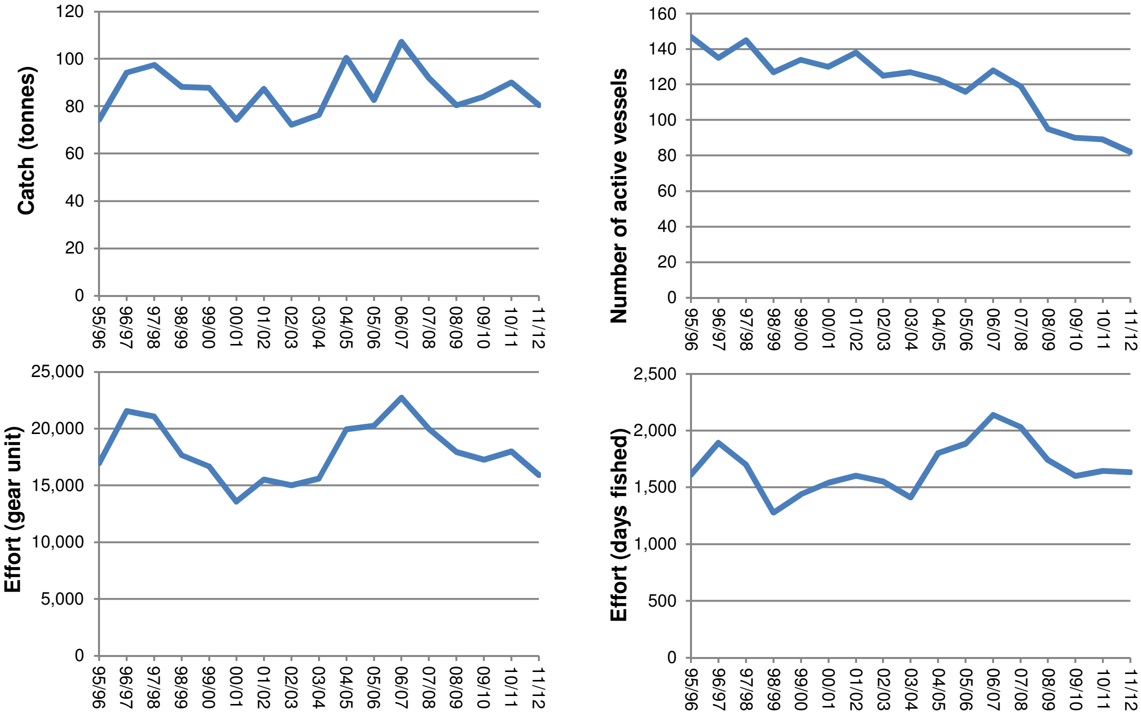


Figure 3.15 Overall catch (tonnes), number of active vessels using the gear, and effort (in gear unit and days fished) for hand line.

Small mesh net

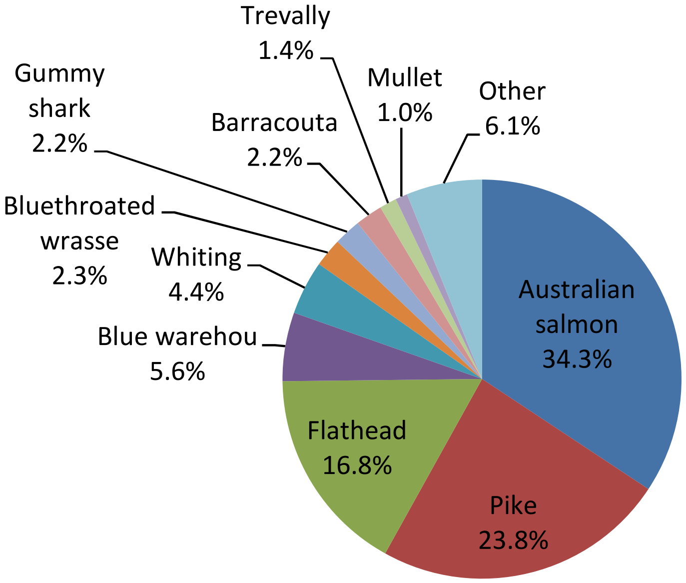


Figure 3.16 Small mesh net catch composition for 2011/12. The vast majority of the trevally catch is Silver Trevally.

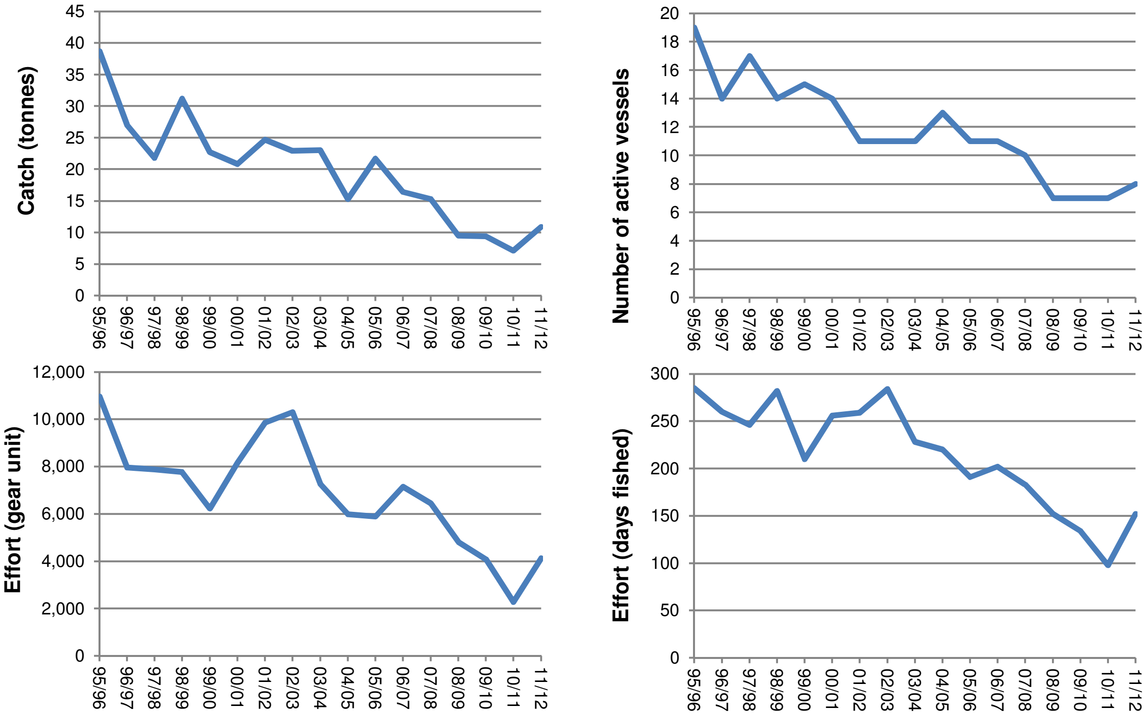


Figure 3.17 Overall catch (tonnes), number of vessels using the gear, and effort (in gear unit and days fished) for small mesh net. Note: the low effort in 2010/11 is due to a significant amount of incorrect records for that fishing year.

Purse seine

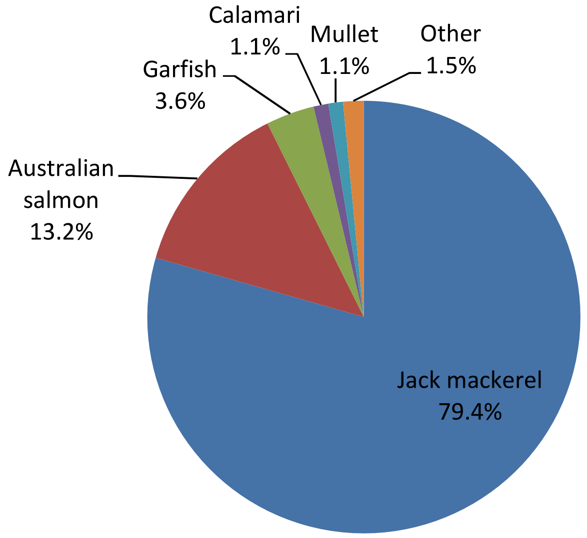


Figure 3.18 Purse seine catch composition for 2011/12.

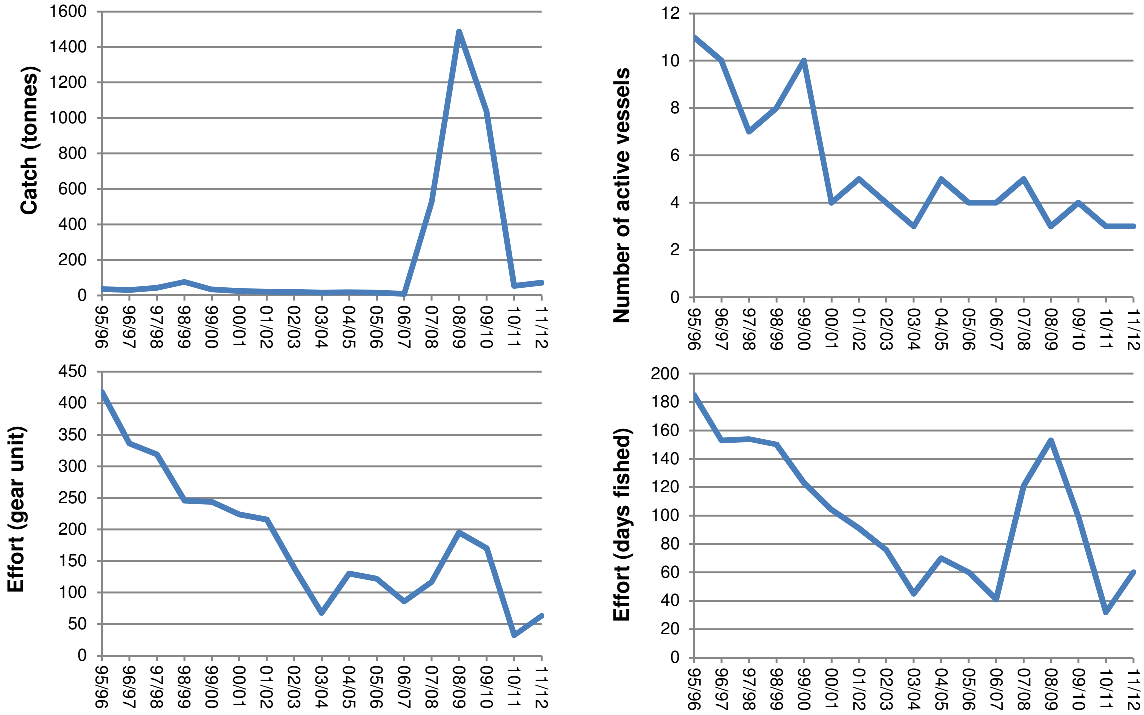


Figure 3.19 Overall catch (tonnes), number of active vessels using the gear, and effort (in gear unit and days fished) for purse seine.

Squid jig

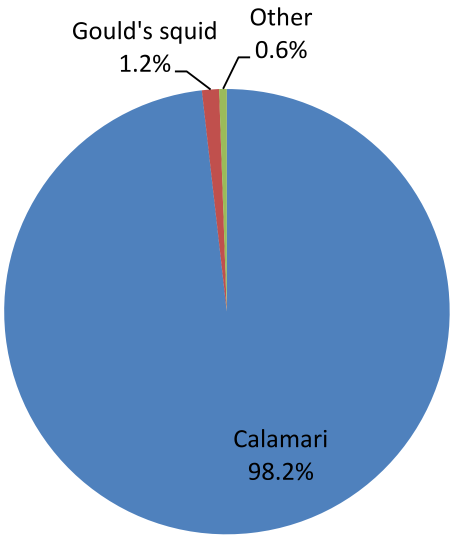


Figure 3.20 Squid jig catch composition for 2011/12.

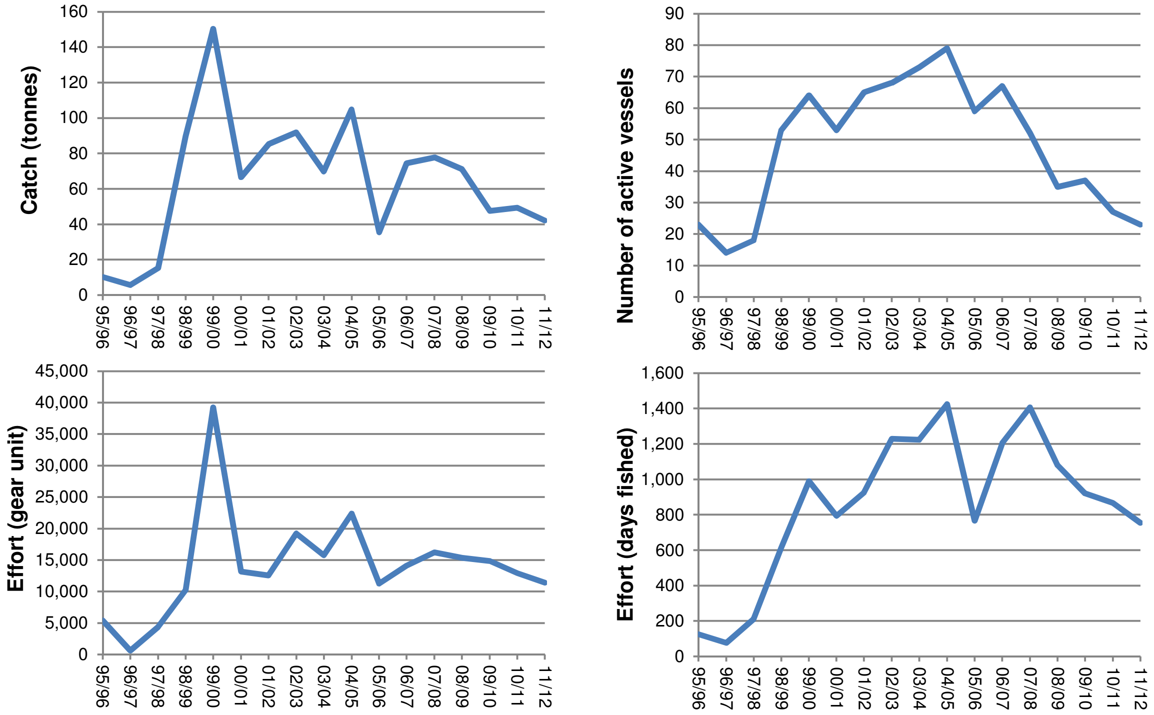


Figure 3.21 Overall catch (tonnes), number of active vessels using the gear, and effort (in gear unit and days fished) for squid jig.

Spear

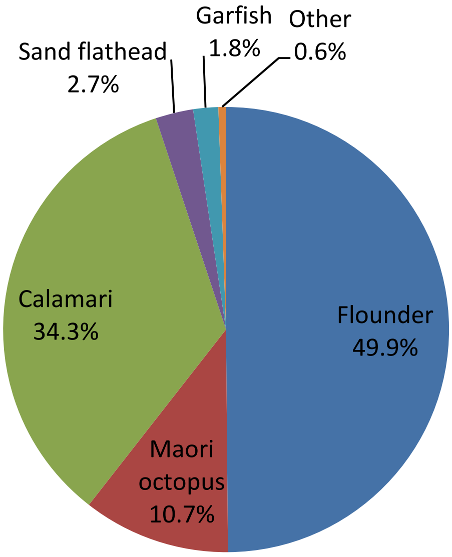


Figure 3.22 Spear catch composition for 2011/12.

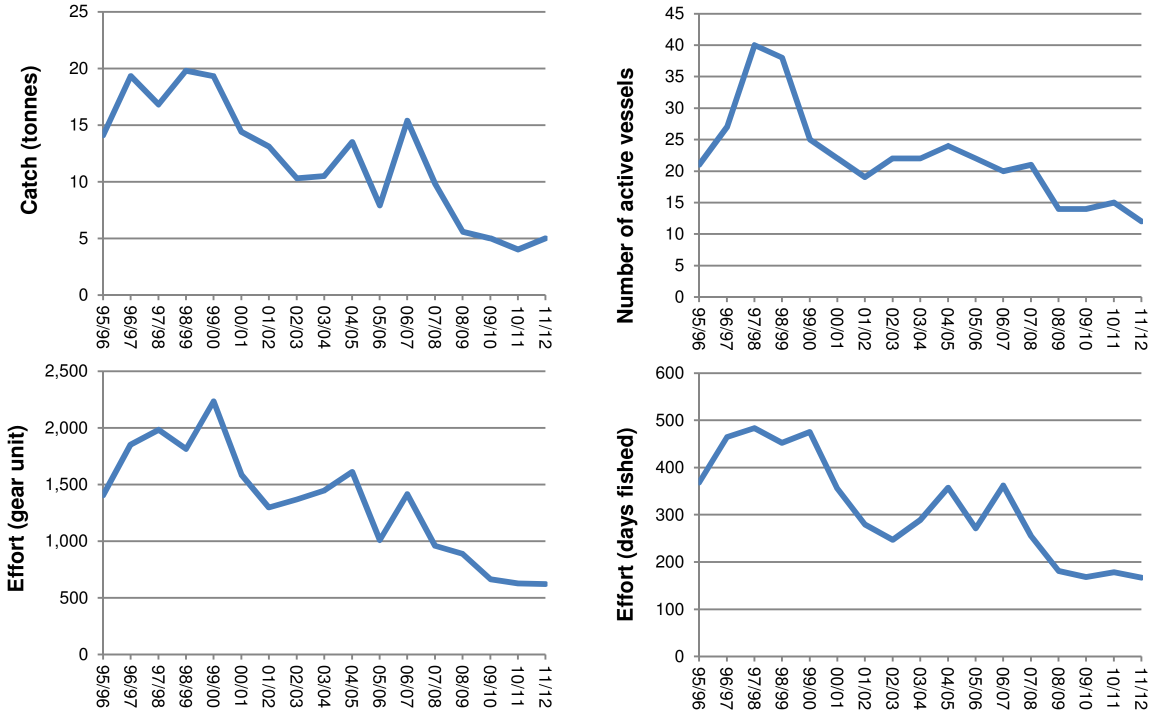


Figure 3.23 Overall catch (tonnes), number of active vessels using the gear, and effort (in gear unit and days fished) for spear.

Troll

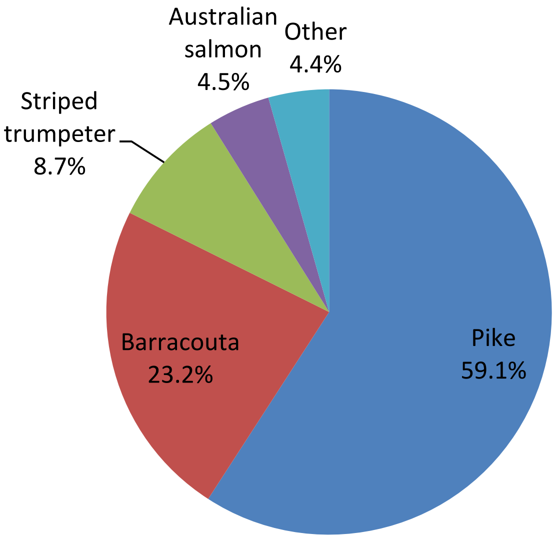


Figure 3.24 Troll catch composition for 2011/12.

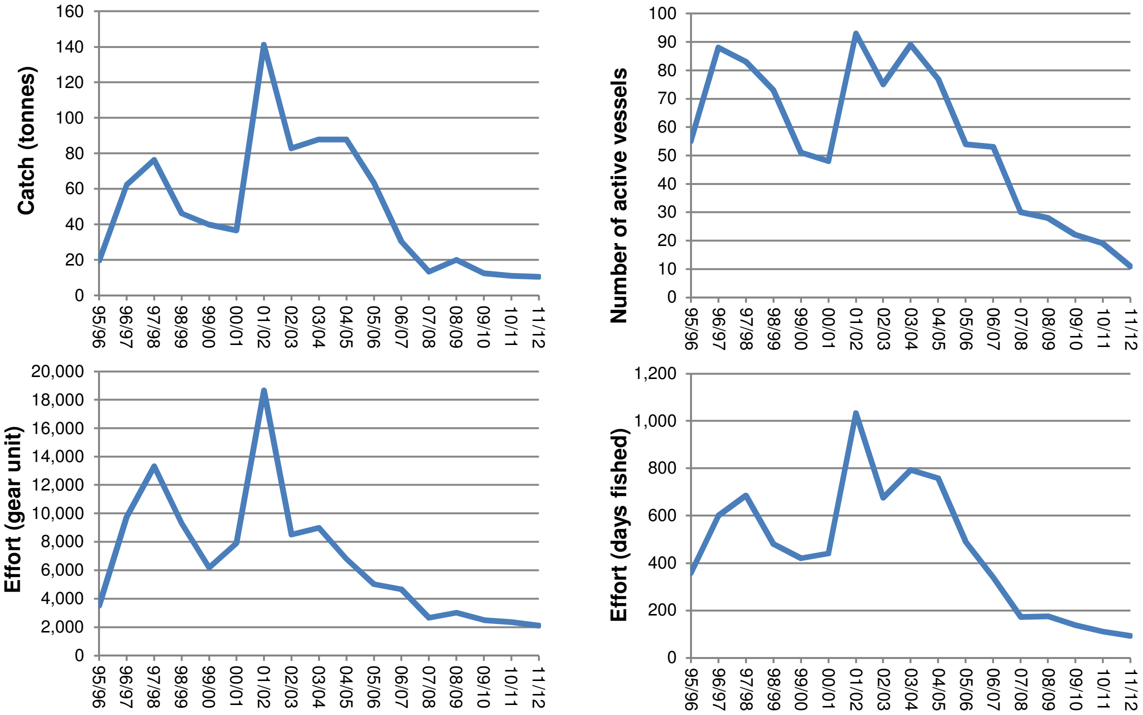


Figure 3.25 Overall catch (tonnes), number of vessels using the gear, and effort (in gear unit and days fished) for troll.

Hand collection

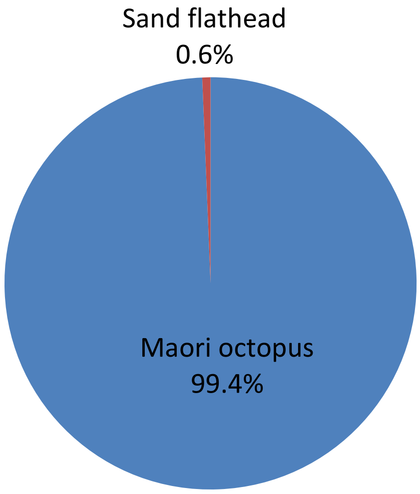


Figure 3.26 Hand collection catch composition for 2011/12.

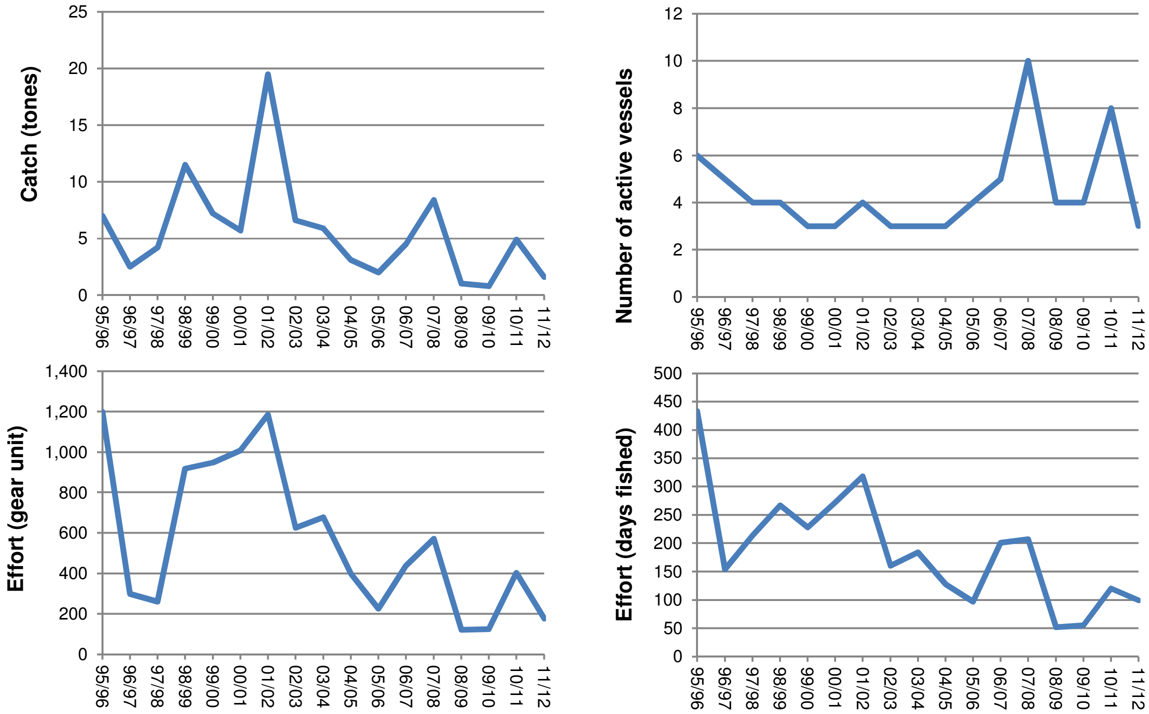
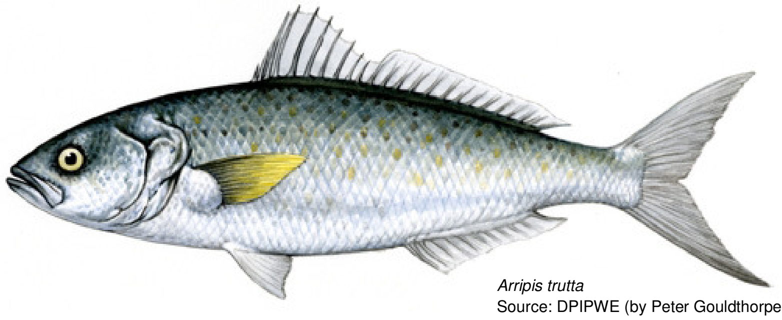


Figure 3.27 Overall catch (tonnes), number of vessels using the gear, and effort (in gear unit and days fished) for spear.

4. Eastern Australian Salmon

Arripis trutta

STOCK STATUS	**SUSTAINABLE**
Species has a long history of exploitation. Commercial landings are driven by market demand.	
IMPORTANCE	Key
STOCK	Eastern Australian
JURISDICTION	Tasmania, Victoria, New South Wales
FISHERIES IN STATE WATERS	Tasmanian Scalefish Fishery (Tasmania)
INDICATOR(S)	Catch, effort and CPUE trends



Arripis trutta
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

<table>
<tr><th>Parameters</th><th>Estimates</th><th>Source</th></tr>
<tr><td>Habitat</td><td>• Open water. Down to 30 m depth.</td><td>Edgar (2008)</td></tr>
<tr><td>Distribution</td><td>• From Victoria to Queensland (Brisbane) and around Tasmania.</td><td>Edgar (2008)</td></tr>
<tr><td>Diet</td><td>• Fish (pelagic predominantly)</td><td>Stewart et al. (2011)</td></tr>
<tr><td>Movement and stock structure</td><td>• One single well-mixed stock along south-east Australia
• Travel great distances between the different States
• Increased population mixing occurs with both increasing age and decreasing latitude</td><td>Stewart et al. (2011)</td></tr>
<tr><td>Natural mortality</td><td>• M between 0.35 and 0.50.</td><td>Stewart et al. (2011)</td></tr>
<tr><td>Maximum age</td><td>• Maximum sampled is 12 years but potentially up to 26 years.</td><td>Stewart et al. (2011)</td></tr>
<tr><td>Growth</td><td>• Maximum length: 89.0 cm.
• Maximum weight: 9.4 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 (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.
Parameters estimates are:
<table>
<tr><th>Sex</th><th>L_∞</th><th></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>Edgar (2008)
Frimodt (1995)
Stewart et al. (2011)</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>
</table>

Spawning	• 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).	Stewart et al. (2011)
Early life history	• 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.	Kailola et al. (1993)

Background

There are two species of Australian Salmon cohabiting in Tasmanian waters: *Arripis trutta* (Eastern Australian Salmon) and *Arripis truttaceus* (Western Australian Salmon). The Eastern Australian Salmon constitute 94% of Tasmanian commercial catches.

Australian Salmon has a long history of exploitation in Tasmania, with large-scale commercial fishing occurring at least since 1958 (Stewart et al. 2011). There are two distinct sectors in the commercial fishery: a small number of large vessels specifically equipped to capture and store large quantities of Australian Salmon, and a large number of small vessels which target the species on an opportunistic basis. One company operating up to three vessels accounts for around 85% of landings for the species.

Beach seining accounts for the majority of the catch. Large-scale beach seine operations involve deploying a net around a school of Australian Salmon using a small boat and then hauling the net into the shallows, forcing the fish to the cod-end which is transferred to the mother ship. Spotter planes are typically used to locate the schools. Purse seine and gillnetting are often used by smaller operators. A total commercial catch limit of 435 t (120% of the average annual catch between 1996/97 and 2006/07) applies to the Tasmanian fishery.

Commercially caught Australian Salmon are frozen whole and sold as rock lobster bait with production levels linked to a large extend to market demand. Some Australian Salmon are sold fresh for human consumption.

Australian Salmon is the second most commonly captured fish species by recreational fishers (Lyle 2005, Lyle et al. 2009), who use mainly line fishing methods to target the species.

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, Purse seine net licence, Recreational Graball and/or Mullet net licence) • Species licence (Australian Salmon licence)-only 8 issued • Spatial and temporal area closures for Australian Salmon licence. **Output control:** • Possession limit of 500kg on vessel at any one time unless endorsed or holder of an Australian Salmon licence. • Possession limit of 15 individuals for recreational • Minimum size (200 mm TL) • Total commercial catch trigger of 435 t
MAIN MARKET	Local and interstate

Current assessment

Catch, effort and CPUE

Commercial catches have decreased from the 2009/10 high, reaching 189.4t in 2011/12 (Fig. 4.1). The majority of catch was caught from beach seine, predominantly from the north-east coast, and to a lesser extent from the north-west coast (Fig.4.1A and 4.2). Effort was similar to the level from the previous year. Catch rates by gear and days fished returned to mid-2000's levels, after a spike in 2008/09 (Fig. 4.1C). It should be noted however that catch rate is influenced by the skewed nature of the data (i.e. the majority of catches are small but the total catch is influenced by only a small number of extremely large catches). In addition, catch rate is not a particularly sensitive indicator of fish stock condition for schooling species such as Australian Salmon, especially if search time is not taken into account.

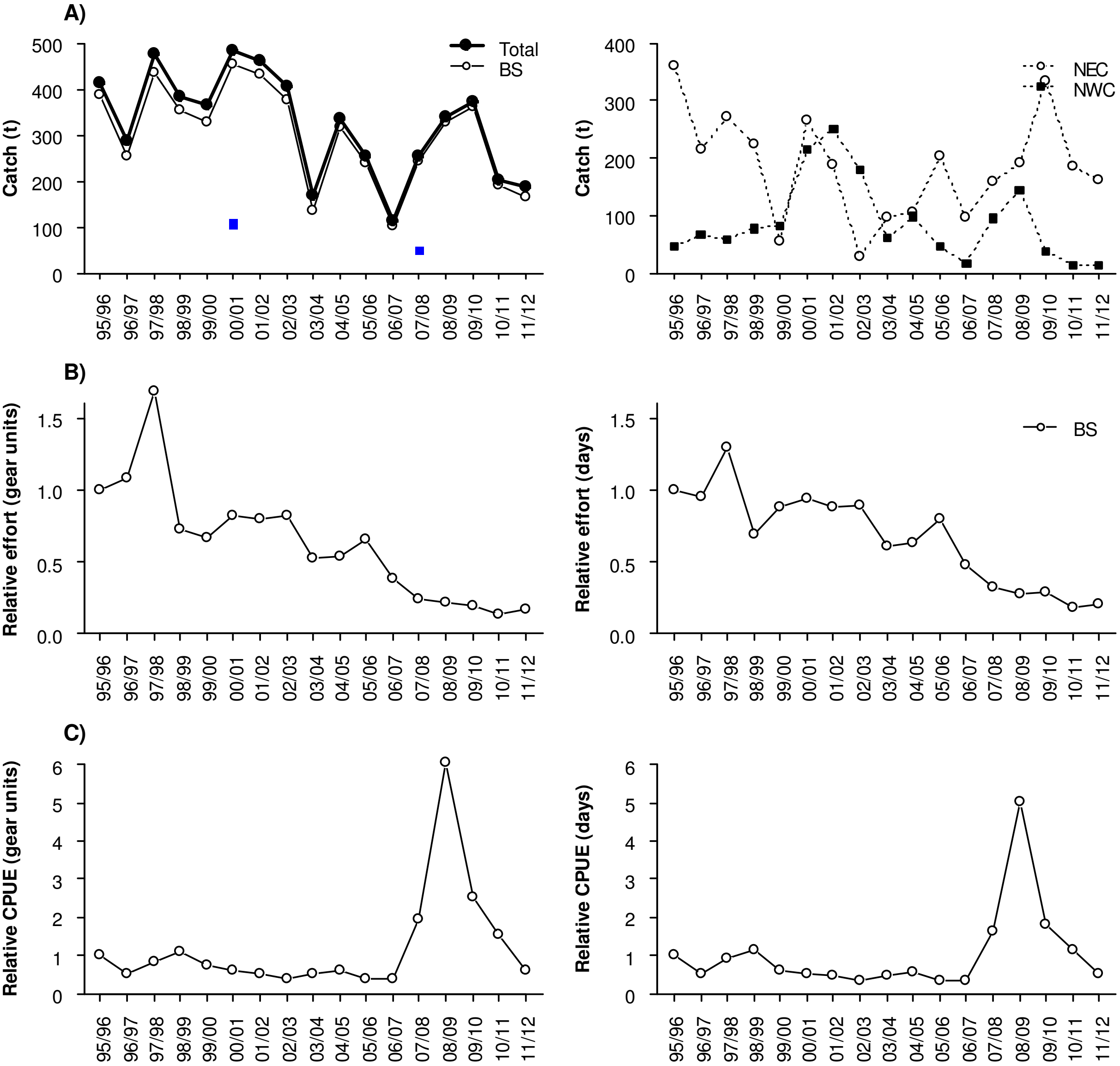


Figure 4.1 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. BS= beach seine, NEC= north east coast, NWC= north west coast.

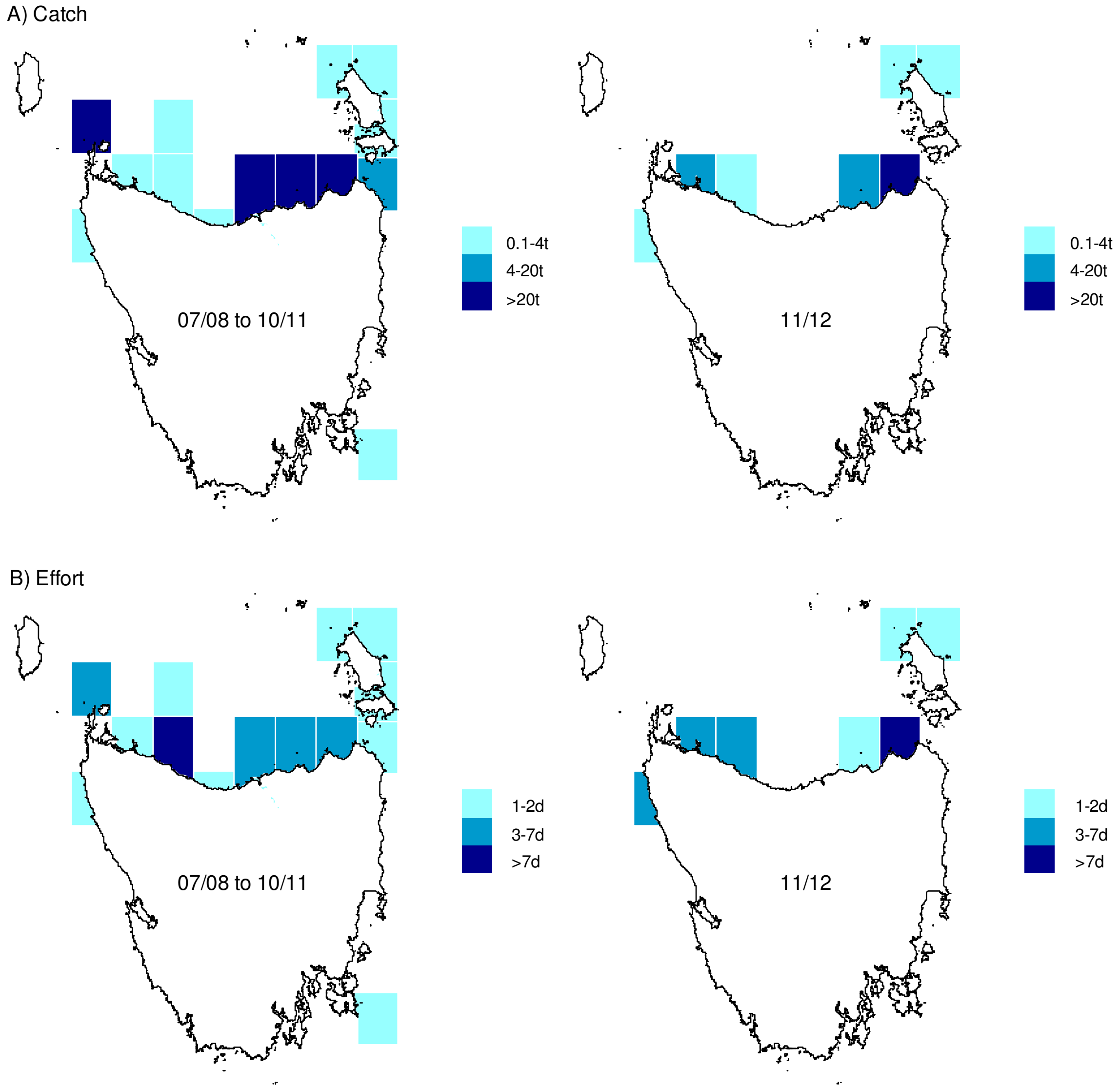


Figure 4.2 (A) Australian Salmon catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	- Total commercial catch >435 t	No	
	- Catch > higher catch from the 1990/91 to 1997/98 range (878.8 t)	No	
	- Catch < lowest catch from the 1990/91 to 1997/98 range (287.3 t)	Yes	97.9 t (34.1%)
	- Catch increases by > 30% from previous year (>264.5 t)	No	
	- Catch decreases by > 30% from previous year (<142.4 t)	No	
Effort trend	- Effort >10% of highest level from 1995/96 to 1997/98 (>835 days fished)	No	
Catch rates trends	- Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0195 t/days fished)	No	

Given that catch rates are not a significant indicator of stock status, 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 > 3^{rd} highest catch value from the reference period (462.1 t)	No	
	• Catch < 3^{rd} lowest catch value from the reference period (254.2 t)	Yes	64.8 t (25.5%)
	• 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 (240.1 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 (17.8%)	No	
Stock stress	• Significant change in the size/age composition	Not assessed	
	• Significant numbers of unhealthy fish landed	No	

Stock status

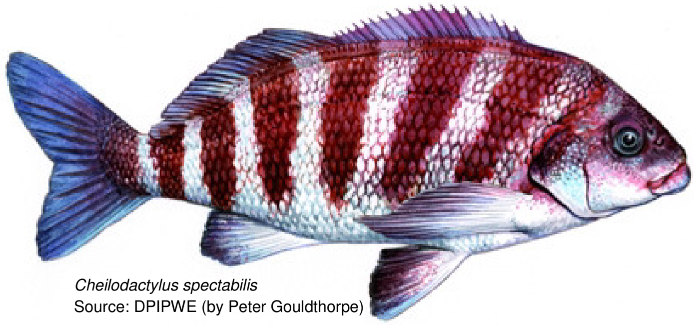
SUSTAINABLE

While one catch reference point was breached in both the current and the proposed scheme, the stock is considered sustainable. Annual production in Australian Salmon is strongly linked to market demand, specifically the bait market, and is thus not a good indicator of stock status. The eastern Australian Salmon represents a single well-mixed stock along south-east Australia. The Tasmanian fishery catches mostly sub-adults which predominantly occur in Tasmanian waters. In addition, there has been little change in size and age composition in Tasmania and in other states (NSW and VIC). The current level of commercial and recreational fishing pressure in Tasmania is well below historical levels and is unlikely to cause the biological stock to become recruitment overfished.

5. Banded Morwong

Cheilodactylus spectabilis

<table>
<tr><td>STOCK STATUS</td><td>TRANSITIONAL DEPLETING</td></tr>
<tr><td colspan="2">Unusual combination of high longevity, fast growth and early maturity. The commercial fishery has been managed using a Total Allowable Catch (TAC) since 2008 and is closely monitored.</td></tr>
<tr><td>IMPORTANCE</td><td>Key</td></tr>
<tr><td>STOCK</td><td>Tasmanian</td></tr>
<tr><td>JURISDICTION</td><td>Tasmania</td></tr>
<tr><td>FISHERIES IN STATE WATERS</td><td>Tasmanian Scalefish Fishery (Tasmania)</td></tr>
<tr><td>INDICATOR(S)</td><td>Catch, effort and CPUE trends; changes in size/age composition</td></tr>
</table>



Cheilodactylus spectabilis
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

<table>
<tr><th>Parameters</th><th>Estimates</th><th>Source</th></tr>
<tr><td>Habitat</td><td>• Rocky reefs down to 50m depth. Females and juveniles inhabit the shallow section of the reef while males dominate in the deeper section of the reef.</td><td>McCormick (1989a, b)</td></tr>
<tr><td>Distribution</td><td>• South Sydney (New South Wales) to eastern Victoria, Tasmania, New Zealand</td><td>Gomon et al. (2008)</td></tr>
<tr><td>Diet</td><td>• Invertebrates, algae, crabs.</td><td>McCormick (1998)</td></tr>
<tr><td>Movement and stock structure</td><td>• Limited movement of juveniles and adults, generally restricted to within 5km of the release site
• No information on the stock structure</td><td>Murphy & Lyle (1999)
Ziegler et al. (2006)
Buxton et al. (2010)</td></tr>
<tr><td>Natural mortality</td><td>• Low. Estimated at M=0.05</td><td>Murphy & Lyle (1999)</td></tr>
<tr><td>Maximum age</td><td>• Females: 93 years
• Males: 96 years</td><td>Ewing et al. (2007)</td></tr>
<tr><td>Growth</td><td>• Males grow to larger sizes than females
• Growth described by a Schnute-Richards growth function
$L = L_{\infty}(1 + \alpha^{(-at^{c})})^{-\frac{1}{b}}$ where L is the length (mm), t is the age (years), L_{∞} is the average maximum length for the species and α, a, b and c are (year-specific) constants.
The most recent parameters estimates (2007) are :
<table>
<tr><th>ex</th><th>L_{∞}</th><th></th><th>b</th><th>c</th><th>α</th></tr>
<tr><td>Female</td><td>442</td><td>18.8</td><td>3.3e⁻⁷</td><td>0.05</td><td>51.4</td></tr>
<tr><td>Males</td><td>516</td><td>2.3</td><td>0.0088</td><td>0.33</td><td>0.1</td></tr>
</table>
• Length-weight relationship for 2007 was estimated at</td><td>Schnute & Richards (1990)
Ziegler et al.(2007a)</td></tr>
</table>

	$W = 3.563EE^{-5}L^{2.875}$ for females and $W = 3.729E^{-5}L^{2.852}$ for males, where *W* is weight (g) and *L* is the fork length (cm).	
Maturity	• Size-at-50% maturity estimated at 320 mm for females (~2.5 years of age).	Ziegler et al.(2007a)
Spawning	• Spawning occurs between mid-February to late May. • Species is a serial spawner.	Murphy & Lyle (1999)
Early life history	• Eggs and larvae are concentrated on the surface. • Banded Morwong has a pelagic stage distributed offshore, as suggested by the large amounts of larvae caught off the shelf break of eastern Tasmania. • Juveniles appear in shallow water on rocky reefs and tide-pools between September and December, after a pelagic phase of 4-6 months.	B. Bruce, Pers. Com. Wolf (1998)

Background

The ‘live fish’ fishery for Banded Morwong began in the early 1990s. All holders of a fishing licence (vessel) were able to take this species and, as a result, there was a dramatic increase in effort directed at the species, with catches peaking at 145 t in 1993/94. Since then, catches have stabilised around 40-50 tonnes. A quota management system with a Total allowable Catch (TAC) was introduced in 2008 (see Fig. 5.1 for areas). The TAC is currently undergoing a staged reduction as follows:

Quota year	TAC (in tonnes)	TAC (in no. fish)	No. of Fish/Quota Unit
2012/13	38.8	29,825	25
2013/14	37.2	28,632	24
2014/15	35.7	27,439	23

Banded Morwong are targeted almost exclusively for the live fish market with large mesh gillnets, primarily 130-140 mm mesh size. The fishery is centred mainly along the east coast of Tasmania, between St. Helens in the north and the Tasman Peninsula in the south, with the largest catches traditionally coming from around Bicheno (Fig. 5.5). Smaller catches have been taken along the south coast and around Flinders Island. Fishing operations are conducted over inshore reefs, with gear set primarily in the 10-20 m depth range. In addition to targeted fishing, the species occurs as a by-product of netting operations primarily targeted at Blue Warehou. Banded Morwong is not an important recreational species with recreational catches estimated between 1 and 2 t per year.

FISHING METHODS	Mainly graball net
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence) • Maximum net length of 1,000 m • Species licence (Banded Morwong licence) (maximum of 28) • Temporal closure (March-April) • Recreational gear license (Recreational Graball and/or Mullet net) **Output control:** • Possession limit of 2 fish for recreational fishers • Minimum and maximum size (360-460 mm TL) • TAC of 29,825 fish (38.8t) for the 2012/13 licensing year
MAIN MARKET	Interstate

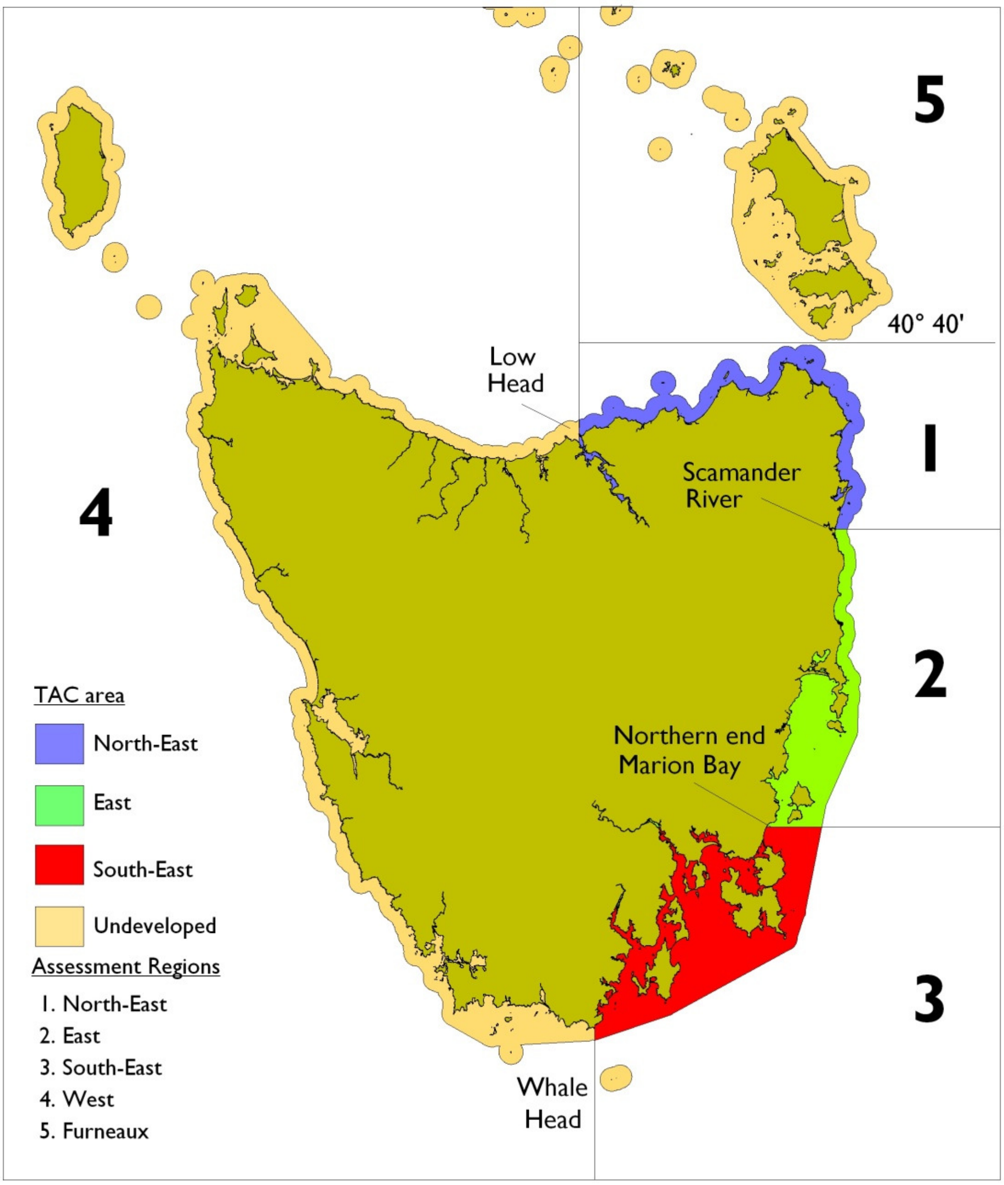


Figure 5.1 Designated TAC areas for Banded Morwong (Areas 1, 2 and 3) from Low Head on the north coast to Whale Head in the south. Areas 4 and 5 are currently undeveloped.

Current assessment

Biological characteristics

Size composition

Significant changes in the size composition between the late 1990’s and the early 2000’s raised concerns about the Banded Morwong stock (Fig. 5.2 and Ziegler et al. 2007a). Size composition appears to have stabilised since, with average size of Banded Morwong around 36 cm (Fig. 5.2). Comparison between average growth curves show that there are less differences between female growth curves post-2007 than between growth curves pre-2007, suggesting that the acceleration of growth (which was evident in the early 2000’s) may also have stabilised.

Age composition

Age composition also showed signs of change from the late 1990’s (Fig. 5.2 and Ziegler et al. 2007a). The age structure is now dominated by young fish around 4-5 years old (Fig. 5.2). There are relatively very few individuals older than 15 years old in current population samples compared to the late 1990’s.

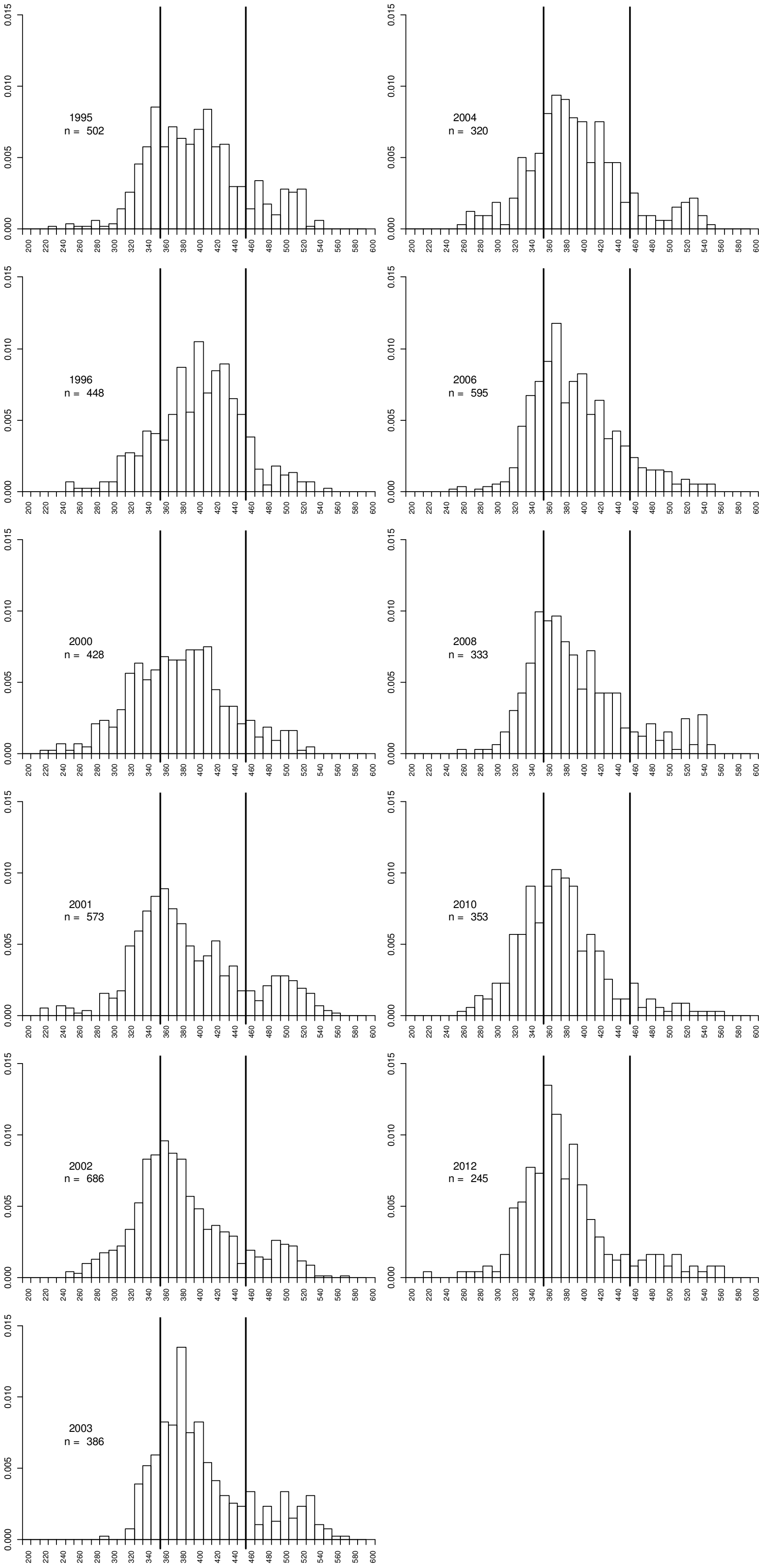


Figure 5.2. Size composition of Banded Morwong by year. *n* is the sample size, the solid lines represent the minimum and maximum size limits.

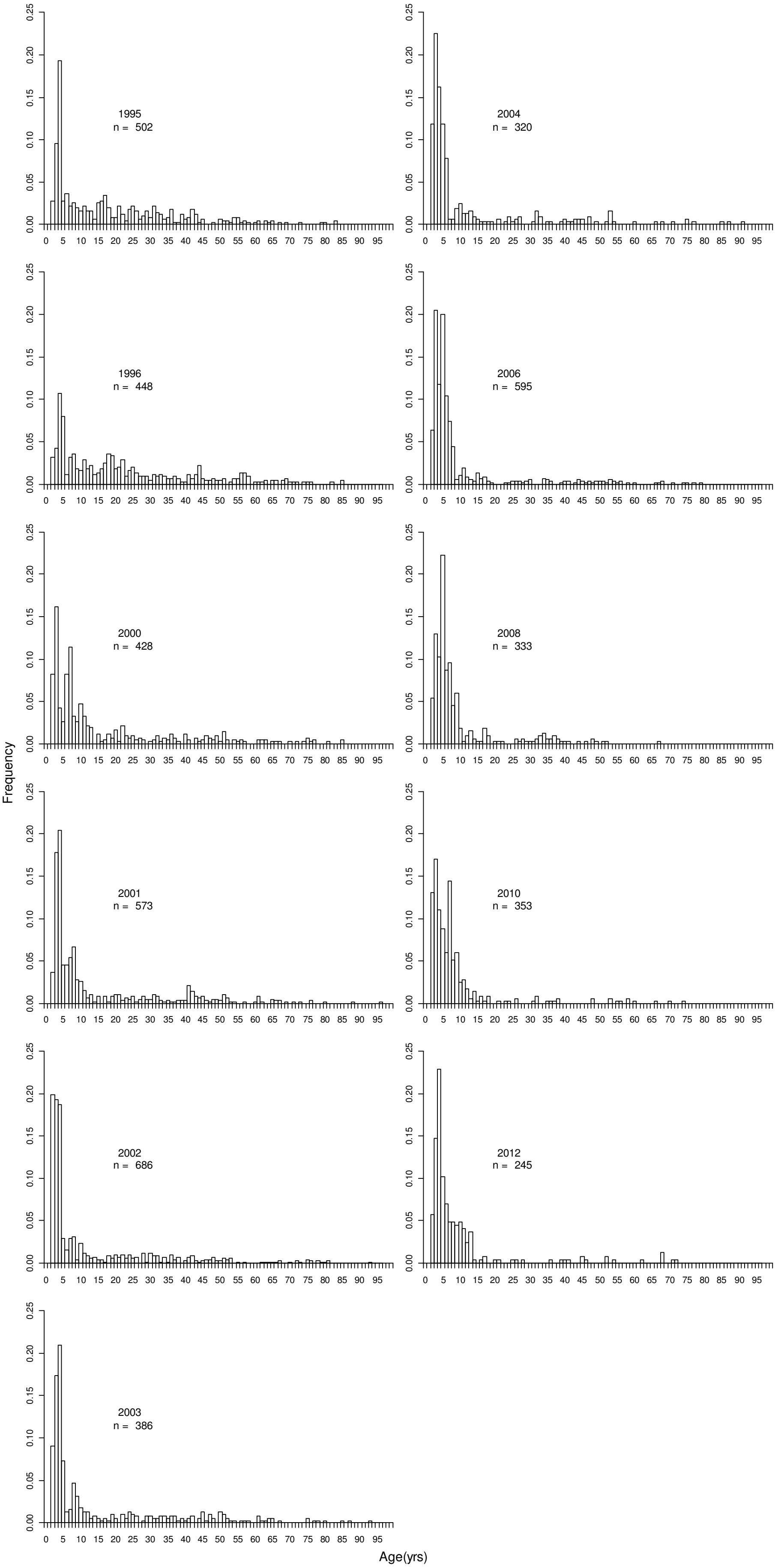


Figure 5.3 Age composition of Banded Morwong by year. *n* is the sample size.

Catch, effort and CPUE

The assessment year for Banded Morwong is based on the quota year (1st March to end of February the following year) rather than fishing years (1st July to end June the following year) as for the other scalefish species. The present Banded Morwong assessment includes data up to and including the 2012/13 quota year (which ended 28 February 2012).

Commercial catches under the quota system are reported as numbers of fish rather than weight, which are then converted to weight based on an average conversion ratio of 1.3 kg per fish. State-wide catches have been relatively stable since the introduction of the quota system in 2008/09, and in 2012/13 were estimated at 39.3 t (Fig. 5.2). The total catch in the TAC area (Region 1-3 in Fig.5.1) was 37.1 t, which represented 95.6% of the 2012/13 TAC. While catches in the Region 3 (SEC) have remained relatively stable over time, catches in Region 2 (EC) and Region 1 (NEC) have been steadily declining since 2009/10 (Fig. 5.2 and Fig. 5.4). Reference points pertaining to regional catches have not been triggered in any of the assessment regions (see Reference points section further below).

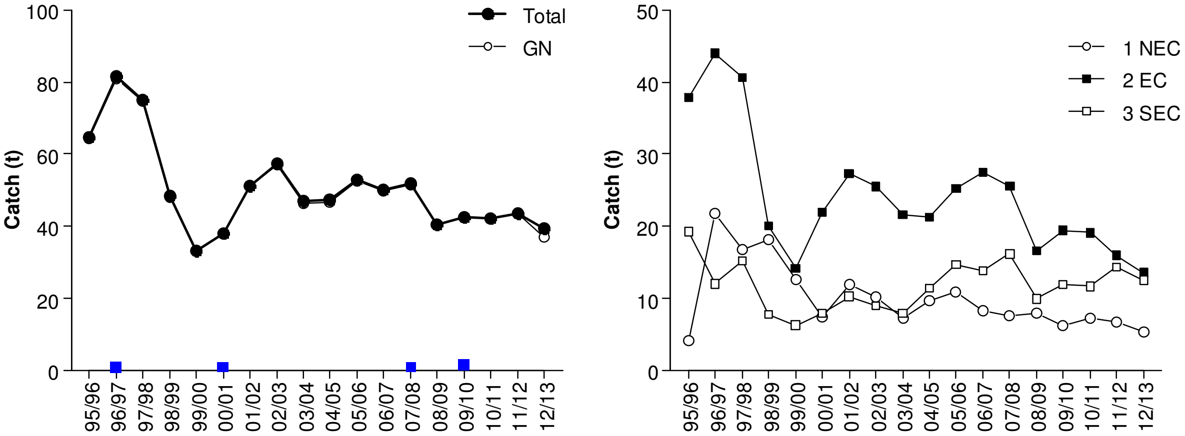


Figure 5.2 Banded Morwong commercial catches (tonnes). Left: Total state-wide (Total) and graball net (GN) catches, and best estimates of recreational catches (blue squares); Right: regional graball net catches in the TAC areas 1 NEC, 2 EC and 3 SEC.

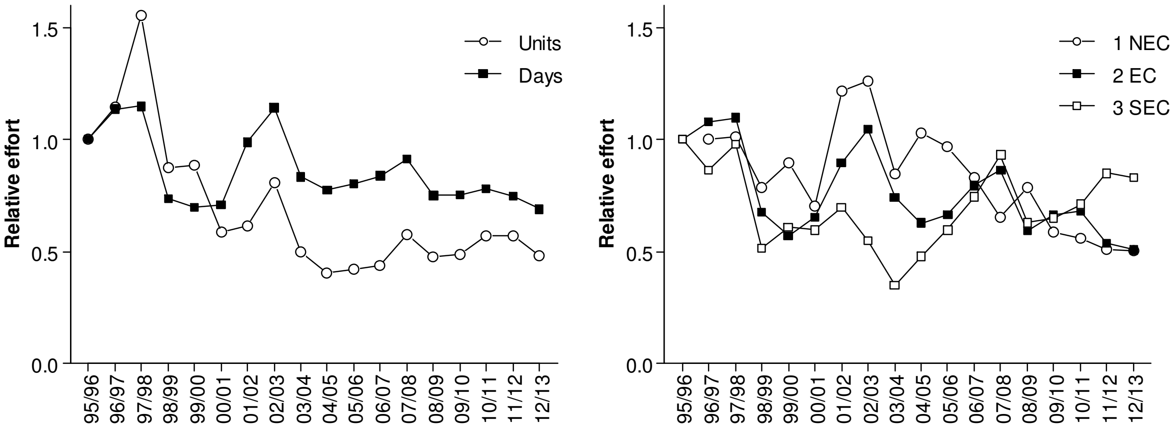


Figure 5.3 Left: State-wide commercial effort by method based on gear units and day fished relative to 1995/96. Right: Relative effort in day fished in the TAC areas 1 NEC, 2 EC and 3 SEC.

In 2012/13 effort in both days fished and gear units (100m net hour) decreased compared to 2011/12 (Fig. 5.3). Fishers have progressively reduced their fishing activity and deployed less gear on average for each day fished over the last 10 years (Fig. 5.4). Increasing levels of seal interactions over time has driven affected fishers to fish with less gear or doing fewer sets each day to reduce losses to seals (Ziegler et al. 2006).

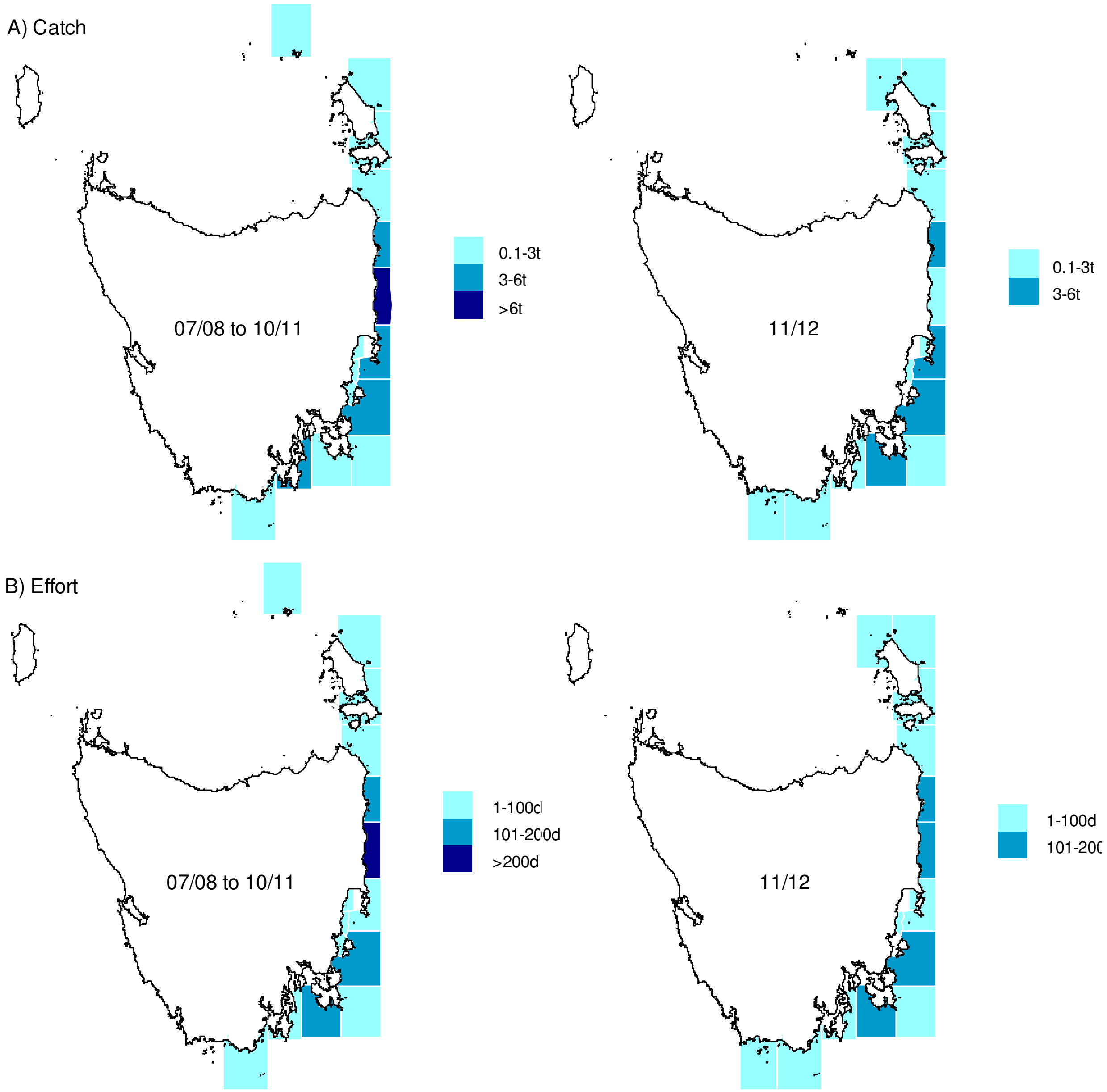


Figure 5.4 (A) Banded Morwong catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2011/12 (left) and during 2012/13 (right).

Overall standardised catch rates in the whole TAC area fell between 1995/96 and 1999/2000, before rising back to the 1995/96 levels (Fig. 5.5). Since 2010/11 however, catch rates have sharply declined and are now at the lowest level since 1995/96. Region 1 (NEC) has seen an increase in catch rates between 2009/10 and 2010/11 to levels comparable to the late 1990's, however in 2012/13 catch rates fell back to the pre-2009 level. Region 3 (SEC) also saw an increase in catch rates between 2009/10 and 2011/12 but catch rates for the current assessment year have fallen to the 2nd lowest level since 1995/96. Catch rates in Region 2 (EC) had stabilised since 2000 but have dropped significantly this assessment year to a record low. As a consequence, catch rates were below the reference points for Region 2 (EC), Region 3 (SEC) and for the whole State (see Reference point section further below).

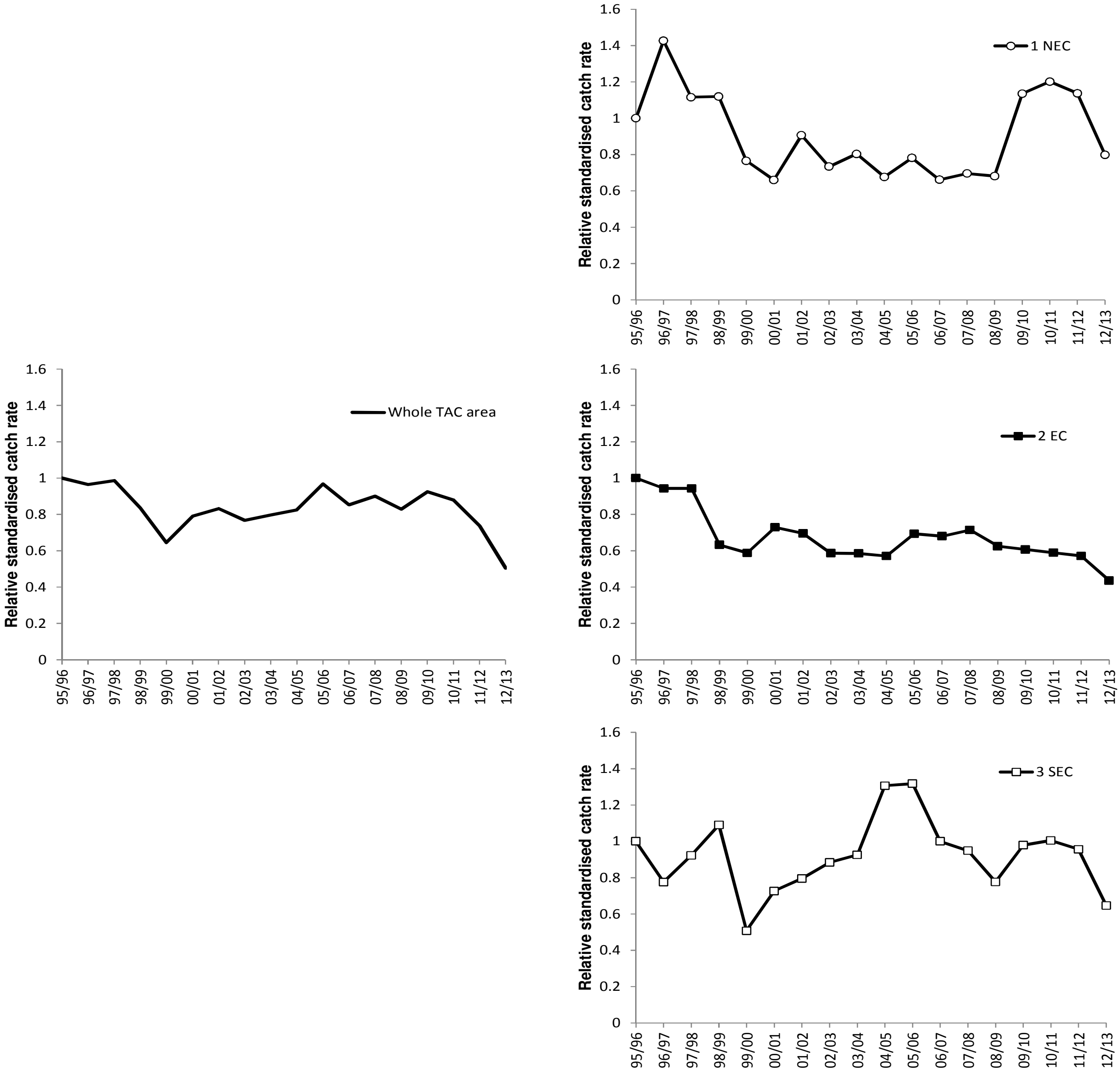


Figure 5.5 Banded Morwong standardised graball catch per unit effort (CPUE by days fished) relative to 1995/96, from the whole TAC area (left), and in the TAC areas 1 NEC, 2 EC and 3 SEC (right).

Selected stock assessment results

Details of the Banded Morwong model can be found in Ziegler et al. (2007b). The model was used to project mature biomass and CPUE into the future under various TAC scenarios, namely the 2012/13 TAC (38.8t), the 2013/14 TAC (37.2t), the 2014/15 TAC (35.7t) and a comparative TAC of 30t. State-wide and for all regions, only the modelled TAC of 30t achieves a reversal of the decreasing trend in mature biomass over the next 10 years, bringing the 2021 mature biomass back to the current (2013) level (Fig. 5.6).

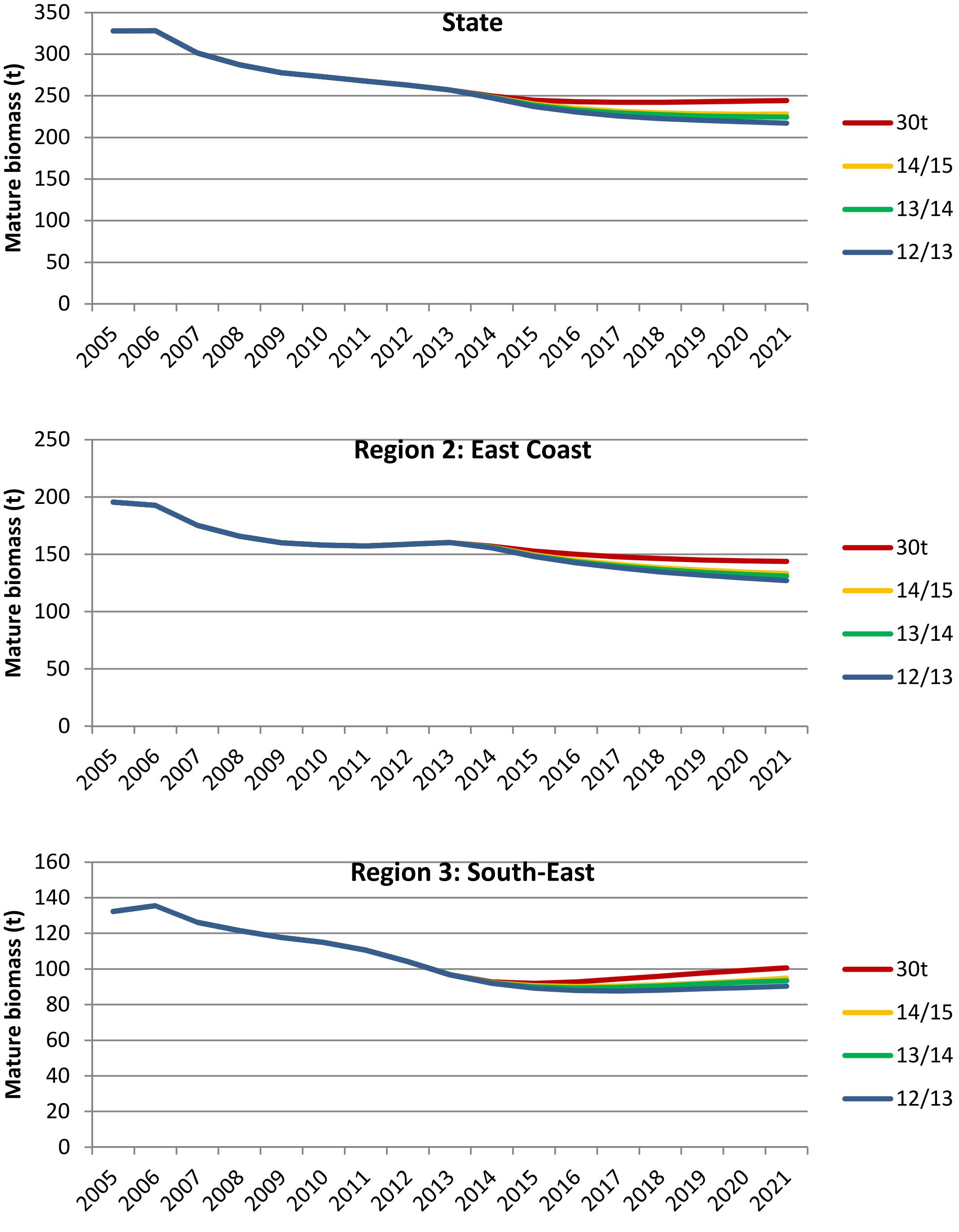


Figure 5.6 Predicted mature biomass from the Banded Morwong model under the 2012/13 (38.8 t), 2013/14 (37.2 t), 2014/15 (35.7 t) TAC settings and a comparative 30 t TAC for the whole State, Region 2 (East) and Region 3 (South-east).

Limit reference points under the various TAC were calculated using the model, namely a 90% probability of the mature biomass catch limit being above 30% of the virgin biomass by 2016 and a 90% probability of the catch per unit effort being above the 10-year low (2000/01) by 2016. Only Region 3 (SEC) had a 90% probability of reaching the mature biomass reference point by 2016 under all TAC's, and a 90% probability of reaching the CPUE reference point by 2016 under the 2014/15 TAC and the 30t TAC. Region 2 and the State as a whole were not predicted to reach the limit reference points regardless of the TAC applied (Table 5.1).

Table 5.1 Probabilities of the mature biomass being above 30% of the virgin biomass (with a 90% probability) by 2016 and the CPUE being above the 10-year low by 2016 under various TAC scenarios.

Region	Limit reference point	TAC 2012/13 (38.8t)	TAC 2013/14 (37.2t)	TAC 2014/15 (35.7t)	TAC 30t
2 - EC	CPUE	89	95	95	100
	Mature biomass	18	18	27	63
3 - SEC	CPUE	68	85	92	99
	Mature biomass	100	100	100	100
Statewide	Mature biomass	94	96	96	99

Reference points

The 2014/15 TAC predictions were used to assess the limit reference points for mature biomass and catch per unit effort.

Performance indicators	Reference points		Breached?	By how much?
Fishing mortality	• Catch region 1 >30% TAC (>10.7 t)		No	
	• Catch region 2 > 65% TAC (>23.2 t)		No	
	• Catch region 3 > 40% TAC (>14.3 t)		No	
	• Outside TAC area > 10t (>3.6 t)		No	
	• Commercial catch <90% TAC (<32.1 t)		No	
Biomass	• Mature biomass catch limit >30% of the virgin biomass with a 90% probability in 2016	2- EC	Yes	
		3- SEC	No	
		State	Yes	
	• Catch per Unit Effort > the 10-year low (2000/01) with a 90% probability in 2016	2- EC	Yes	
		3- SEC	No	
	• Catch rate <0.9 x average from reference period 2000/01 to 2006/07	1- NEC	No	
		2- EC	Yes	25%
		3- SEC	Yes	28%
		State	Yes	32%
Stock stress	• Significant change in the size/age composition		Yes	Change age/size composition, acceleration of growth, earlier maturity (Ziegler et al. 2008), appears to have recently stabilised

	• Change in catches of non-commercial fish relative to 1990/91 to 1997/98 or high incidental/undersize mortality	No	
	• Significant numbers of unhealthy fish landed	No	

Stock status **TRANSITIONAL DEPLETING**

While none of the fishing mortality indicators were exceeded, several of the biomass reference points were breached. Region 2 (EC) appears particularly vulnerable, breaching both the mature biomass and catch-per-unit effort reference points. Even under a 30t TAC (corresponding to 5.7 tonnes less than the current 2014/15 TAC), the mature biomass for Region 2 is not predicted to reach the acceptable limits by 2016.

Overall, the model estimated a decrease in mature biomass between 1990-2009 in Region 2 (EC) from around 436 tonnes to 134 tonnes or 31% of the initial levels, and in region 3 (SEC) from around 218 tonnes to 97 tonnes or 44% of the initial levels. These estimates change from one assessment to the next. In this case, the substantial (and unexpected) decline in catch-rate over the last two years has changed model results substantially, providing a reduction in both the estimate of the initial (1990) stock biomass and the current stock biomass.

The structure of the fished population has changed substantially in both regions. Recent stock rebuilding in the southern stocks was based on strong recruitment pulses in the 2000s coupled with higher productivity through increased growth rates and earlier maturity (Ziegler et al. 2007a). As a result, the fishery in both regions is now largely recruitment-driven with only a small proportion of the catch made up by older females. With continually high harvest rates above the internationally recognised reference points for mature biomass of $H_{40\%}$ or $H_{30\%}$ in recent years, the fishery mainly removes and depends on newly-recruited fish from the populations at a potentially unsustainable rate. While a number of year classes contribute to the fishery, even a relatively short period of low recruitment could lead to substantial declines in catch rates and mature biomass.

The higher dependence on new recruitment in both regions was reflected in the risk assessment. With the current TAC the model predicts that mature biomass and catch rate will continue to decline. With the scheduled TACs for 13/14 and 14/15 the model predicts that catch rate and mature biomass will decrease before stabilising. Model based reference points for the East Coast are met by the 14/15 TAC, however even a reduction to 30t would be insufficient to meet the reference points for the East Coast or Statewide. However, given uncertainty in the assessment and the magnitude of inter-annual fluctuations in CPUE the time-horizon for the current reference points (2016) may be too short and may suggest that given the accepted 2014/15 further TAC reduction, re-assessment of the fishery in 2014 may be sufficient without management imposing an additional TAC reduction at this time in response to these fluctuations.

Due to the biological characteristics of Banded Morwong, stock recovery under all considered TACs is expected to be a slow process. There is considerable uncertainty in the assessment about the basic population dynamics of Banded Morwong, mainly in regards to the potential separation of stocks in fished onshore and unfished offshore populations. In addition, the species' productivity appears to be able to respond strongly and quickly to stock biomass changes.

The Banded Morwong TAC is set as a tonnage but implemented in numbers. Each fisher is allocated a certain number of fish by dividing their allocated catch (in kg) by a predetermined average fish weight. The same average weight is used throughout the state. This is an unusual setup resulting from practical difficulties in weighing fish at place of landing. There are indications of high grading resulting from this system both through catch records and anecdotal reports. The motivation is that by discarding smaller fish, fishers can increase their average fish weight and thereby increase their revenue. Potential problems include:

- Exceeding the TAC – An increase in average weight above the assumed value will result in a catch exceeding the TAC.
- Preferential targeting of areas with large fish – Average catch size can also be boosted by targeting areas with large fish. The current system provides an economic incentive to do so.
- Biological effects of a changed size structure – High grading will change the size structure, the biological effects of this have not been quantified.
- Difficulties in interpreting CPUE data – High grading (by discarding small fish) lowers CPUE.

This issue has however been flagged for amendment in the remake of the Scalefish Management Plan, where it is proposed to move to a fully based weight system.

6. Barracouta

Thyrsites atun

STOCK STATUS	**Not assessed**
Large fishery for Barracouta in the 1960's but little market for the species nowadays.	
IMPORTANCE	Minor
STOCKS	Bass Strait and Eastern Tasmania
JURISDICTION	Tasmania, Victoria (for Bass Strait stock)
FISHERIES IN STATE WATERS	Tasmanian Scalefish Fishery (Tasmania)
INDICATOR(S)	Catch, effort and CPUE trends

Thyrsites atun
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

<table>
<tr><th>Parameters</th><th>Estimates</th><th>Source</th></tr>
<tr><td>Habitat</td><td>• Open water and coastal bays. Down to 550 m depth.</td><td>Edgar (2008)
Kailola et al. (1993)</td></tr>
<tr><td>Distribution</td><td>• From mid-Western Australia to south Queensland, and around Tasmania. Also widely in the southern hemisphere in temperate latitudes.</td><td>Edgar (2008)</td></tr>
<tr><td>Diet</td><td>• Pelagic crustaceans, cephalopods, fishes (e.g. anchovy and Jack Mackerel)</td><td>Nakamura and Parin (1993)</td></tr>
<tr><td>Movement and stock structure</td><td>• 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</td><td>Paul (2000)
Kailola et al. (1993)
Blackburn and Gartner (1954)</td></tr>
<tr><td>Natural mortality</td><td>• $M = 0.3$</td><td>Hurst et al. (2012)</td></tr>
<tr><td>Maximum age</td><td>• At least 10 years, potentially up to 15 years.</td><td>Kailola et al. (1993)
Hurst et al. (2012)</td></tr>
<tr><td>Growth</td><td>• Maximum length: 1.4 m
• Maximum weight: 6 kg
• Growth described by von Bertalanffy growth function
$L = L_\infty\left(1 - e^{-k(t-t_0)}\right)$
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.
Parameters 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>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</td><td>Edgar (2008)
Nakamura and Parin (1993)
Grant et al. (1978)
Blackburn (1960)</td></tr>
</table>

	weight (g) and *L* is the fork length (cm).	
Maturity	• Sexual maturity at about 50-60 cm FL and about 2-3 years of age	Hurst et al. (2012)
Spawning	• October to March in Tasmania	Kailola et al. (1993)
Early life history	• Little data. Eggs are pelagic and juveniles inhabit sheltered waters of southern bays and estuaries.	Kailola et al. (1993) Hurst et al. (2012)

Background

Barracouta used to be the subject of a large commercial trolling fishery in Tasmania in the 1960's and 1970's, with catches ranging from 600 tonnes to 1 600 tonnes (Kailola et al. 1993). The market for Barracouta, however, dropped out in the mid-1970's and there is now little commercial fishing for the species, which fluctuates in availability in State waters.

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

Current assessment

Catch, effort and CPUE

Trolling is the main fishing method used to target Barracouta. Catches peaked in the early 2000's with maximum of 132.1 tonnes but gradually declined from 2004/05 to reach low levels (4 tonnes in 2011/12, Fig. 6.1A). Catches were mainly taken from southern Tasmania in the last 4 years but fishing is now concentrated on a few areas east of King Island, around the Tasman Peninsula and off Devonport (Fig. 6.2).

Barracouta is targeted by the recreational sector. Catches were estimated at 46.9 tonnes in 2000/01 (Lyle 2005) and 10.8 tonnes in 2007/08 (Lyle et al. 2009), the latest estimate being on par with commercial catches for the same period (13.3 tonnes).

After the peak in the early 2000's, effort has declined and stabilised since 2007/08 at a low level (Fig. 6.1B). Catch rates have been relatively stable over time (Fig. 6.1C).

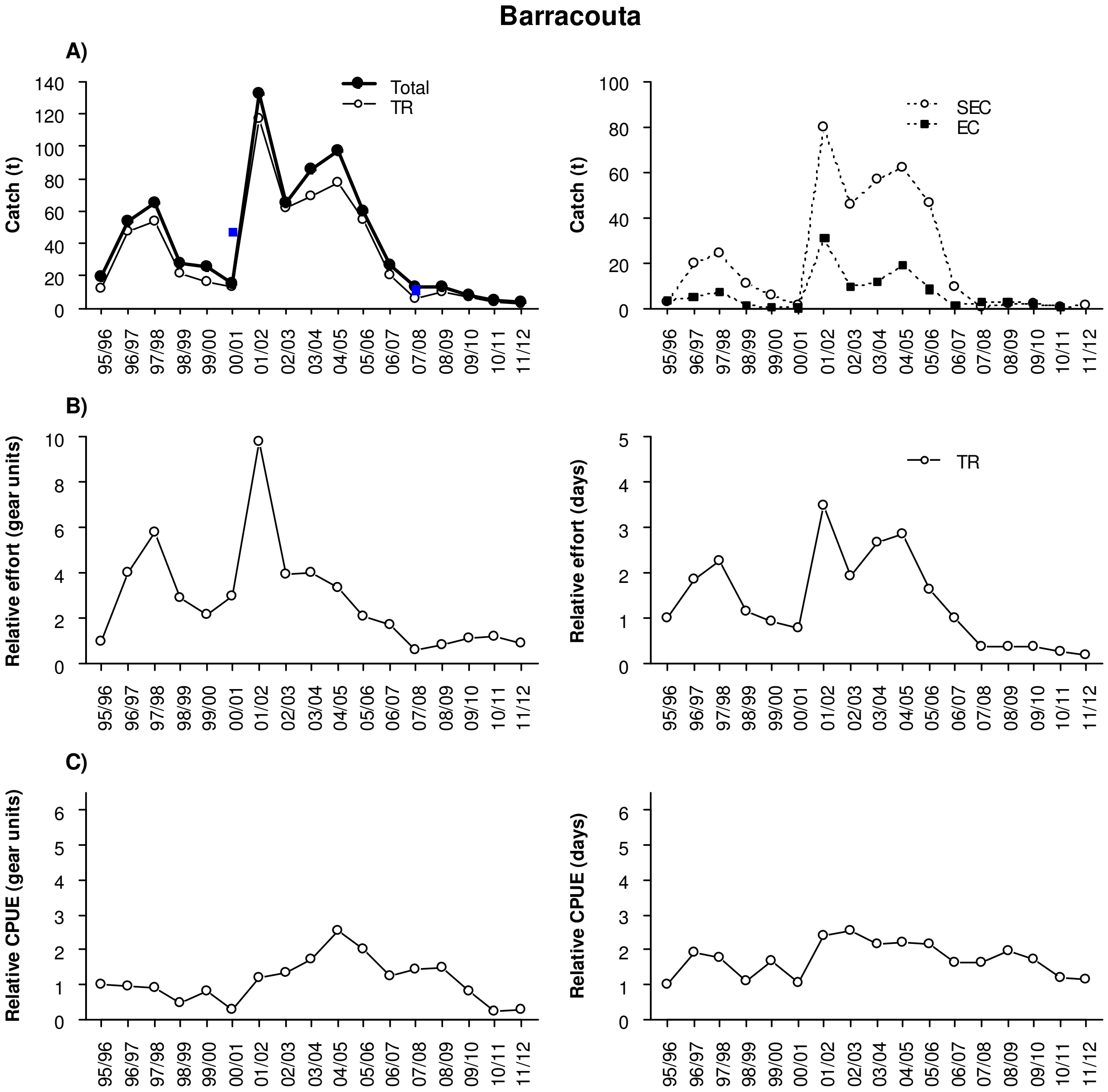
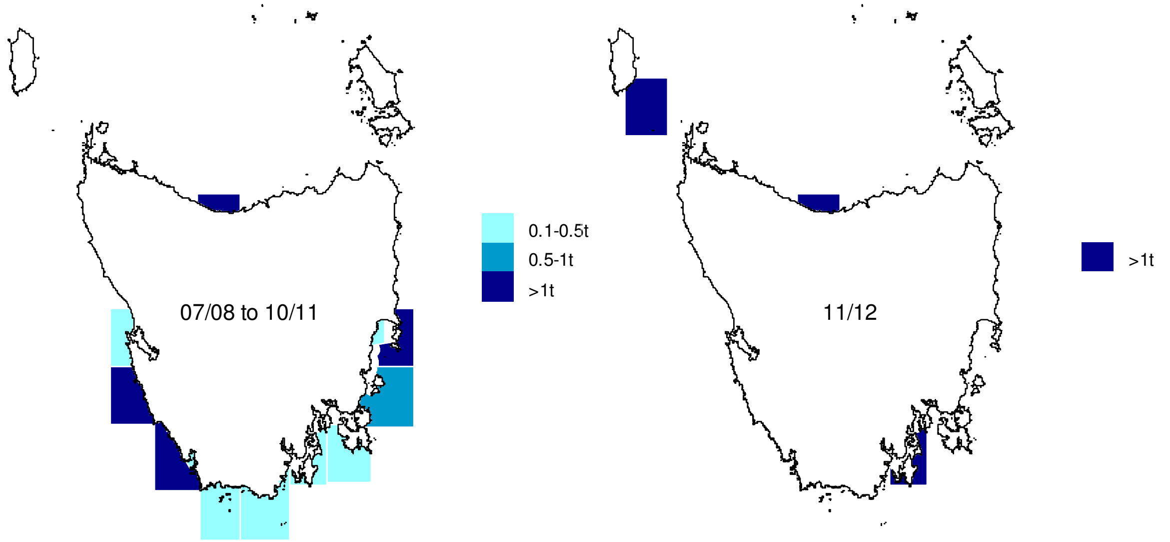


Figure 6.1 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. TR= troll, HL= hand line, SEC= south east coast, EC= east coast.

A) Catch



B) Effort

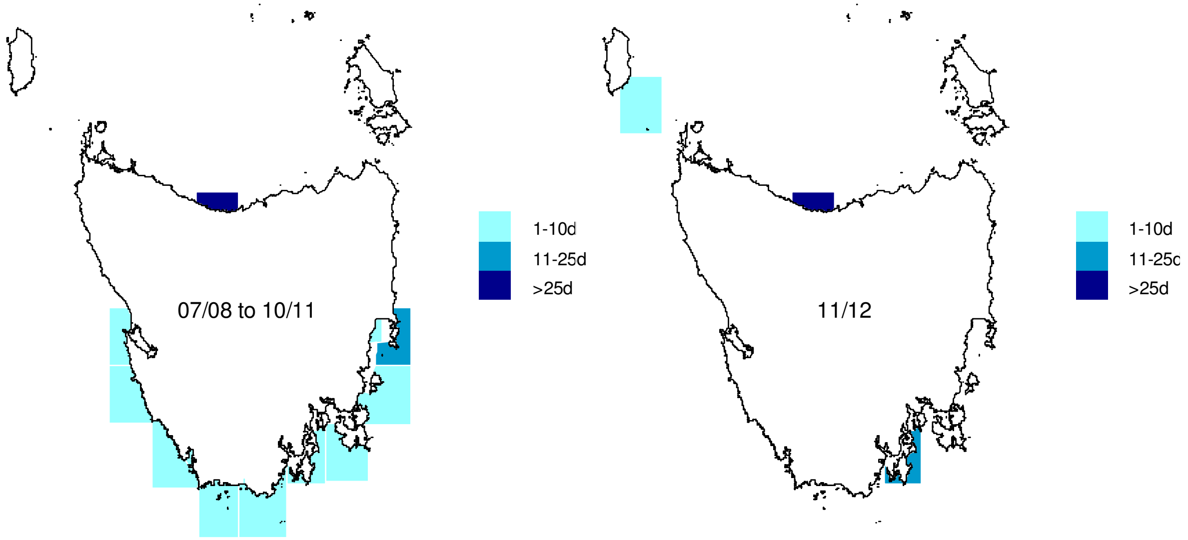


Figure 6.2 (A) Barracouta catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	• Catch > higher catch from the 1990/91 to 1997/98 range (351.5 t)	No	
	• Catch < lowest catch from the 1990/91 to 1997/98 range (19.3 t)	Yes	15.3 t (79.3%)
	• Catch increases by > 30% from previous year (>6.5 t)	No	
	• Catch decreases by > 30% from previous year (<3.5 t)	No	
Effort trend	• Effort >10% of highest level from 1995/96 to 1997/98 (>773 days fished)	No	
Catch rates trends	• Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0145 t/days fished)	No	

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (85.2 t)	No	
	• Catch < 3rd lowest catch value from the reference period (25.1 t)	Yes	21 t (83.9%)
	• 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 (75.6%)	No	
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0087)	No	
Stock stress	• Significant change in the size/age composition of commercial catches	Not assessed	
	• Significant numbers of unhealthy fish landed	No	

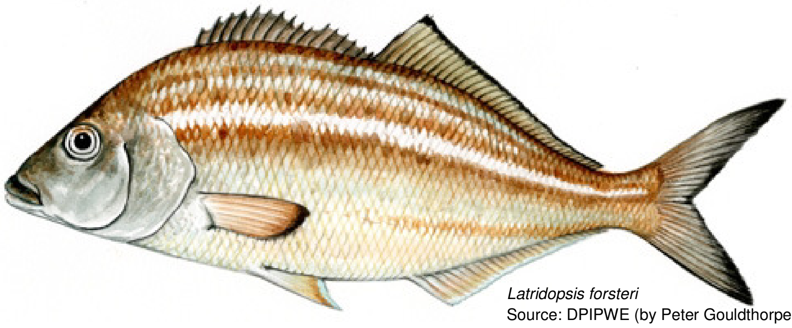
Stock status **NOT ASSESSED**

Historically, Barracouta has undergone large fluctuations in population size and availability, possibly linked to recruit variability and environmental factors. Catches of Barracouta have been declining steadily since the mid-2000's in response to a decrease in effort targeting the species due to the lack of market opportunities and are not considered indicative of stock status.

7. Bastard Trumpeter

Latridopsis forsteri

STOCK STATUS	**NOT ASSESSED**
This species is mainly taken as a by-product rather than a commercial target species, and in recent years the recreational catch exceeds commercial landings.	
IMPORTANCE	Key
STOCK	Tasmanian
JURISDICTION	Tasmania
FISHERIES IN STATE WATERS	Tasmanian Scalefish Fishery (Tasmania)
INDICATOR(S)	Catch, effort and CPUE trends



Latridopsis forsteri
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

<table>
<tr><th>Parameters</th><th>Estimates</th><th>Source</th></tr>
<tr><td>Habitat</td><td>• Exposed reefs and sandy bottom down to 160m depth.</td><td>May & Maxwell (1986)
Edgar (2008)</td></tr>
<tr><td>Distribution</td><td>• Sydney (New South Wales) to southern South Australia, Tasmania, southern New Zealand</td><td>Edgar (2008)</td></tr>
<tr><td>Diet</td><td>• Small fish, invertebrates.</td><td>Edgar (1997)</td></tr>
<tr><td>Movement and stock structure</td><td>• 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.</td><td>Edgar et al. (2004)
Gomon et al.(2008)</td></tr>
<tr><td>Natural mortality</td><td>• Undetermined.</td><td></td></tr>
<tr><td>Maximum age</td><td>• Up to 20 years</td><td>Murphy and Lyle (1999)</td></tr>
<tr><td>Growth</td><td>• Maximum length: 65 cm
• Maximum weight: 4 kg
• Growth described by von Bertalanffy growth function
$L = L_\infty\left(1 - e^{-k(t-t_0)}\right)$
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.
Parameters estimates are :<table><tr><th>Sex</th><th>L_∞</th><th>k</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>Edgar (2008)
Gomon et al.(2008)
Murphy and Lyle (1999)</td></tr>
</table>

Maturity	• Sexual maturity at sizes >45 cm and ages > 4 years.	Murphy and Lyle (1999)
Spawning	• Believed to spawn in late winter	Murphy and Lyle (1999)
Early life history	• Small juveniles settle from the plankton on reefs in large numbers at intervals of several years.	Edgar (2008)
Recruitment	• Variable. No-stock recruitment relationship established.	

Background

Bastard Trumpeter was one of the first fish species to have been commercially exploited in Tasmania. Their apparent abundance around reefs close to the newly established Hobart Town 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.

Bastard Trumpeter are taken today almost exclusively by graball nets. Bastard Trumpeter have also long been recognised as an important fish by recreational fishers. The species resides on inshore reefs till about 4-5 years of age (and approximately 50 cm long), moving offshore into deepwater sites as they approach maturity, apparently remaining in that habitat for the remainder of their lives (Harries and Lake 1985, Murphy and Lyle 1999). Hence, both commercial and recreational fisheries are based almost entirely on juvenile fish.

FISHING METHODS	Graball net
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence) • Recreational gear license (Recreational Graball and/or Mullet net) **Output control:** • Possession limit of 10 individuals for recreational • Trip limit 200 kg for commercial • Minimum size (380 mm TL)
MAIN MARKET	Local

Current assessment

Catch, effort and CPUE

Bastard Trumpeter catches have been declining steadily since the mid-1990's and appear to have stabilised at around 10 t in the last three years (Fig. 7.1A). Bastard Trumpeters are taken almost exclusively by graball net from inshore waters off the east, south and west coasts (Fig. 7.2). Bastard Trumpeter is now predominantly a recreational species. The estimated catch of 27.3 t in 2009/10 by the recreational sector is more than double that of the commercial sector for the same period (10.5 t).

Graball effort has followed a similar downward trend to catches since the mid-1990's (Fig. 7.1B). Daily catch rates have remained relatively stable over time with a slight decrease since 2006/07 (Fig. 7.1C). This lack of obvious trend, despite the sharp decrease in catches, presumably reflects the fact that Bastard Trumpeter are taken primarily as a by-product rather than as a commercial target species.

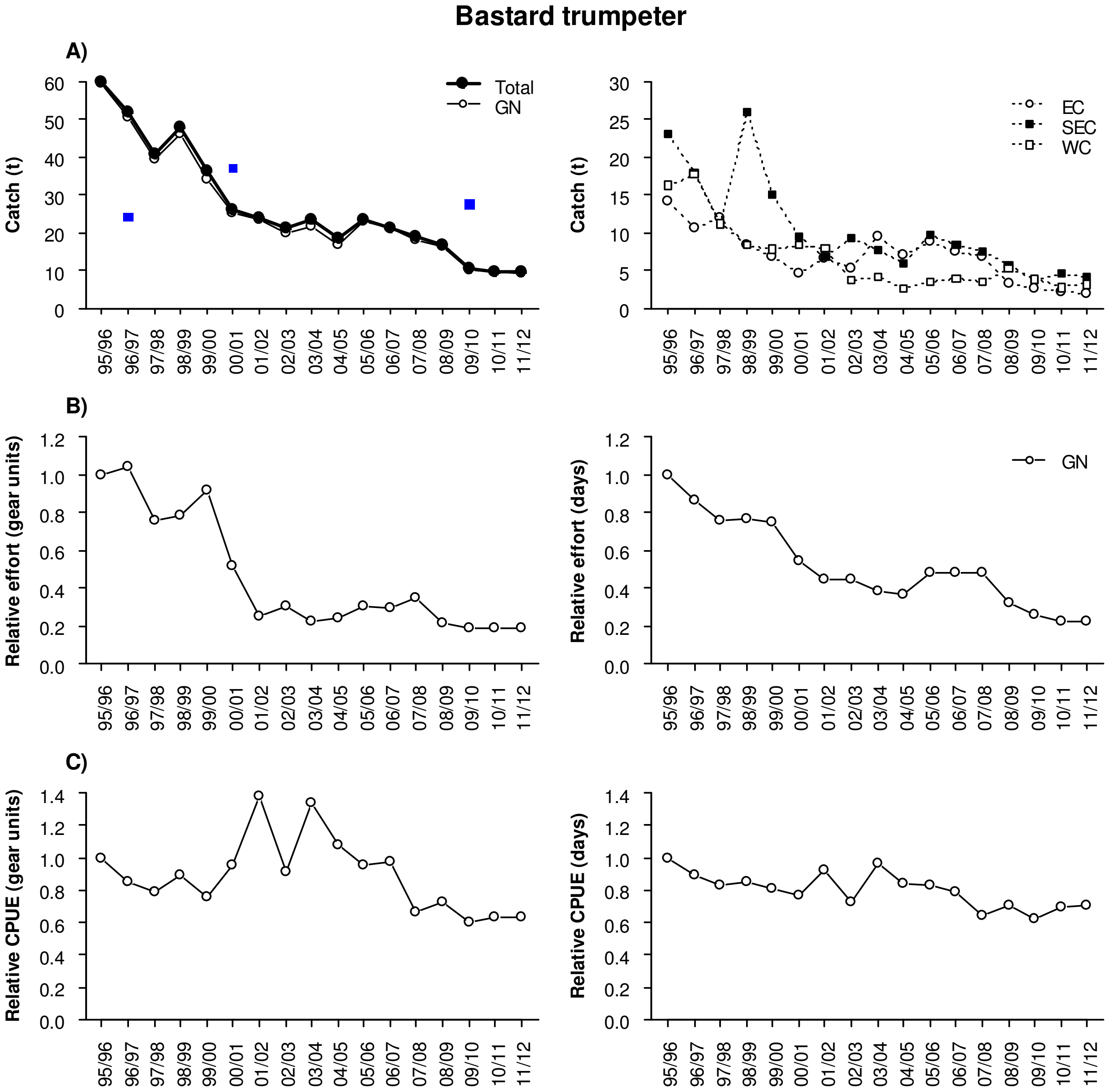


Figure 7.1 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and days fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. GN= graball net, EC= east coast, SEC= south-east coast and WC= west coast.

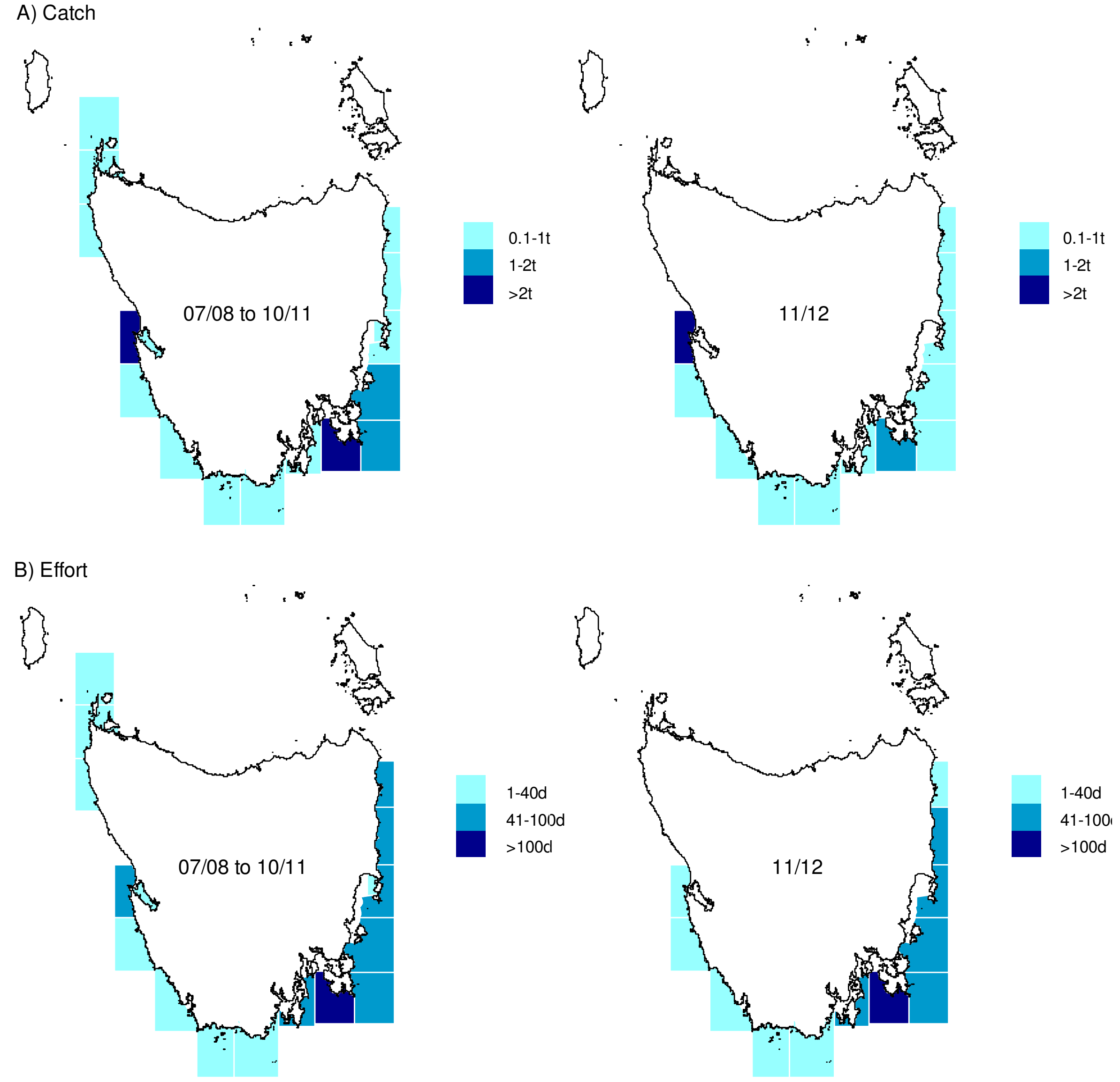


Figure 7.2 (A) Bastard Trumpeter catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	• Catch > higher catch from the 1990/91 to 1997/98 range (63.3 t)	No	
	• Catch < lowest catch from the 1990/91 to 1997/98 range (34 t)	Yes	24.5 t (72.1%)
	• Catch increases by > 30% from previous year (>12.7 t)	No	
	• Catch decreases by > 30% from previous year (<6.9 t)	No	
Effort trend	• Effort >10% of highest level from 1995/96 to 1997/98 (>2717 days fished)	No	
Catch rates trends	• Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0089 t/days fished)	No	

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (47.6 t)	No	
	• Catch < 3rd lowest catch value from the reference period (21.3 t)	Yes	11.8 t (55.4%)
	• 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 (58.6%)	Yes	Latest estimate: 72.2%
Biomass	• CPUE< 3rd lowest CPUE value from the reference period (0.0108 t/days fished)	Yes	0.0013 t/day fished (12%)
	• 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 stress	• Significant change in the size/age composition of commercial catches	Not assessed	
	• Significant numbers of unhealthy fish landed	No	

Stock status

NOT ASSESSED

The lowest catch and CPUE reference points were breached. Because Bastard Trumpeter is a by-product rather than a target species, total catch rather than CPUE may be a better indicator of abundance/availability for the species. As such, the trend in commercial production suggests that current inshore populations are 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, although relatively low market demand for Bastard Trumpeter also appears to be a factor influencing catches.

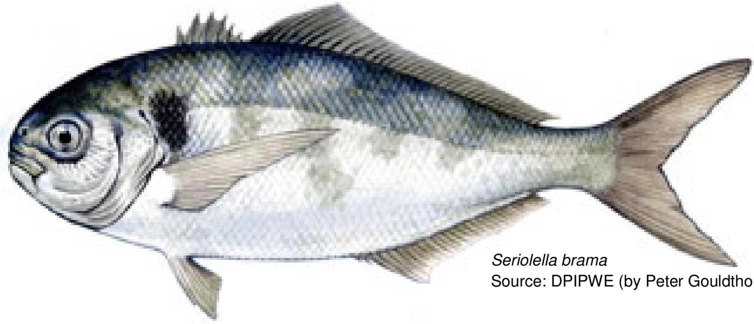
The Tasmanian fishery is based almost entirely on juveniles. As fish grow, they appear to move offshore and are rarely caught. No information is available on the adult section of the population but it is clear that fishing pressure exerted on those individuals that evade the inshore fishery is very low (by-catch in shark nets or deepwater fish traps operated as part of the commonwealth SESSF appears to be negligible). The species exhibits strong recruitment variability that can result in short-term variability 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 level has been low in recent years. Since commercial and recreational fisheries are based on juveniles, recruitment as well as growth overfishing could be occurring.

It is worth noting that the stabilisation of the catch since 2009/10 corresponds to the introduction of several management measures for the species (increase in the minimum legal size, introduction of commercial and recreational catch 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). Increasing the minimum size limit to above the size at maturity would be beneficial to the stock but would also effectively close down the current commercial and recreational fisheries for the species.

8. Blue Warehou

Seriolella brama

STOCK STATUS	**OVERFISHED**
Commonwealth-managed species. Sporadically abundant in Tasmanian waters. Despite a reduction in Total Allowable Catch (TAC) for the Commonwealth fishery, stocks have shown little signs of recovery.	
IMPORTANCE	Key
STOCKS	Eastern Bass Strait and Western Bass Strait
JURISDICTION	Commonwealth
FISHERIES IN STATE WATERS	Tasmanian Scalefish Fishery (Tasmania) 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	• 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. (2001b) Robinson et al. (2008)
Natural mortality	• Estimated between M=0.30 and M=0.45.	Knuckey and Sivakumaran (2001)
Maximum age	• Up to 15 years	AFMA (2012)
Growth	• Maximum length: 90 cm • Maximum weight: 4 kg • Growth (in New Zealand) described by von Bertalanffy	Gomon et al.(2008) Frimodt (1995) BWAG (1998)

<table>
<tr><td></td><td>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.
Parameters 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></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 north-west coasts in Tasmania</td><td>Bruce et al. (2001b)</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 south-eastern Tasmania nursery areas.
• Larvae settle to the bottom at length > 14.5 mm BL</td><td>Bruce et al. (2001b)
Neira et al. (1998)</td></tr>
<tr><td>Recruitment</td><td>• Variable. No-stock recruitment relationship established.</td><td></td></tr>
</table>

Background

Blue warehou occur seasonally in Tasmanian inshore waters, the region representing the southern-most extent of the species' distribution. The availability of Blue Warehou in coastal waters is assumed to be influenced by prevailing oceanographic conditions and availability of prey species, in particular salps. These factors produce marked inter-annual variability in abundance and hence catches taken from State waters.

Blue Warehou is a Commonwealth managed species and a Memorandum of Understanding (MoU) exists to cover catches from Tasmanian State Fishing Waters. Within the context of this MoU, State catches of Blue Warehou are to be managed within historical levels.

FISHING METHODS	Mainly graball net, also small mesh nets and seine net
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence) • Recreational gear license (Recreational Graball and/or Mullet net) **Output control:** • Possession limit of 20 individuals for recreational fishers • Minimum size (250 mm TL)
MAIN MARKET	Local and interstate

Current assessment

Catch, effort and CPUE

The species is taken primarily in graball nets (Fig. 8.1A), with a range of other capture methods used including other gillnet categories (e.g. small mesh, and shark net for Commonwealth fisheries) and seine nets. Due to low availability since the early 2000's, the species has been rarely targeted. The current catch of 3.8 tonnes represents a 64.5% decrease from the previous year and is the lowest commercial catch since the 1970's. Two stocks of Blue Warehou occur in southern Australian waters, the east and the west Bass Strait stocks (Bruce et al. 2001b). The Tasmanian fishery is mainly centred off the south-east coast and thus probably targets the eastern stock (Fig. 8.2). Catches are also taken off the north-east coast, probably involving the western stock.

Blue Warehou are also targeted by recreational fishers using gillnets, and to a lesser extent line fishing. Recreational catches are generally lower for the species (Fig. 8.1A), although the latest recreational estimates from 2009/10 shows similar catches for both sectors (32.5t for recreational and 37.5t for commercial).

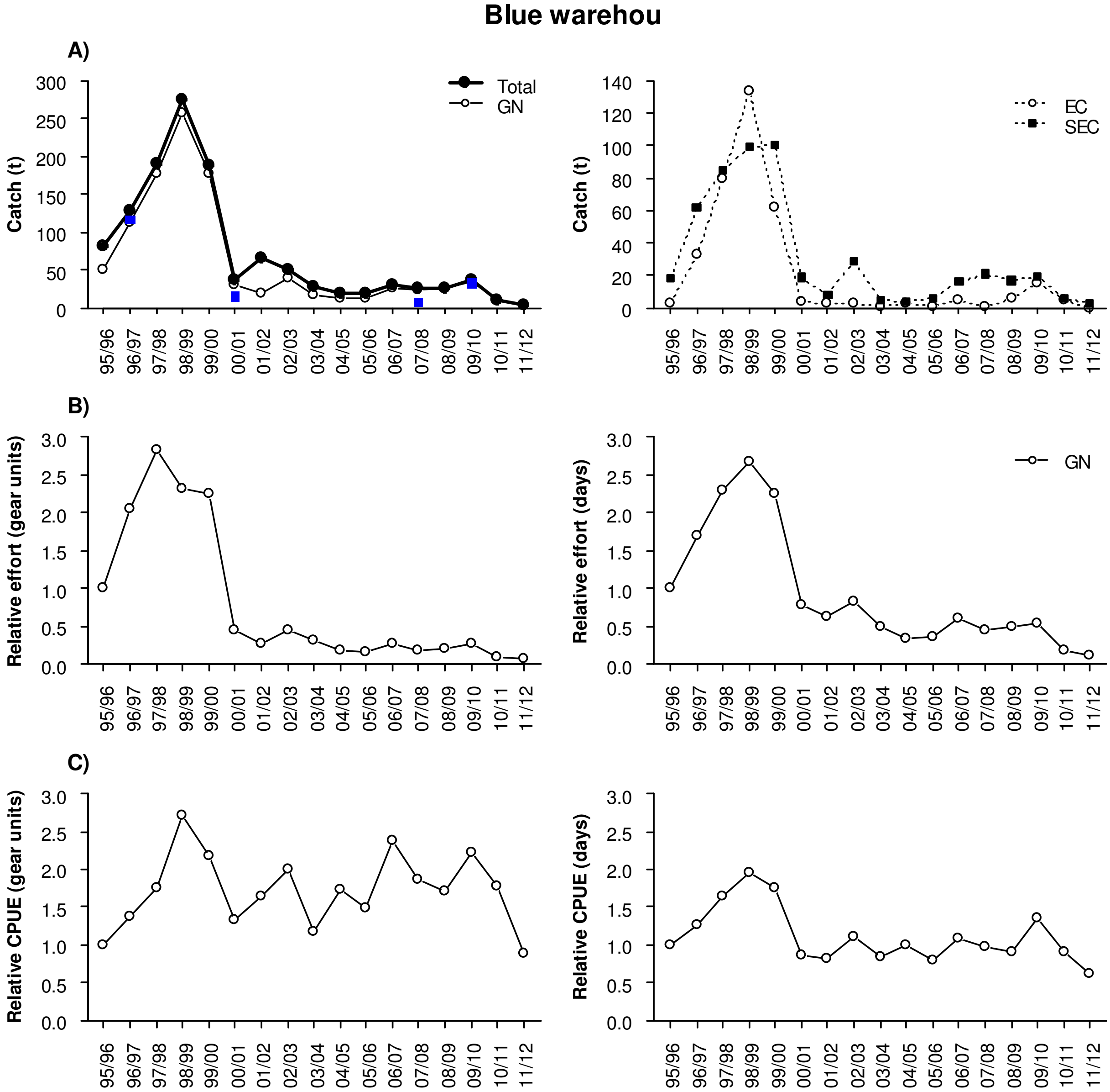
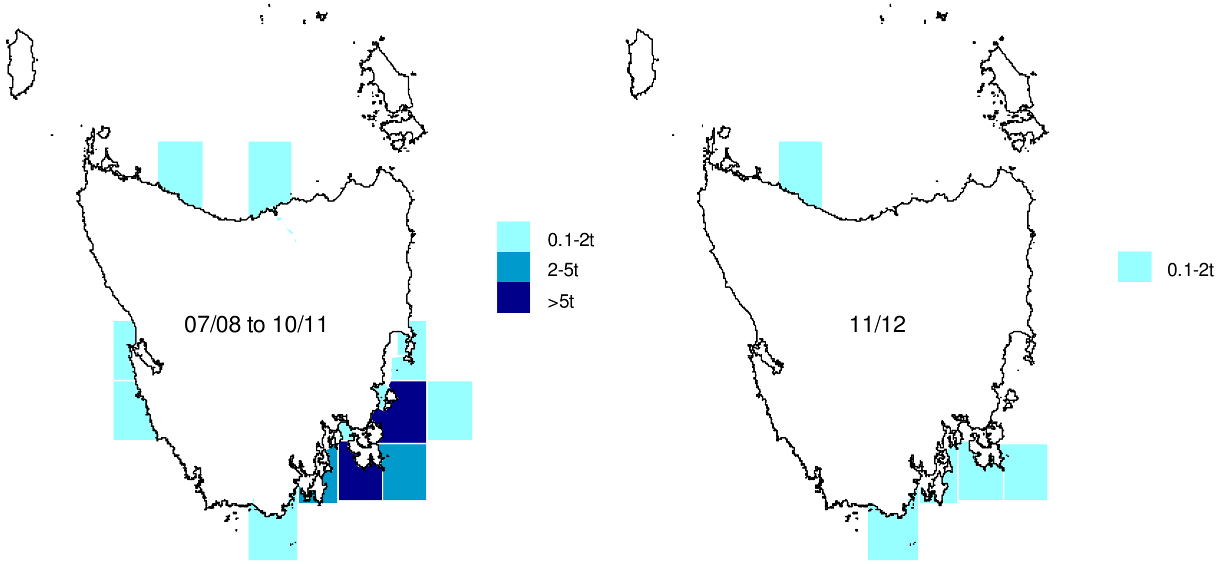


Figure 8.1 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. GN= graball net, SEC= south east coast, EC= east coast.

Following an increase in commercial graball effort between 1995/96 and 1998/99 that resulted in increased catches, effort has fallen to a substantially lower level (Fig. 8.1B). Current effort is at its lowest since 1995/96, which is largely in response to the reduced availability of Blue Warehou in Tasmanian waters.

Graball catch rates increased markedly in the latter part of the 1990's reflecting increased availability and targeting of Blue Warehou around Tasmania at the time (Fig. 8.1C). Catch rates have since then declined, fluctuating around similar levels to those of the mid-1990's. Catch rates for the present assessment year 2011/12 is at their lowest level.

A) Catch



B) Effort

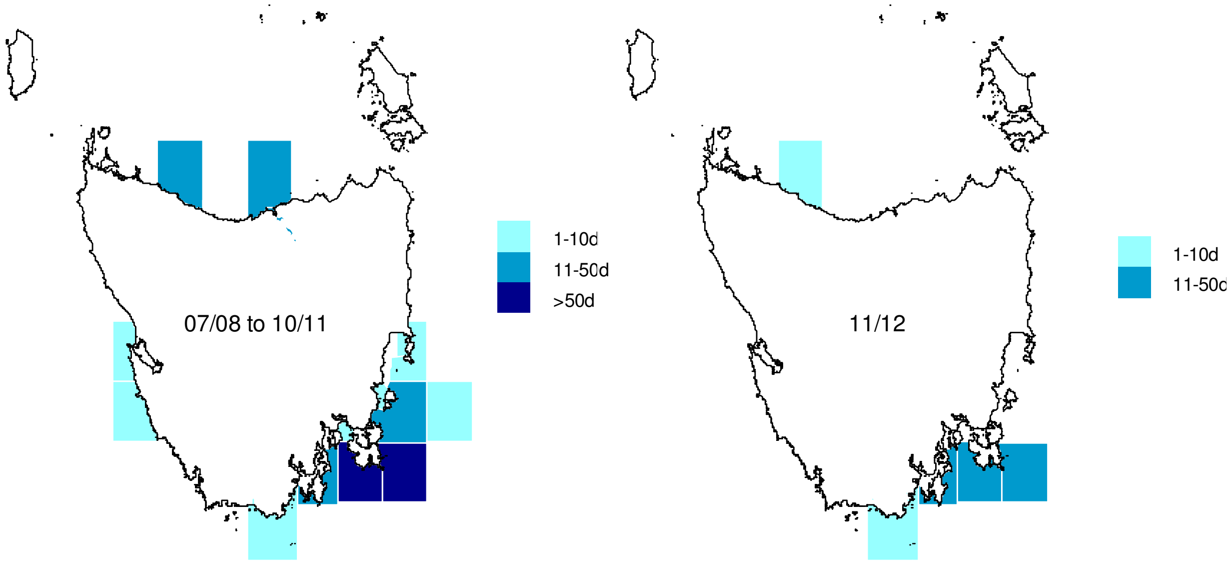


Figure 8.2 (A) Blue Warehou catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	- Catch > higher catch from the 1990/91 to 1997/98 range (317.6 t)	No	
	- Catch < lowest catch from the 1990/91 to 1997/98 range (82.3 t)	Yes	78.4 t (95.3%)
	- Catch increases by > 30% from previous year (>14 t)	No	
	- Catch decreases by > 30% from previous year (<7.5 t)	Yes	3.5 t (49.2%)
Effort trend	- Effort >10% of highest level from 1995/96 to 1997/98 (2387 days fished)	No	
Catch rates trends	- Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (0.0183 t/days fished)	Yes	0.0027 t/days fished (14.8%)

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	- Commercial catch limit of 318 tonnes as per Memorandum of Understanding (MoU)	No	
	- Catch > 3rd highest catch value from the reference period (187.6 t)	No	
	- Catch < 3rd lowest catch value from the reference period (27.5 t)	Yes	23.7 t (86.1%)
	- Catch variation from the previous year above the greatest inter-annual increase from the reference period (84.8 t)	No	
	- Catch variation from the previous year above the greatest inter-annual decrease from the reference period (151.6 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 (21.7%)	Yes	Latest estimate: 46.4%
Biomass	- CPUE< 3rd lowest CPUE value from the reference period (0.0229 t/days fished)	Yes	0.0073 t/days fished (31.9%)
	- Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0113)	No	
Stock stress	- Significant change in the size/age composition of commercial catches	Not assessed	
	- Significant numbers of unhealthy fish landed	No	

Stock status

OVERFISHED

The availability of Blue Warehou in Tasmanian inshore waters is influenced by a range of environmental factors as well as stock size. As such, the references points of catch and CPUE may not be a good indicator of abundance/availability for the species.

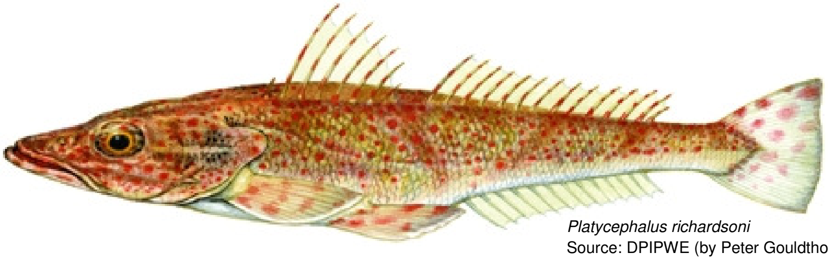
However, recent depressed catches are almost certainly linked to a reduced biomass, the result of overfishing by Commonwealth and State fisheries during the 1990's. The Commonwealth Total Allowable Catch (TAC) for Blue Warehou has been progressively decreased since 2003, and was further reduced to 133 tonnes for 2011/12 since both the western and eastern stocks were considered to be overfished and unlikely to recover under the current management arrangements (AFMA 2012). While operators actively avoid catching Blue Warehou, there have been few signs of recovery for the species so far and the Fishery Status Reports 2010 classified the status of Blue Warehou stocks as overfished (for biomass) and uncertain (for fishing mortality) (Woodhams et al. 2012). In accordance with the Commonwealth assessment, Blue Warehou is assessed as overfished in Tasmanian waters.

9. Flathead

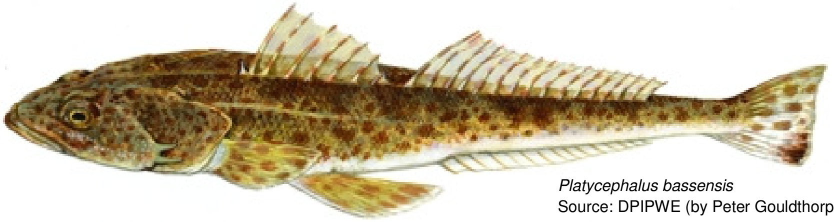
Tiger Flathead *Platycephalus richardsoni*

Southern Sand Flathead *Platycephalus bassensis*

STOCK STATUS	**SUSTAINABLE (Tiger Flathead)** **NOT ASSESSED (Southern Sand Flathead)**
Both Flathead species are caught by commercial and recreational fishers, however, the Tiger Flathead is the dominant species in the commercial catch while Sand Flathead dominates the recreational catch.	
IMPORTANCE	Key
STOCK	Southern Australia
JURISDICTION	Commonwealth
FISHERIES IN STATE WATERS	Tasmanian Scalefish Fishery (Tasmania) Southern and Eastern Scalefish and Shark Fishery (Commonwealth)
INDICATOR(S)	Catch, effort and CPUE trends



Platycephalus richardsoni
Source: DPIPWE (by Peter Gouldthorpe)



Platycephalus bassensis
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	Tiger: Exposed sand and silt habitat. 10-400 m depth Sand: Sheltered sand and silt habitat. Down to 100m depth.	Edgar (2008) Tilzey et al. (1990)
Distribution	Tiger: Victoria to New South Wales and around Tasmania. Sand: From Western Australia to New South Wales and around Tasmania.	Edgar (2008) Gomon et al.(2008)
Diet	Tiger: Fish Sand: Fish and crustaceans	Coleman and Mobley (1984) Ayling et al. (1975)
Movement and stock structure	Tiger: Young inhabit shallow waters of the continental shelf and move into the outer shelf zone as they reach maturity Sand: Seasonal movements between inshore and offshore in east and south-east Tasmania	Kailola et al. (1993) Jordan 1998
Natural mortality	Tiger*: M* between 0.21 and 0.46 Sand*: M* between 0.28 and 0.59 (per year)	Klaer (2010) Bani (2005)
Maximum age	Tiger: 12 years Sand: 20 years	Rowling (1994) Bani (2005)
Growth	Tiger:	Edgar (2008)

<table>
<tr>
<td></td>
<td>• Maximum length: 650 mm (FL)
• Maximum weight: 2.9 kg
• Growth (in NSW) described by von Bertalanffy growth function $L = L_\infty\left(1 - e^{-k(t-t_0)}\right)$
where L is the 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.
Parameters estimates are:
<table>
<tr><th>Sex</th><th>L_∞</th><th>k</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 W is weight (g) and L is the total length (mm).

Sand:
• 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. Growth appears very variable according to location and year.
Parameters estimates (for Coles Bay) are:
<table>
<tr><th>ex</th><th>L_∞</th><th>k</th><th>$t_{0\infty}$</th><th>Year</th></tr>
<tr><td>Females</td><td>39.01</td><td>0.25</td><td>-1.57</td><td>001/02</td></tr>
<tr><td></td><td>45.35</td><td>0.15</td><td>-2. 3</td><td>2002/03</td></tr>
<tr><td>Males</td><td>37.43</td><td>0.21</td><td>-1.76</td><td>2001/02</td></tr>
<tr><td></td><td>34.40</td><td>0.39</td><td>- .51</td><td>2002/03</td></tr>
</table>
</td>
<td>Gomon et al.(2008)

Barnes et al. (2011)

Bani (2005)
Gomon et al.(2008)</td>
</tr>
<tr>
<td>Maturity</td>
<td>Tiger:
• Reach sexual maturity at 4-5 years and total length of 30 cm for males and 36 cm for females.
Sand
• 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>Fairbridge (1951)

Bani and Moltschaniwsky (2008)</td>
</tr>
<tr>
<td>Spawning</td>
<td>• Tiger: December to February
• Sand: From October to March, with a peak from October-December. Spawning occur throughout their range in southern and eastern Tasmania, including on the shelf.</td>
<td>Kailola et al. (1993)
Jordan (2001b)</td>
</tr>
<tr>
<td>Early life history</td>
<td>Tiger: unknown
Sand:
• Settlement occurs over an extended period, between 4 to 14 months after spawning
• Size at settlement at around 2.1 cm.</td>
<td>Jordan (2001b)</td>
</tr>
<tr>
<td>Recruitment</td>
<td>• No-stock recruitment relationship established for any species</td>
<td></td>
</tr>
</table>

Background

Several species of Flathead occur in Tasmanian waters, but the commercial catches are dominated by Tiger Flathead taken by Danish seine. Sand Flathead are caught to a lesser extent by handline and as a by-product in graball nets. However, the two species were not routinely distinguished in catch returns until 2007 and as a consequence catches by species have been inferred based on gear fishing method.

Sand Flathead is an important recreational species, which is targeted by handline. Tiger Flathead only constitute a minor component of the recreational harvest (around 10%).

FISHING METHODS	Danish seine (Tiger Flathead), hand line and graball net (Sand Flathead)
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence, class Danish seine) • Recreational gear licence (Recreational Graball and/or Mullet net) **Output control:** • Possession limit of 30 individuals (all Flathead species combined) for recreational • Minimum size (300 mm TL)
MAIN MARKET	Mostly local

Current assessment

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 each species prior to 2007 based on the average proportion of species by gear type from 2007/08 to 2011/12 (Fig. 9.1). Tiger Flathead catches declined steadily between 2000/01 and 2003/04 but more than doubled in 2005/06 (Fig. 9.1A and 9.2A). Since then catches have fluctuated between 40t and 70t per annum, and are currently at 51.5t. Sand Flathead catches remained relatively stable between 10 and 15 t per annum until 2008/09 but have subsequently declined slightly to reach 7.6t in 2011/12 (Fig. 9.1B).

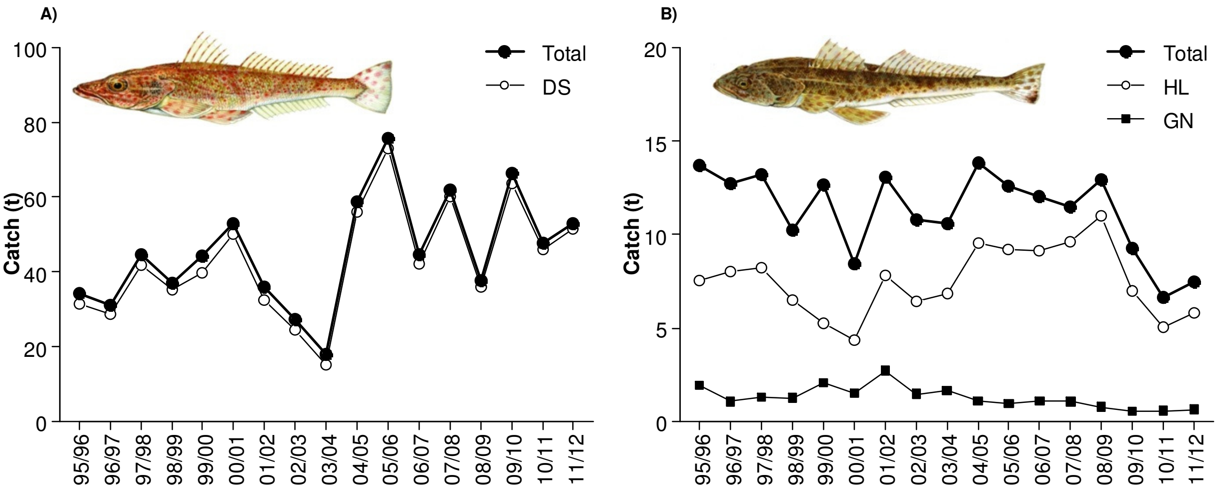


Figure 9.1 Back-calculated annual commercial catch (tonnes) by gear for A) Tiger Flathead and B) Sand Flathead.

Catches in 2011/12 were derived mainly from the south-east and east coasts, with smaller quantities also taken from the north-east (Flinders Island) and north-west coasts (Fig. 9.2A and 9.3). Catch and effort for the latter two regions have declined compared to the previous 4 year period (Fig. 9.3).

Recreational Flathead catches were estimated at 361 tonnes in 2000/01 (Lyle 2005) and 292 tonnes in 2007/08 (Lyle et al. 2009), with Sand Flathead by far the dominant species taken (>90% in numbers) (Fig. 9.2A).

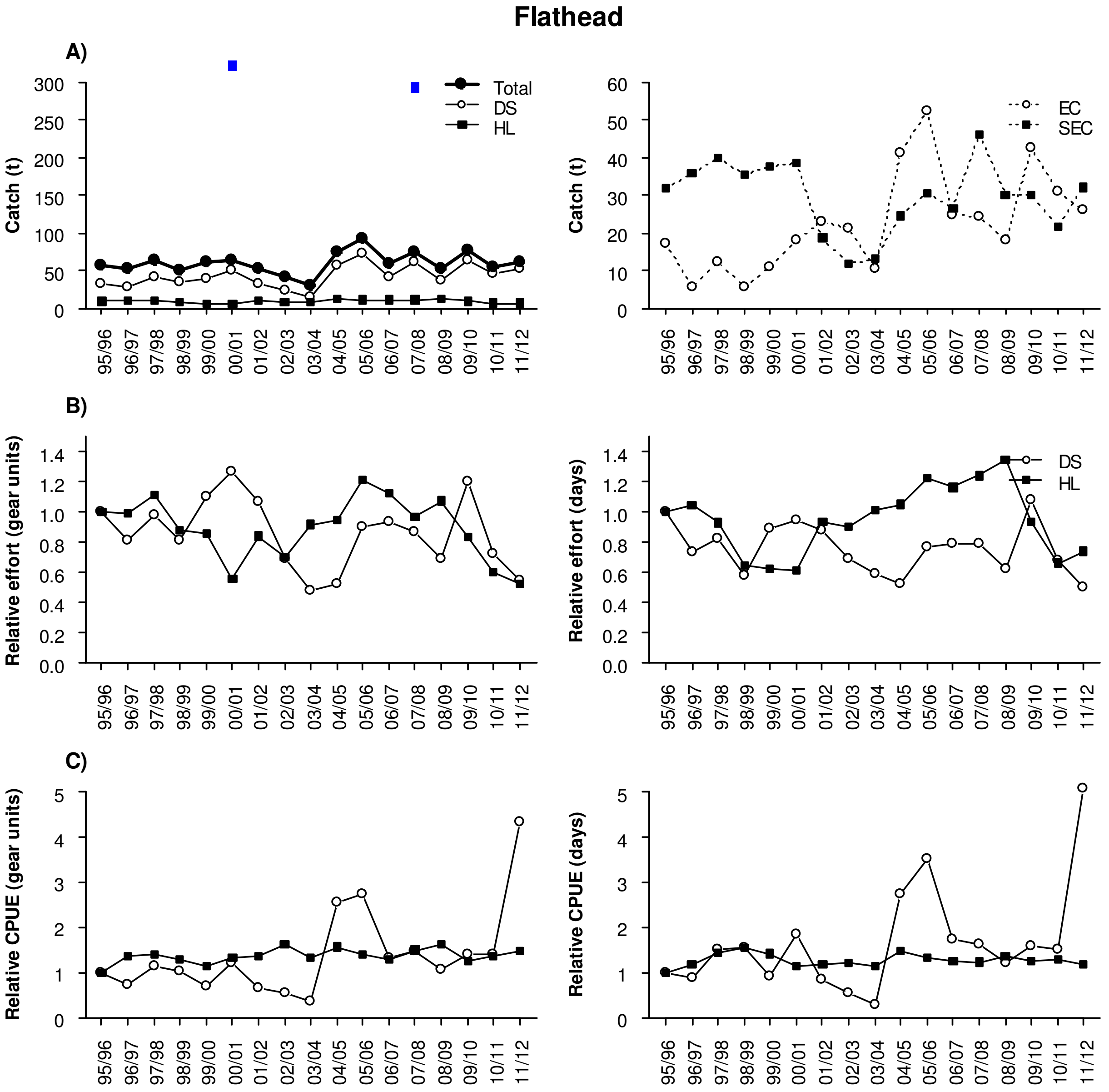
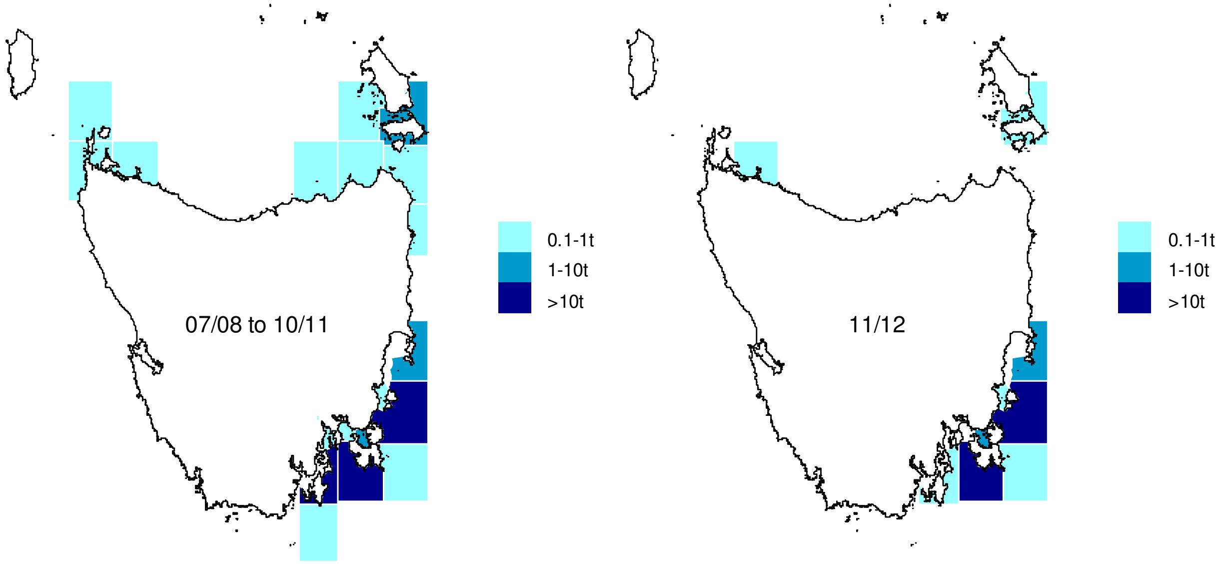


Figure 9.2 A) Combined annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Combined commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Combined commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. DS= Danish seine, HL= hand line, SEC= south east coast, EC= east coast.

Effort for both gear types has fluctuated without obvious trend and overall has remained relatively stable since the mid-1990's (Fig. 9.2B). There was a gradual increase in days fished with Danish seine before a sharp decline in 2008/09. Danish seine catch rates have fluctuated strongly in recent years, presumably reflecting the level of targeting for the species (Fig. 9.2C). Few vessels participate in this fishery, with only three active vessels in 2011/12. The high Danish seine CPUE for the current assessment year was influenced by one operator who was exclusively targeting Tiger Flathead.

A) Catch



B) Effort

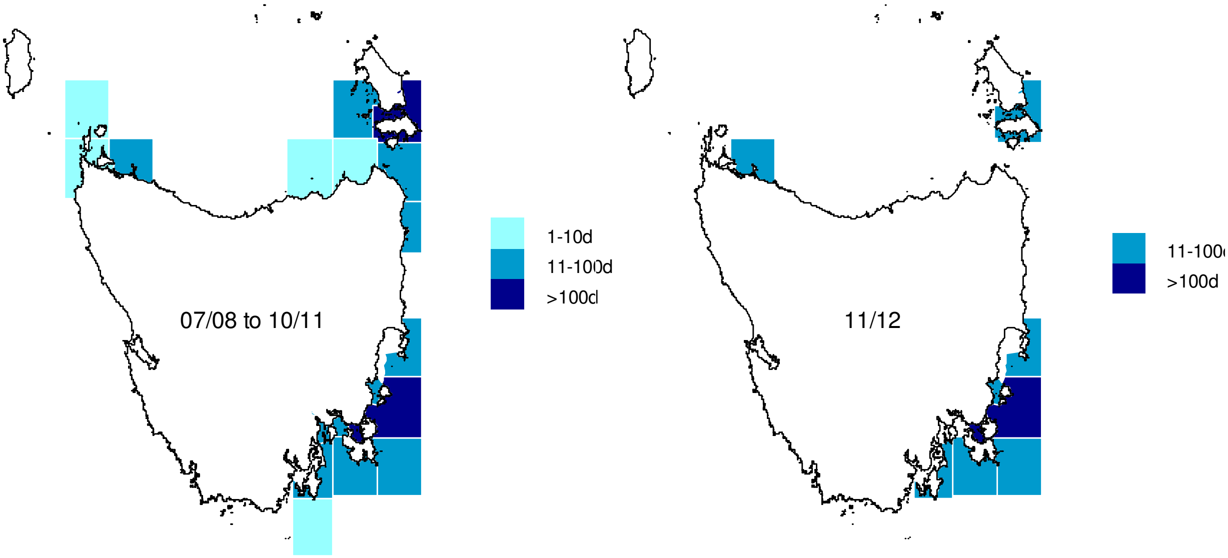


Figure 9.3 (A) Combined Flathead catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	- Catch > higher catch from the 1990/91 to 1997/98 range (165.3 t)	No	
	- Catch < lowest catch from the 1990/91 to 1997/98 range (51.8 t)	No	
	- Catch increases by > 30% from previous year (> 72.4 t)	No	
	- Catch decreases by > 30% from previous year (<39 t)	No	
Effort trend	- Effort >10% of highest level from 1995/96 to 1997/98 (>1341 days fished)	No	
Catch rates trends	- Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0103 t/days fished)	No	

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	- Catch > 3rd highest catch value from the reference period (63.4 t)	No	
	- Catch < 3rd lowest catch value from the reference period (50.6 t)	No	
	- Catch variation from the previous year above the greatest inter-annual increase from the reference period (31.9 t)	No	
	- Catch variation from the previous year above the greatest inter-annual decrease from the reference period (43.5 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 (85.1%)	No	
Biomass	- CPUE< 3rd lowest CPUE value from the reference period (0.01288 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 stress	- Significant change in the size/age composition of commercial catches	Not assessed	
	- Significant numbers of unhealthy fish landed	No	

Stock status

Tiger Flathead	🟩 **SUSTAINABLE**
Sand Flathead	**NOT ASSESSED**

Danish seine catches are highly variable and tend to be inversely related with catches of Whiting (refer Fig. 2.1), which is also a target species for Danish seine. None of the reference points were breached. While commercial catches of Tiger Flathead have been maintained at higher levels in the past, there are additional and significant trawl catches of Flathead (almost exclusively Tiger Flathead) taken from Commonwealth waters as part of the South East Fishery. Tasmanian catches only constitute a fraction of the overall catches from this stock (extending from New South Wales to Victoria), which has been classified as not overfished (Flood et al. 2012, Woodhams et al. 2012). In accordance with the Commonwealth assessment, Tiger Flathead is assessed as sustainable in Tasmanian waters.

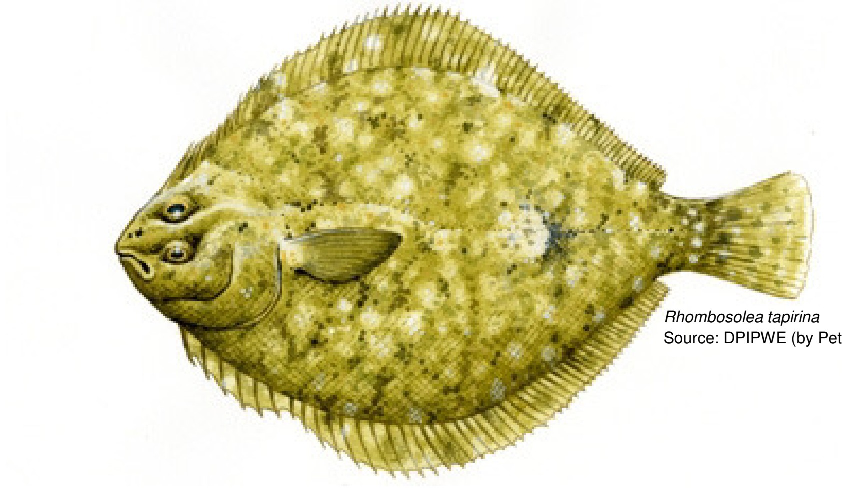
The Sand Flathead stock status is not known, though undersized fish appear to be highly abundant and the size limit is set above the size at maturity. The main impact on Sand Flathead stocks is from the recreational sector with catches over 20 times greater than the commercial sector. Future assessments will focus on assessing the southern Sand Flathead stock status.

Increased interest from commercial operators is likely, as evidenced in the Danish seine catches since 2004, with rising market prices and reduced access to and availability of other scalefish species. Future catch trends should be monitored closely along with those taken by the recreational sector. Given the possibility that Danish seine effort may increase it would be prudent to consider spatial management options that avoids the regional concentration of effort and operators.

10. Flounder

Pleuronectidae family

STOCK STATUS	**NOT ASSESSED**
Greenback Flounder (*Rhombosolea tapirina*) constitute the majority of the commercial catches.	
IMPORTANCE	Minor
STOCK	Tasmanian
JURISDICTION	Tasmania
FISHERIES IN STATE WATERS	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends



Rhombosolea tapirina
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

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

	Males 52.21 0.24 -1.32 • 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).	
Maturity	• Sexual maturity at about 218.6 mm TL for females and 190 mm TL for males.	Crawford (1984)
Spawning	• 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	Crawford (1984)
Early life history	• 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.	Edgar (2008) Crawford (1984, 1986) Jenkins (1986)
Recruitment	• No-stock recruitment relationship established.	

Background

While the various Flounder species are not always differentiated in the logbooks, Greenback Flounder constitute the vast majority of the commercial catch. Long-snouted Flounder (*Ammotretis rostratus*) are also taken in small quantities relative to Greenback Flounder. Flounder are specifically targeted using spears and gillnets as the main fishing methods. However, the recreational ban in 2010 of night setting for gillnets has essentially dissipated the gillnet fishing for Flounder—except in Macquarie Harbour.

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

Current assessment

Catch, effort and CPUE

Catch of Flounder has been steadily declining since the mid-1990's to reach 4 tonnes in 2011/12 (Fig. 10.1A). Since the night gillnetting ban, Flounders are caught almost exclusively using spear. There has been a general reduction in the fished area for the species in the current year compared with the previous four years (Fig. 10.2). The totality of the catch now originates from a few areas, namely Macquarie Harbour on the west coast (where night netting is still permitted), Great Oyster Bay on the east coast, and Frederick Henry Bay and Pitt Water on the south-east coast (Fig. 10.2).

Flounder is an important recreational species, and catches for the recreational sector are on par with those of the commercial sector (Fig. 10.1A). Recreational catches were estimated at 15.2 tonnes in 2000/01 (Lyle 2005) and 10.1 tonnes in 2007/08 (Lyle et al. 2009).

Following the trend in catches, effort for both methods has been steadily declining since the mid-1990's, with graball effort currently at minimal levels.

Catch rates by gear unit for both gear types have remained relatively steady over time while gillnet catch rates based on catch per day has been slowly declining (Fig. 10.1C).

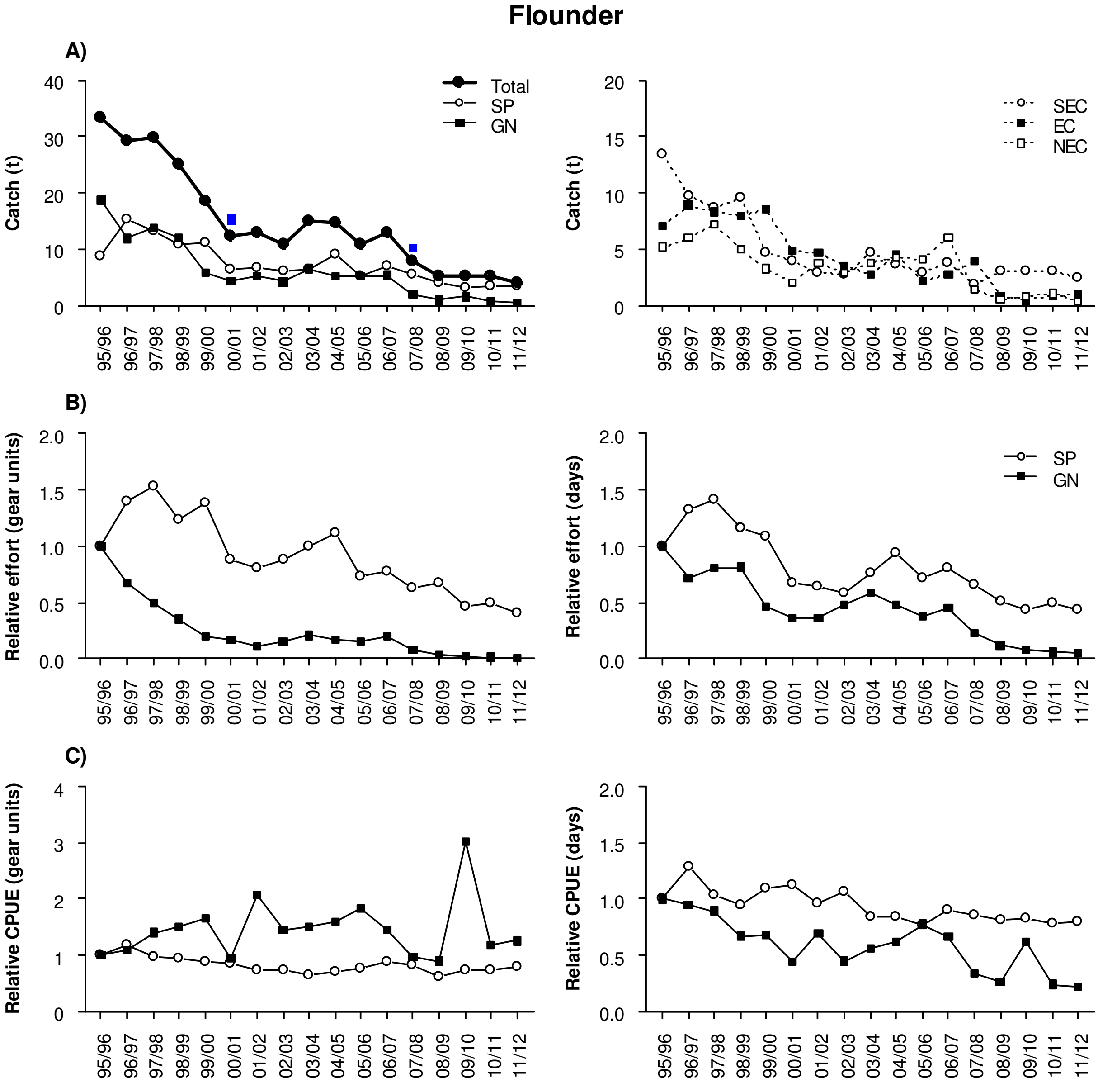
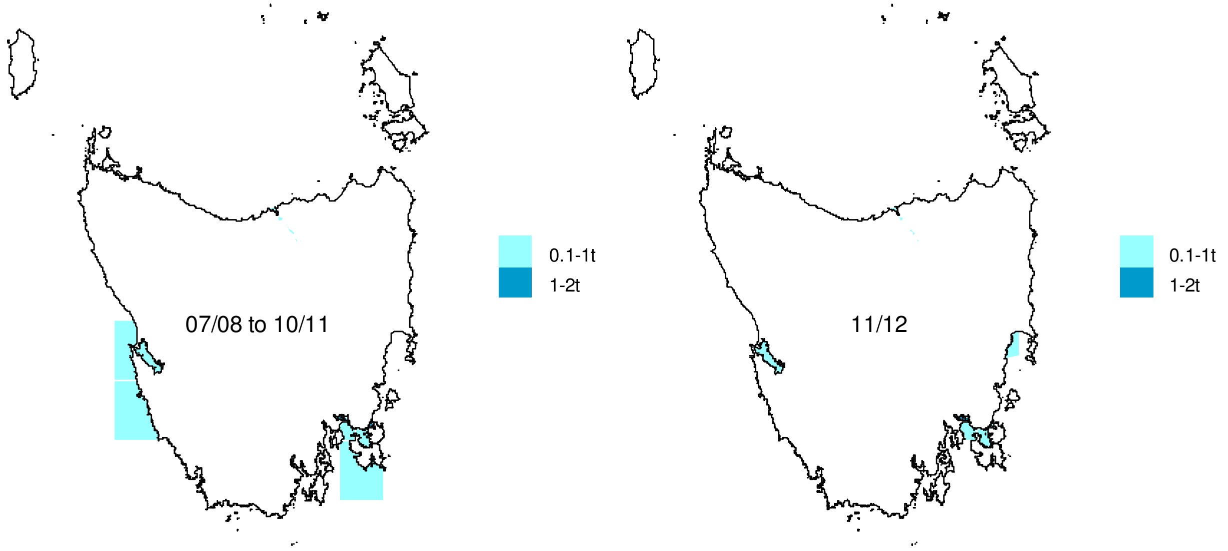
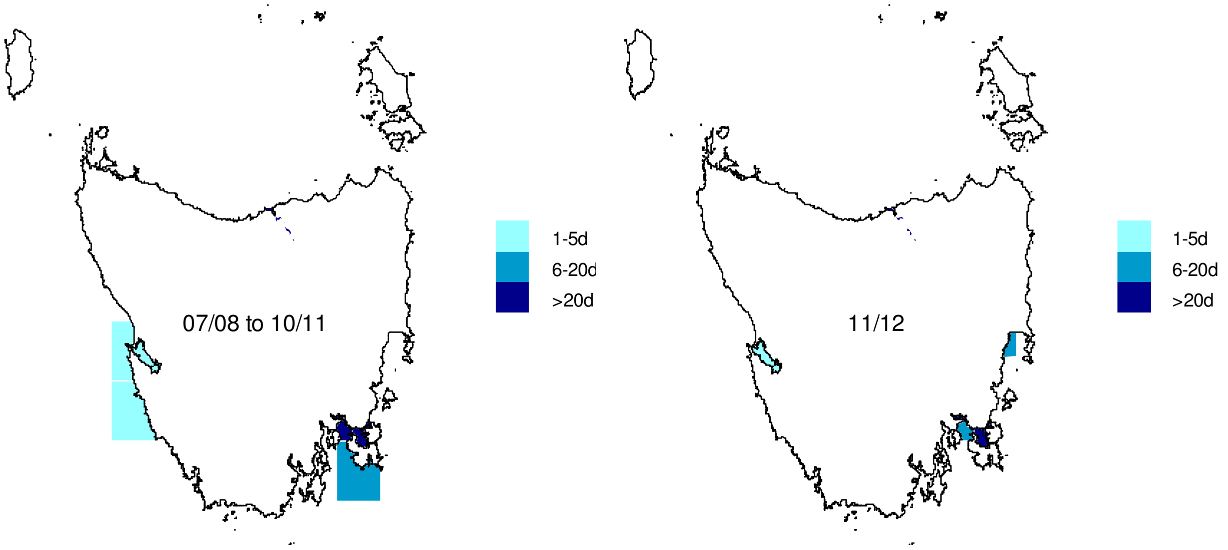


Figure 10.1 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. SP= spear, GN= graball net, NEC= north east coast, SEC= south east coast, EC= east coast.



A) Catch



B) Effort

Figure 10.2 (A) Flounder catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	- Catch > higher catch from the 1990/91 to 1997/98 range (44 t)	No	
	- Catch < lowest catch from the 1990/91 to 1997/98 range (27.1 t)	Yes	23 t (85.1%)
	- Catch increases by > 30% from previous year (>6.7 t)	No	
	- Catch decreases by > 30% from previous year (<3.6 t)	No	
Effort trend	- Effort >10% of highest level from 1995/96 to 1997/98 (1391 days fished)	No	
Catch rates trends	- Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0126 t/days fished)	Yes	0.003 t/days fished (24.1%)

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 (12.4 t)	Yes	8.3 t (67.4%)
	- 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 (55.1%)	Yes	Last estimate: 56.4%
Biomass	- Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0013)	No	
Stock stress	- Significant change in the size/age composition of commercial catches	Not assessed	
	- Significant numbers of unhealthy fish landed	No	

Stock status

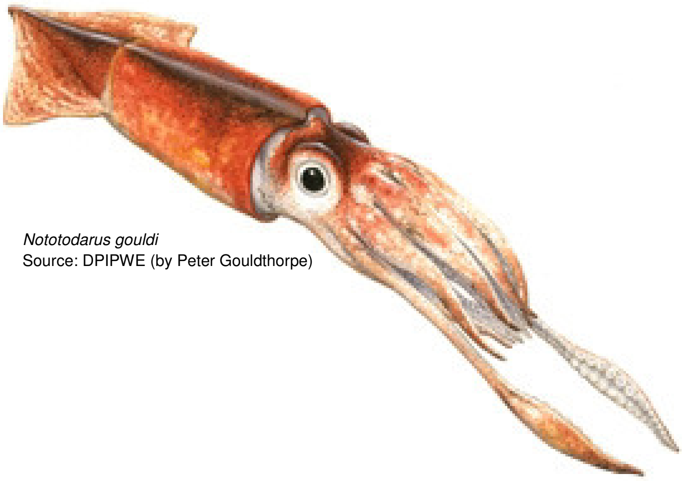
NOT ASSESSED

The decrease in catches for the species is likely to be related to market demand but also have been impacted by the ban on overnight gillnetting (i.e. unattended netting for commercial scalefishers). The Tasmanian catch is sold locally and the demand for Flounder has decreased over the last two decades. However, a decrease in availability cannot be excluded.

11. Gould's Squid

Nototodarus gouldi

STOCK STATUS	SUSTAINABLE
High inter-annual variability in abundance. Commonwealth fishery operating in Bass Strait. Dual-endorsed vessels fish in Tasmanian waters especially in years of peak abundance years.	
IMPORTANCE	Minor
STOCK	Southern Australia
JURISDICTION	Commonwealth
FISHERIES IN STATE WATERS	Tasmanian Scalefish Fishery (Tasmania) 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 300km^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.	Norman and Reid (2000)

	• 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.	Jackson et al. (2005b) Jackson et al. (2003)
Maturity	• Size-at-50% maturity: between 30.6 to 31.4 cm 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, can vary significantly in abundance between years. Environmental conditions are acknowledged as influences on larval and juvenile survival (Flood et al. 2012). It is likely that there is only one biological stock throughout southern Australian waters.

The Commonwealth Southern Squid Jig Fishery operates in Bass Strait waters using automatic squid jig machines. Occasionally, Gould's Squid become available in high numbers in Tasmanian State waters, particularly around south east Tasmania. Some of the dual endorsed automatic squid jig vessels therefore fish in State waters during the summer before moving back to fishing grounds in Bass Strait.

Gould's Squid are processed into "tubes" and stored frozen. Given the unpredictable occurrence of the species in Tasmanian waters there is limited processing capacity in Tasmania, which has stalled the development of the fishery. Marketing of Gould squid being problematic and catch does not always reflect biomass.

FISHING METHODS	Automated squid jig
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence, Automated squid jig licence if operating more than 4 automated squid jig machines) • Temporal and spatial closures (Mid October-Mid November) of some east coast waters **Output control:** • Possession limit of 15 individuals for recreational
MAIN MARKET	Interstate

Current assessment

Catch, effort and CPUE

Gould's Squid availability in Tasmanian waters is highly variable, which is reflected in the catch history (Fig. 11.1A). Since 1995/96, there has been a few peaks of abundance notably in 1999/2000, 2006/07 and smaller peaks in 2009/10 and 2011/12. The Gould's Squid catch for

2011/12 was 160.3 tonnes. In between these peaks, catches of the species have fluctuated between 0.1 and 50 tonnes. The majority of the catch is taken in the south east and east coast of Tasmania, with some also taken from the north coast (Fig.11.2).

Gould's Squid catches from the recreational sector (Fig. 11.1A) were estimated at 5 tonnes in 2000/01 (Lyle 2005) and 36.6 tonnes in 2007/08 (Lyle et al. 2009).

Effort follows the catch pattern closely and matches the availability of the species (Fig. 11.1B). Very little fishing occurred for Gould's Squid in 2005/06 (around 1.8 tonnes) and no fishing with automatic squid jig was recorded in Tasmanian water for that year (Fig. 11.1B).

Overall, catch rate have remained relatively low until 2008/09. Since then, there has been an increase in catch rate, both in gear units and by days fished (Fig. 11.1C).

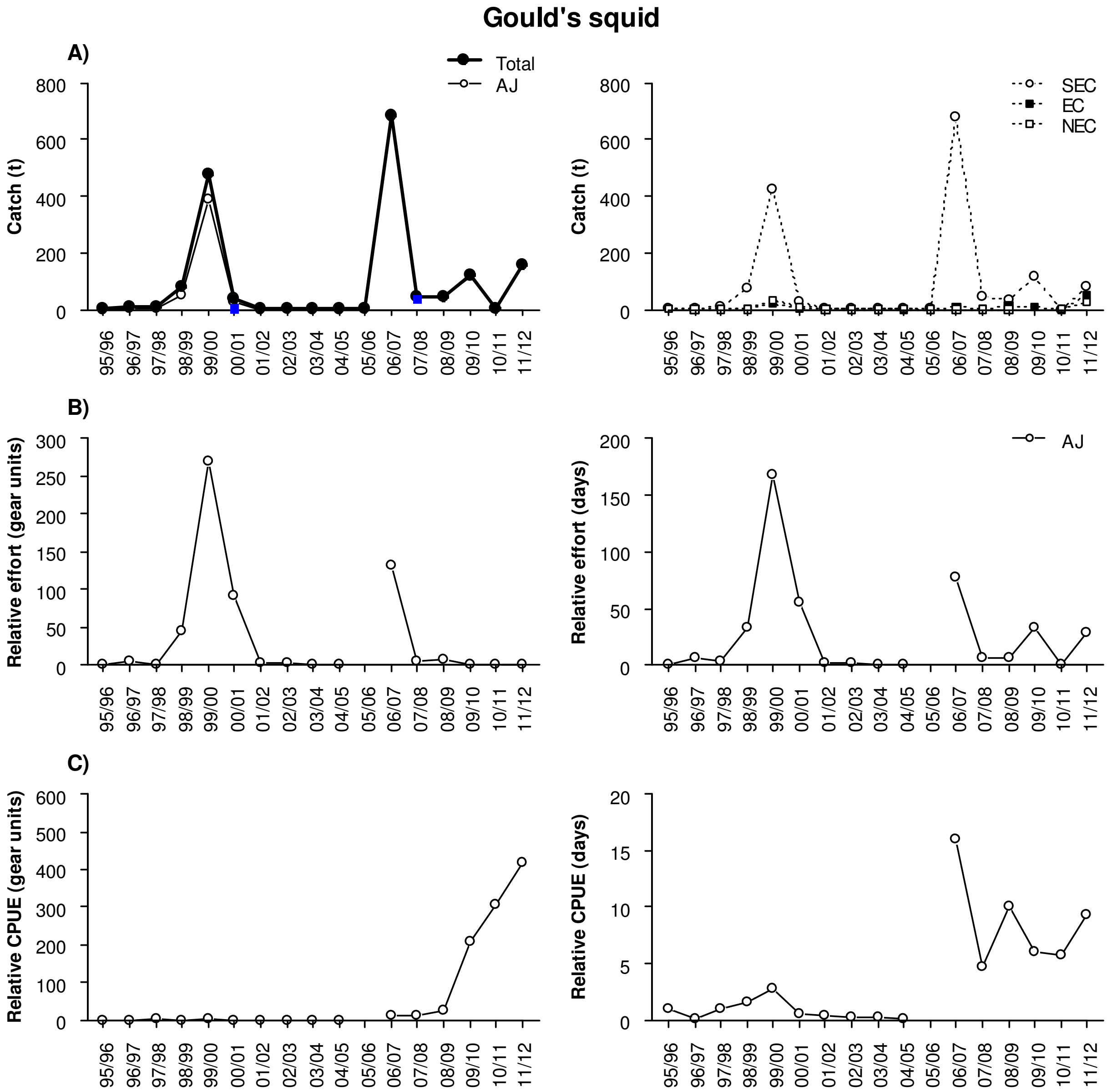
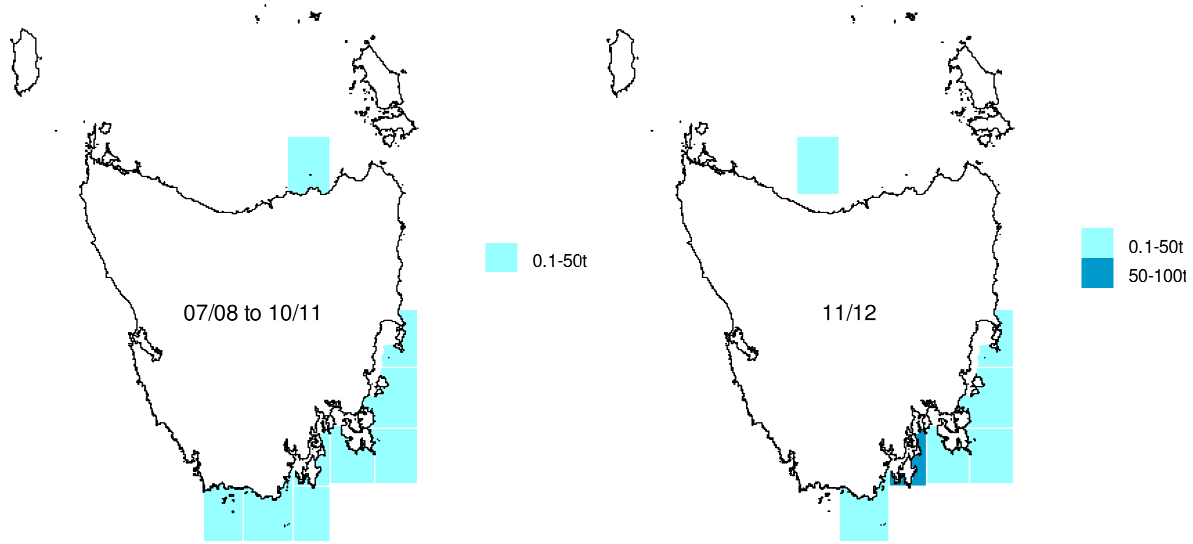


Figure 11.1 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. AJ= automatic squid jig, NEC= north east coast, SEC= south east coast, EC= east coast. Note: no fishing using Automatic squid jig was recorded for 2005/06.

A) Catch



B) Effort

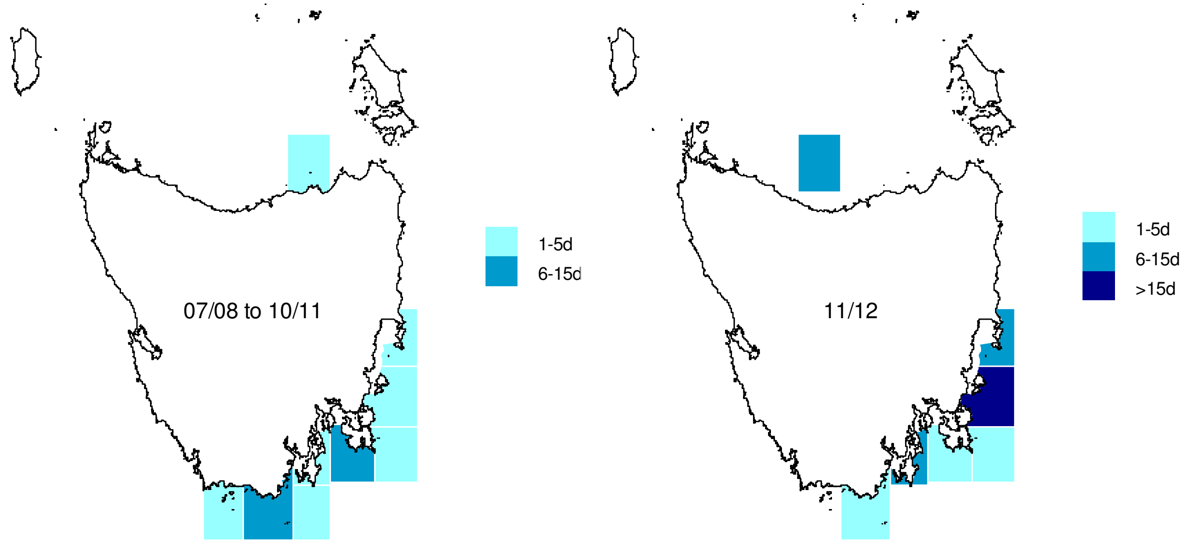


Figure 11.2 (A) Gould's Squid catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	• Catch > higher catch from the 1990/91 to 1997/98 range (35.1 t)	Yes	125.2 t (356.7%)
	• Catch < lowest catch from the 1990/91 to 1997/98 range (5.7 t)	No	
	• Catch increases by > 30% from previous year (>3.5 t)	Yes	156.8 t (4472.5%)
	• Catch decreases by > 30% from previous year (1.9 t)	No	
Effort trend	• Effort >10% of highest level from 1995/96 to 1997/98 (>238 days fished)	No	
Catch rates trends	• Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0048 t/days fished)	No	

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (79.7 t)	Yes	80.6 t
	• 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	37.9t (185%)
	• Proportion of recreational catch to total catch > previous proportion estimate (11.2%)	Yes	Last estimate: 44.4%
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0656)	No	
Stock stress	• Significant change in the size/age composition of commercial catches	Not assessed	
	• Significant numbers of unhealthy fish landed	No	

Stock status

SUSTAINABLE

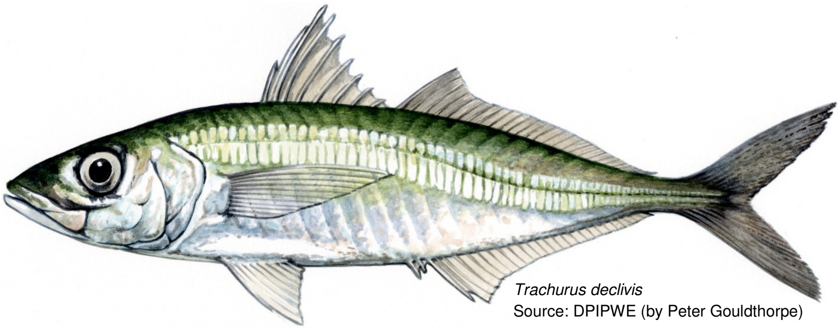
The highest catch reference point was breached; however this is not very meaningful for a species with high fluctuating availability. The recreational reference points were also breached, however it is unlikely that the recreational sector poses a threat to the stock, as estimated catches remain small in comparison to the commercial sector when Gould's Squid are available in Tasmanian waters and even more so when Southern Squid Jig Fishery catches are taken into consideration.

Gould's Squid are short lived, multiple spawners and display highly variable growth and size/age at maturity, meaning they can rapidly increase in numbers during favourable environmental conditions. As a result, Gould's Squid may 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 very susceptible to environmental impacts on subsequent recruitment. The fishing effort in the Commonwealth Southern Squid Jig Fishery has decreased markedly since the late 1990's due to economic factors and catches are considered lower than the historical catches from the late 1970's. A biological stock depletion study found that no overfishing had occurred (Sahlqvist and Skirtun 2011). The species was classified as Sustainable by the Key Australian Fish Stock Reports (Flood et al. 2012) and this assessment has been applied to the Tasmanian component of the fishery.

12. Jack Mackerel

Trachurus declivis

STOCK STATUS	**SUSTAINABLE**
Shared stock with Commonwealth fishery.	
IMPORTANCE	Minor
STOCKS	East Australian and West Australia
JURISDICTION	Tasmania
FISHERIES IN STATE WATERS	Tasmanian Mackerel Fishery (Tasmania) Tasmanian Scalefish Fishery (Tasmania) 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. Also in 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 2 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 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. Parameters estimates are:	Paul (2000) Lyle et al. (2000)

<table>
<tr><td></td><td><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>.267</td><td>-1.21</td></tr></table>
• Length-weight relationship was estimated at $W = 1.46.10^{-8}L^{2.982}$ for both males and females, where W is weight (g) and L is the length (cm).</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>
</table>

Background

The Jack Mackerel fishery in Tasmania started in the early 1970's, with a one year venture catching 6 300 tonnes in 1973. In 1985 another venture aimed at fishmeal production started using purse seine nets and Jack Mackerel landings rose rapidly to reach 40 000 tonnes in 1986/87 (Kailola et al. 1993). By 2000, fishers were struggling to catch surface schools and the industry introduced mid-water trawling for the species (and redbait) in Commonwealth waters. Jack Mackerel caught in Tasmania waters are still primarily targeted with purse seine. Small quantities of Jack Mackerel are also taken as by-product by beach seine. Catches are managed within the global limits set by the TAC for the Commonwealth Small Pelagic Fishery (i.e. the combined catches from State and Commonwealth waters do not exceed the operator's allocation for the Commonwealth Small Pelagic Fishery).

FISHING METHODS	Mainly purse seine, also beach seine
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence) • Species licence (Mackerel licence) • Recreational gear licence (Recreational Graball and/or Mullet net) **Output control:** • Possession limit of 30 individuals for recreational • Commercial catches taken by purse seine licence holders (A & B) are decremented against the TAC allocated to the Commonwealth Small Pelagic Fishery
MAIN MARKET	Local (Tasmania)

Current assessment

Catch, effort and CPUE

Catches of Jack Mackerel in Tasmanian waters and reported in the General Fishing Returns have been variable since 1995/96, oscillating between 2.6 and 59.8 tonnes up until 2007/08 when there was a sharp increase in purse seine effort targeting Jack Mackerel (Fig. 12.1A). The Jack Mackerel catches peaked at 919.6 tonnes in 2008/09, but declined sharply in 2010/11 and 2011/12 to around 60 t, the result of the major purse seiner ceasing operations. Catches focus on the south east coast (Fig. 12.2) with a reduction of fishing ground to one area off Maria Island and Marion Bay in the year 2011/12. However, it should be noted that between 1995 and 1999, purse seine catches taken as part of the then Zone A Jack Mackerel fishery, and recorded in a separate logbook, ranged from 447 (1995/96) to 8 458 tonnes (1997/98), averaging 4 485 tonnes per year for that period. These data are not presented in Fig. 12.1A.

Jack Mackerel is not a significant recreational species, catches estimated at 3.2 tonnes in 2000/01 (Lyle 2005) and 1 tonne in 2007/08 (Lyle et al. 2009) (Fig. 12.1A).

The use of purse seine by the major operator between 2007/08 to 2009/10 resulted in a spike in effort for that period of time. Beach seine effort for Jack Mackerel has been slowly declining over time (Fig. 12.1B).

Catch rates have fluctuated until the spike in 2007/08 and have remained at a higher level since (Fig. 12.1C).

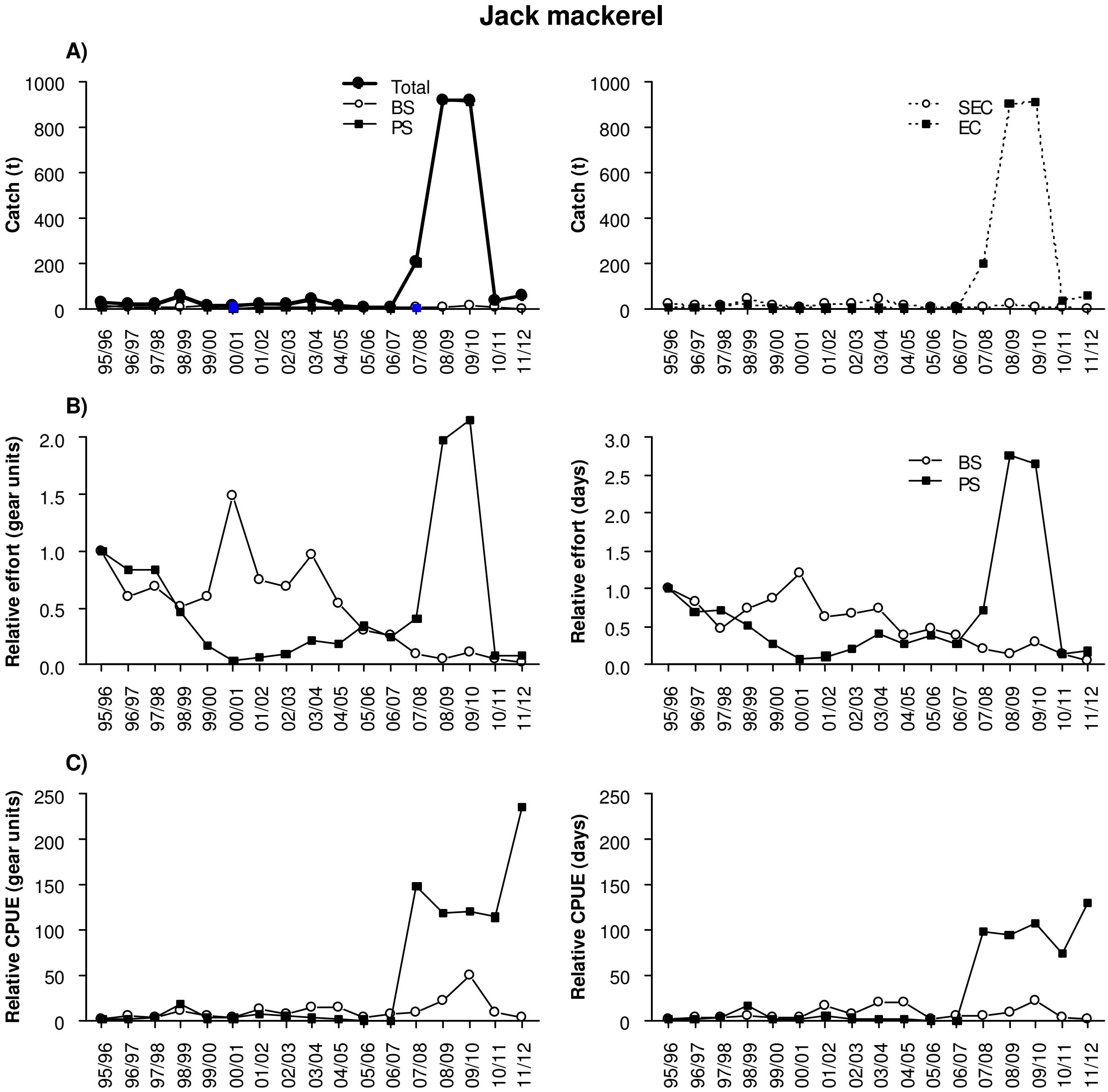
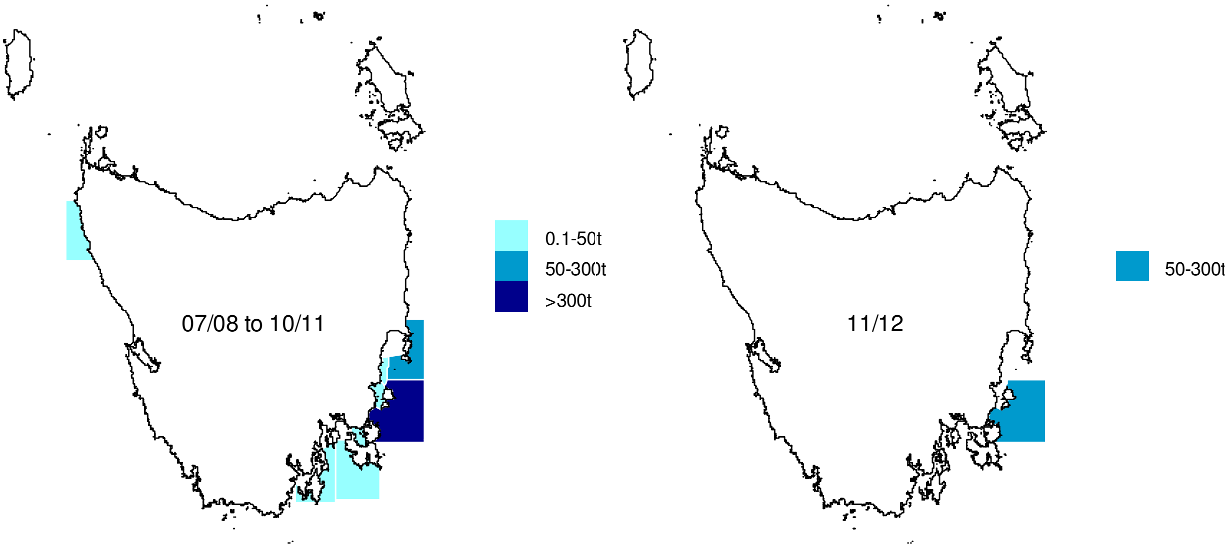


Figure 12.1 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. BS= beach seine, PS= purse seine, SEC= south east coast, EC= east coast.

A) Catch



B) Effort

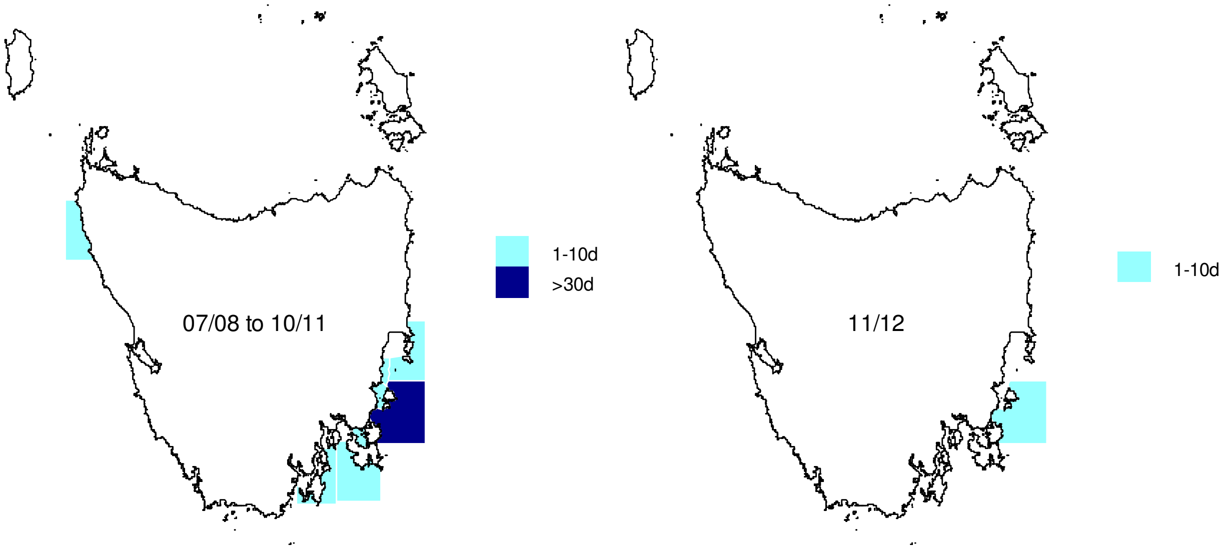


Figure 12.2 (A) Jack Mackerel catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Limit reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	- Catch > higher catch from the 1990/91 to 1997/98 range (48.4 t)	Yes	8 t (16.5%)
	- Catch < lowest catch from the 1990/91 to 1997/98 range (6.1 t)	No	
	- Catch increases by > 30% from previous year (>46.4 t)	Yes	10 t (21.5%)
	- Catch decreases by > 30% from previous year (<25 t)	No	
Effort trend	- Effort >10% of highest level from 1995/96 to 1997/98 (>239 days fished)	No	
Catch rates trends	- Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0191 t/days fished)	No	

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	- Catch > 3rd highest catch value from the reference period (26.2 t)	Yes	30.2 t (115.3%)
	- Catch < 3rd lowest catch value from the reference period (8.6 t)	No	
	- 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 (27.1%)	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)	Yes	0.28 (1103.7%)
Stock stress	- Significant change in the size/age composition of commercial catches	Not assessed	
	- Significant numbers of unhealthy fish landed	No	

Stock status

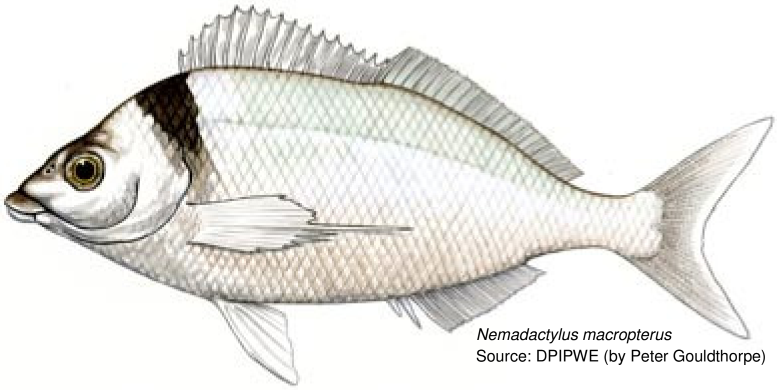
SUSTAINABLE

The reference points for highest catch and decline CPUE were breached. Current catches are negligible compared with historical catches. Recent trends have been the response to one operator entering and leaving the fishery in recent years, and do not reflect the stock status. The Jack Mackerel fishery is assessed by the Commonwealth Small Pelagic Fishery Resource Assessment Group. Both the east and west Jack Mackerel stocks have been assessed as not overfished and not subject to overfishing by the Fishery Status Reports 2010 (Woodhams et al. 2012) and this assessment has been applied to the Tasmanian component of the fishery.

13. Jackass Morwong

Nemadactylus macropterus

STOCK STATUS	**NOT ASSESSED**
Commonwealth-managed fishery.	
IMPORTANCE	Minor
STOCK	South Australia
JURISDICTION	Commonwealth
FISHERIES IN STATE WATERS	Tasmanian Scalefish Fishery (Tasmania) 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 mid Queensland to southern Western Australia, and around Tasmania. Also in 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 3 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 $L = L_\infty\left(1 - e^{-k(t-t_0)}\right)$ 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.	Francis (2001) Kailola et al. (1993) Jordan (2001a)

<table>
<tr><td></td><td>Parameters estimates are:
<table><tr><th><i>Sex</i></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 about 3 years of age</td><td>Edgar (2008)</td></tr>
<tr><td>Spawning</td><td>• Between February and June
• At least 2 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. (2001a)</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 7-9cm long.
• Juveniles live near shallow reefs</td><td>Francis (2001)
Bruce et al. (2001a)
Kailola et al. (1993)</td></tr>
<tr><td>Recruitment</td><td>• No-stock recruitment relationship established.</td><td></td></tr>
</table>

Background

Jackass Morwong is a Commonwealth-managed species. While there is a good market for Jackass Morwong, the species is not available in large numbers in Tasmanian waters and is hence a by-product of graball net rather than a target species. Tasmanian commercial catches reached a maximum of around 250 tonnes in the late 1980's with the inshore trawl fishery operations, but this fishery has since ceased and State catches have declined significantly. Most of the Jackass Morwong catch originate from trawling outside Tasmanian waters and the stocks were assessed to be overfished from 2008 to 2010 (Woodhams et al. 2012).

FISHING METHODS	Mainly graball net, also hand line and drop line
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence) • Recreational gear licence (Recreational Graball and/or Mullet net) **Output control:** • Possession limit of 15 fish for recreational • Minimum size: 25 cm TL
MAIN MARKET	Local

Current assessment

Catch, effort and CPUE

Commercially, Jackass Morwong is mainly caught by graball net and landings have continuously declined since 1995/96 to reach 2.8 tonnes in 2011/12 (Fig 13.1A). The majority of the catch is taken from the east and south east coast (Fig. 13.2).

Jackass Morwong is an important recreational species, with catches estimated at higher levels than those of the commercial fishery (Fig. 13.1A). Estimates were 31.9 tonnes in 2000/01 (Lyle 2005), 6.8 tonnes in 2007/08 (Lyle et al. 2009) and 7.7 tonnes in 2011/12 (Tracey et al. 2013).

A decline in effort both in gear units and in days fished has mirrored the declining catches for the species (Fig. 13.1B). Catch rates have slowly declined since the early 2000's and stabilised in 2007/08 at a low level (Fig. 13.1C).

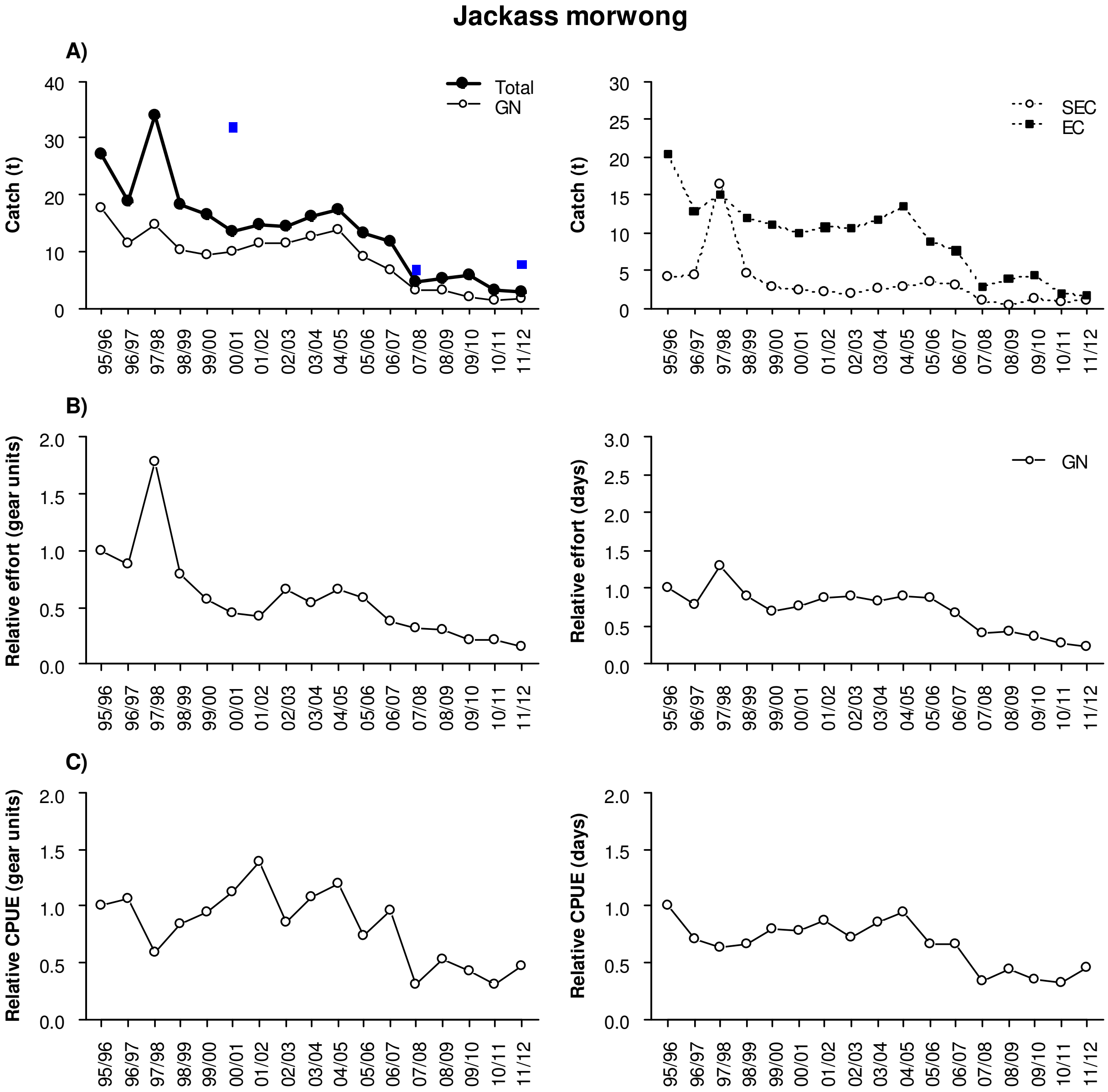
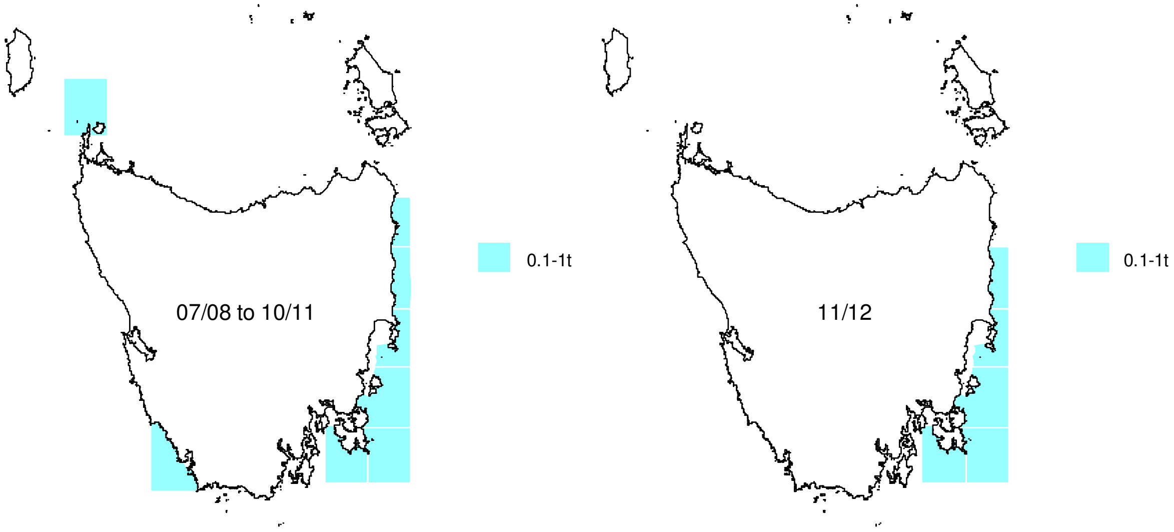


Figure 13.1 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. GN= graball net, SEC= south east coast, EC= east coast.

A) Catch



B) Effort

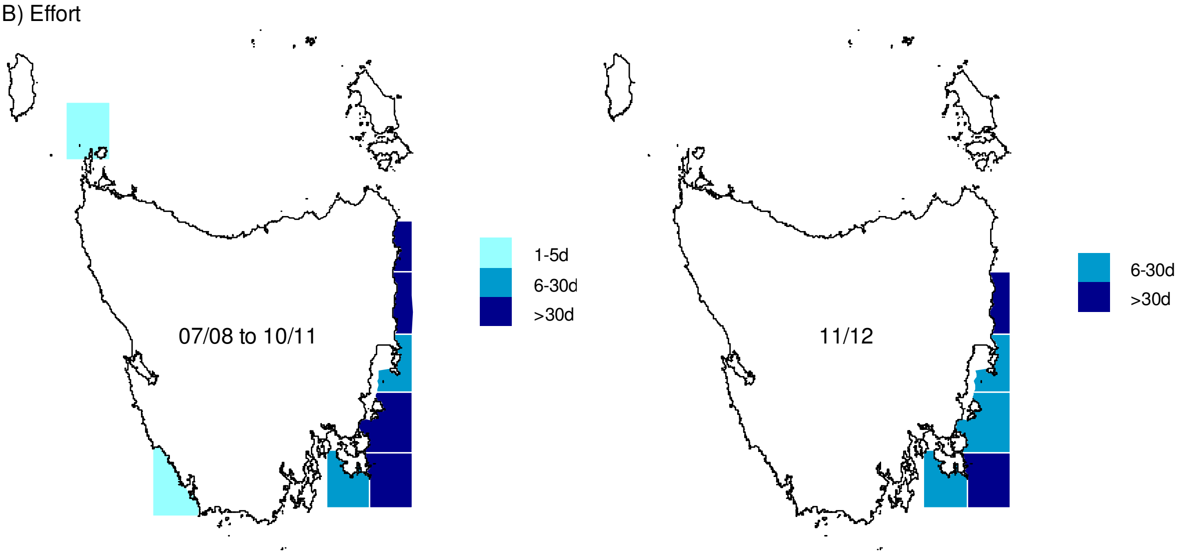


Figure 13.2 (A) Jackass Morwong catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	• Catch > higher catch from the 1990/91 to 1997/98 range (136.9 t)	No	
	• Catch < lowest catch from the 1990/91 to 1997/98 range (19 t)	Yes	16.2 t (85.3%)
	• Catch increases by > 30% from previous year (>4.2 t)	No	
	• Catch decreases by > 30% from previous year (<2.2 t)	No	
Effort trend	• Effort >10% of highest level from 1995/96 to 1997/98 (>1057 days fished)	No	
Catch rates trends	• Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0095 t/days fished)	Yes	0.0007 (7.4%)

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (19 t)	No	
	• Catch < 3rd lowest catch value from the reference period (13.6 t)	Yes	10.9 t (79.8%)
	• 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 (59.6%)	Yes	Last estimate: 73.3%
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period • (-0.0020)	No	
Stock stress	• Significant change in the size/age composition of commercial catches	Not assessed	
	• Significant numbers of unhealthy fish landed	No	

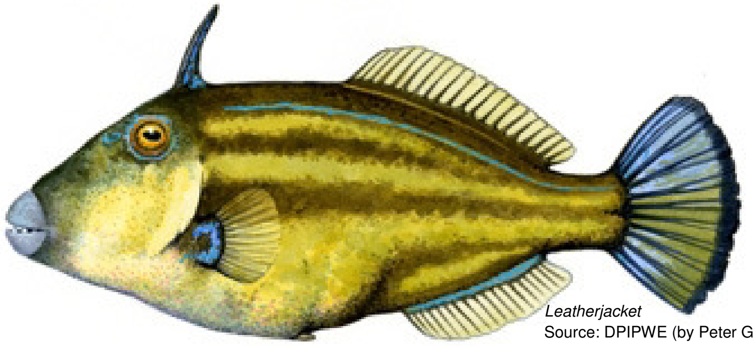
Stock status	**NOT ASSESSED**

One of the recreational indicators was breached, indicating that the proportion of recreational catch to total catch has increased since last recreational survey (2007/08). However, this was at similar level to the 200/01 survey (70.1%). The lowest catch reference point was breached, which reflects the ongoing declining commercial catches in Tasmanian waters. The Jackass Morwong stocks were considered as overfished in the late 2000's but the latest Fishery Status Reports has reclassified the stocks as not overfished and not subject to overfishing (Woodhams et al. 2012), due to a reduction of catches for the species as a response to management action in the Commonwealth fishery and revision of the stock assessment model. The total catch (recreational and commercial) of Jackass Morwong for Tasmania is low by comparison with Commonwealth catches.

14. Leatherjacket

Monacanthidae family

STOCK STATUS	**UNDEFINED**
Various species of Leatherjackets are found inshore around Tasmania's coastline and are not differentiated in logbooks. Leatherjackets are a by-product species and are not actively targeted. There is little biological information available for most species.	
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 (1995b)
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	

Background

Leatherjackets are a by-product of fish traps and they are also caught in netting operations but are generally not retained. While Leatherjackets are consumed on the mainland, the market for them in Tasmania is small.

FISHING METHODS	Mainly fish trap, also graball net and handline
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence) • Recreational gear licence (Recreational Graball and/or Mullet net) **Output control:** • Possession limit of 15 combined leatherjacket species for recreational • Minimum size: 20 cm
MAIN MARKET	Local

Current assessment

Catch, effort and CPUE

Leatherjacket catches have declined continuously since the early 2000's, reaching 2.2 tonnes in 2011/12 (Fig. 14.1A). While catches from graball net have remained constant at low levels since 1995/96, catches from fish traps have declined over time. Leatherjackets are caught from the east, north-east and north-west coasts, although in 2011/12, catches have concentrated on the east and north-east coasts only (Fig. 14.2).

Leatherjackets are also caught by the recreational sector, with catch estimates in recent surveys at a similar level to commercial catches (Fig. 14.1A). Estimates were 8.2 tonnes in 2000/01 (Lyle 2005), 2.6 tonnes in 2007/08 (Lyle et al. 2009) and 2.3 tonnes in 2009/10.

Effort has decreased over time for both fish trap and graball (Fig. 14.1B). Fish trap effort (in gear units and fishing day) dropped significantly around 2007/08. Abalone guts were the preferred bait used in fish traps, however there has been a ban in place since 2008 on their use due to a disease (AGV) in wild abalone population. Consequently, effort for fish trap has dropped significantly state-wide since 2008 as no suitable bait replacement has been found.

Catch rates in gear unit and days fished have remained relatively stable over time for graball nets (Fig. 14.1C). Catch rates for fish trap has been variable but stable. Catch rates in days fished is now back to the 1995/96 level.

Leatherjacket

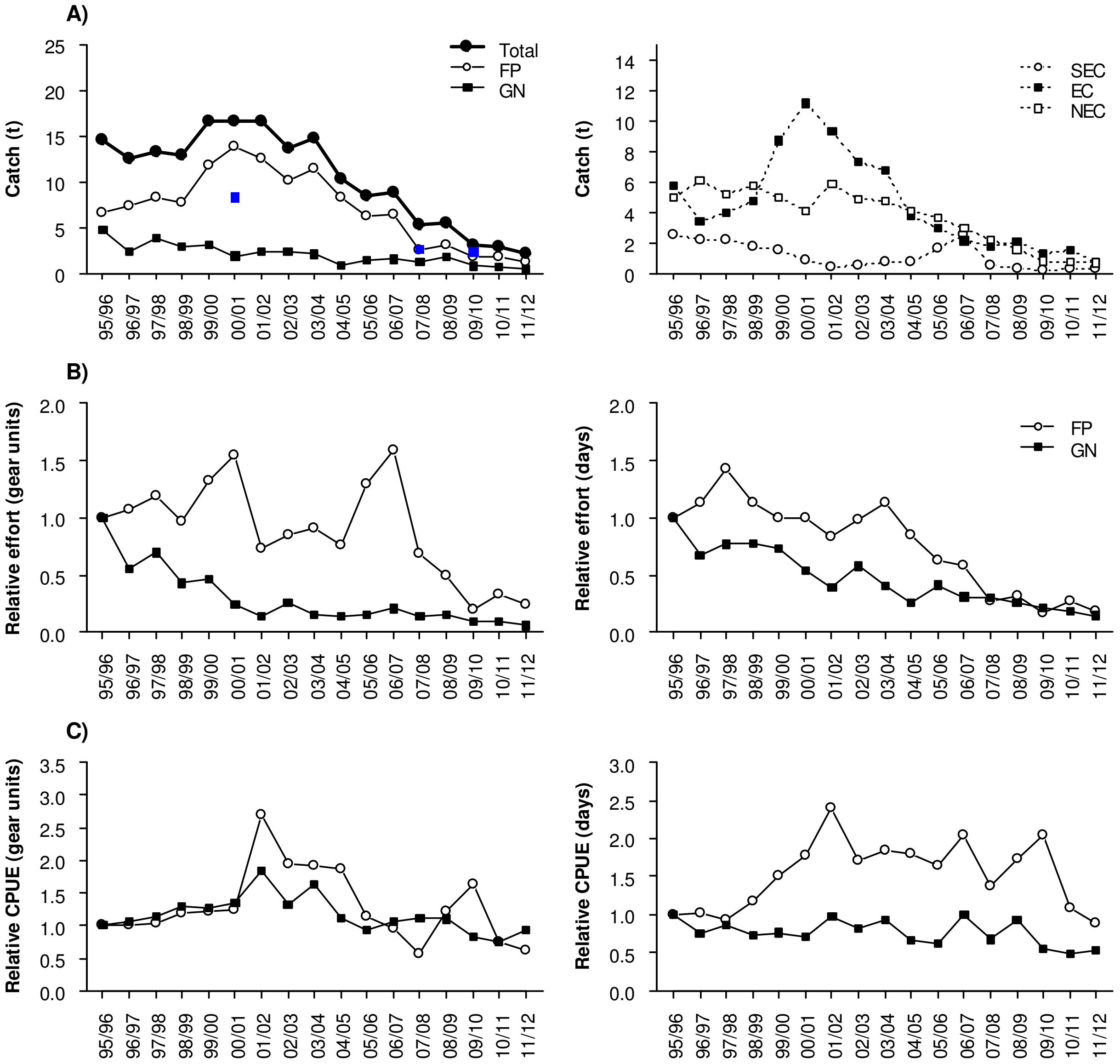
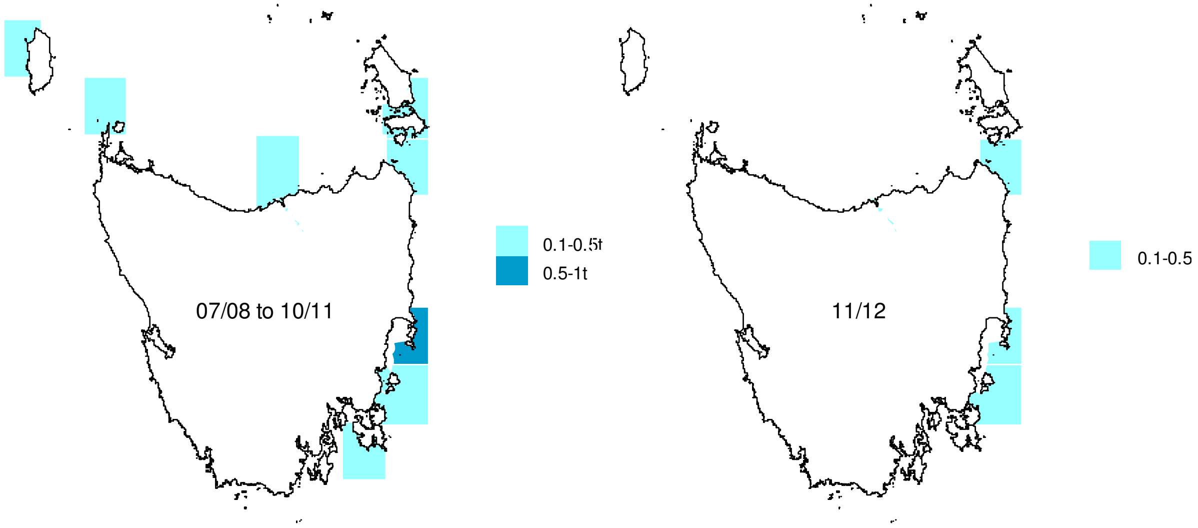


Figure 14.1 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. FP= fish trap, GN= graball net, SEC= south east coast, EC= east coast, NEC= north east coast.

A) Catch



B) Effort

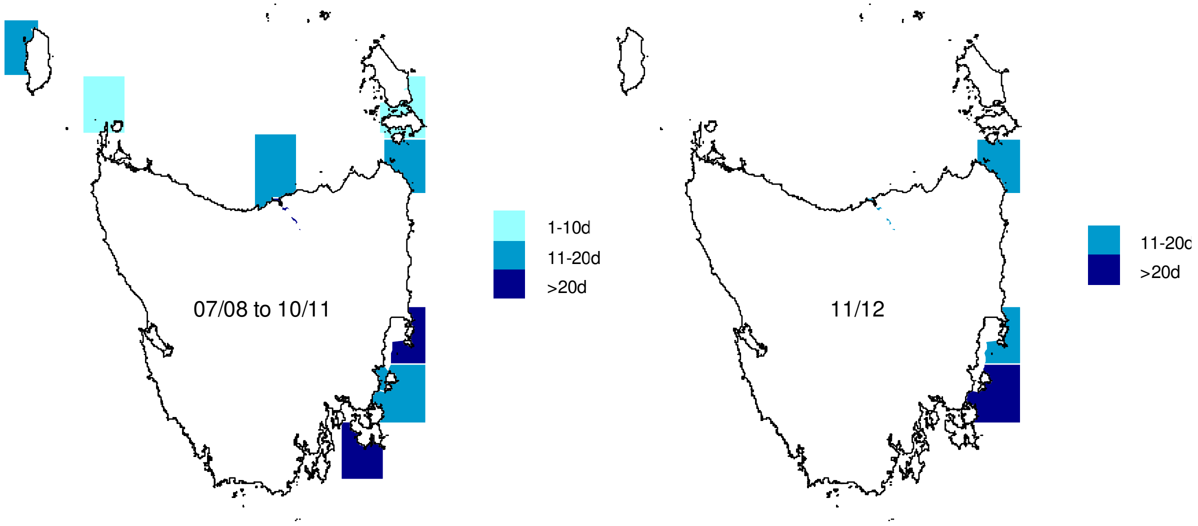


Figure 14.2 (A) Leatherjacket catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	• Catch > higher catch from the 1990/91 to 1997/98 range (27.7 t)	No	
	• Catch < lowest catch from the 1990/91 to 1997/98 range (12.2 t)	Yes	10 t (82%)
	• Catch increases by > 30% from previous year (>3.7 t)	No	
	• Catch decreases by > 30% from previous year (<2 t)	No	
Effort trend	• Effort >10% of highest level from 1995/96 to 1997/98 (>1607 days fished)	No	
Catch rates trends	• Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (0.0046 t/days fished)	No	

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (16.5 t)	No	
	• Catch < 3rd lowest catch value from the reference period (10.4 t)	Yes	8.2 t (79.2%)
	• 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 (32.9%)	Yes	Last estimate: 43.4%
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0016)	No	
Stock stress	• Significant change in the size/age composition of commercial catches	Not assessed	
	• Significant numbers of unhealthy fish landed	No	

Stock status	**UNDEFINED**

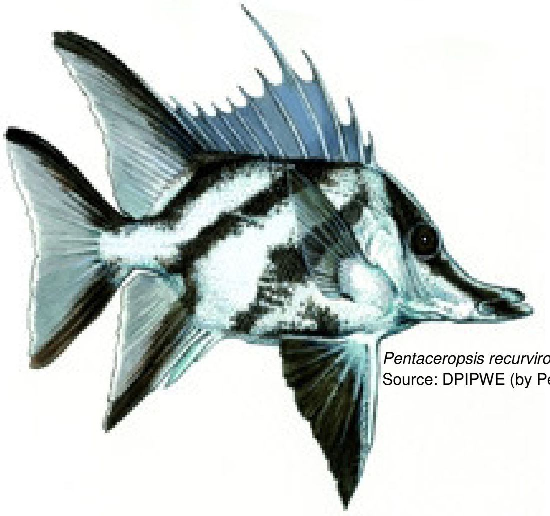
The lowest catch reference point was breached. The breach of the recreational reference point reflects the decrease of commercial catches rather than an increase in recreational targeting for the species.

Leatherjackets tend to be site-attached and have limited home ranges. Two decades of monitoring eastern Tasmanian Marine Protected Areas (MPA) show that there is no significant difference in Leatherjacket abundance inside or outside of MPA's (e.g. brown striped Leatherjacket, toothbrush Leatherjacket), which could suggest that fishing does not have a significant impact on Leatherjacket populations. This information combined with the fact that Leatherjackets are not a targeted group and that catches are at their lowest, suggest that Leatherjackets are unlikely to be recruitment overfished. There is however too little information at the species level to ascertain the stock status.

15. Longsnout Boarfish

Pentaceropsis recurvirostris

STOCK STATUS	**NOT ASSESSED**
Little information is available for this species.	
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	

Background

Boarfish is a by-product from graball netting. Because of the large minimum legal size and the requirement to release undersized fish, boarfish is also a by-catch species. There is a small local market for the species for boarfish, which is considered a good product. Shark nets also catch boarfish as a by-product in State waters, but these catches are now reported to the Commonwealth since 2000/01.

FISHING METHODS	Graball net, shark net in the past
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence) • Recreational gear licence (Recreational Graball and/or Mullet net) • No spearing allowed **Output control:** • 50kg commercial trip limit (take and possession) • Possession limit of 2 individuals for recreational • Minimum size: 45 cm
MAIN MARKET	Mainly local

Current assessment

Catch, effort and CPUE

In Tasmania, boarfish catches are now exclusively derived from graball net (Fig. 15.1A). Catches have been declining over time but appear to have stabilised since 2008/09, the 2011/12 landings reaching 3.5 tonnes. Catches are taken exclusively from the east and south-east coasts (Fig. 15.2). No recreational estimates are available for this species.

After peaking in 1997/98, graball net effort has remained stable (Fig. 15.1B). Catch rates have remained relatively stable over time (Fig. 15.1C).

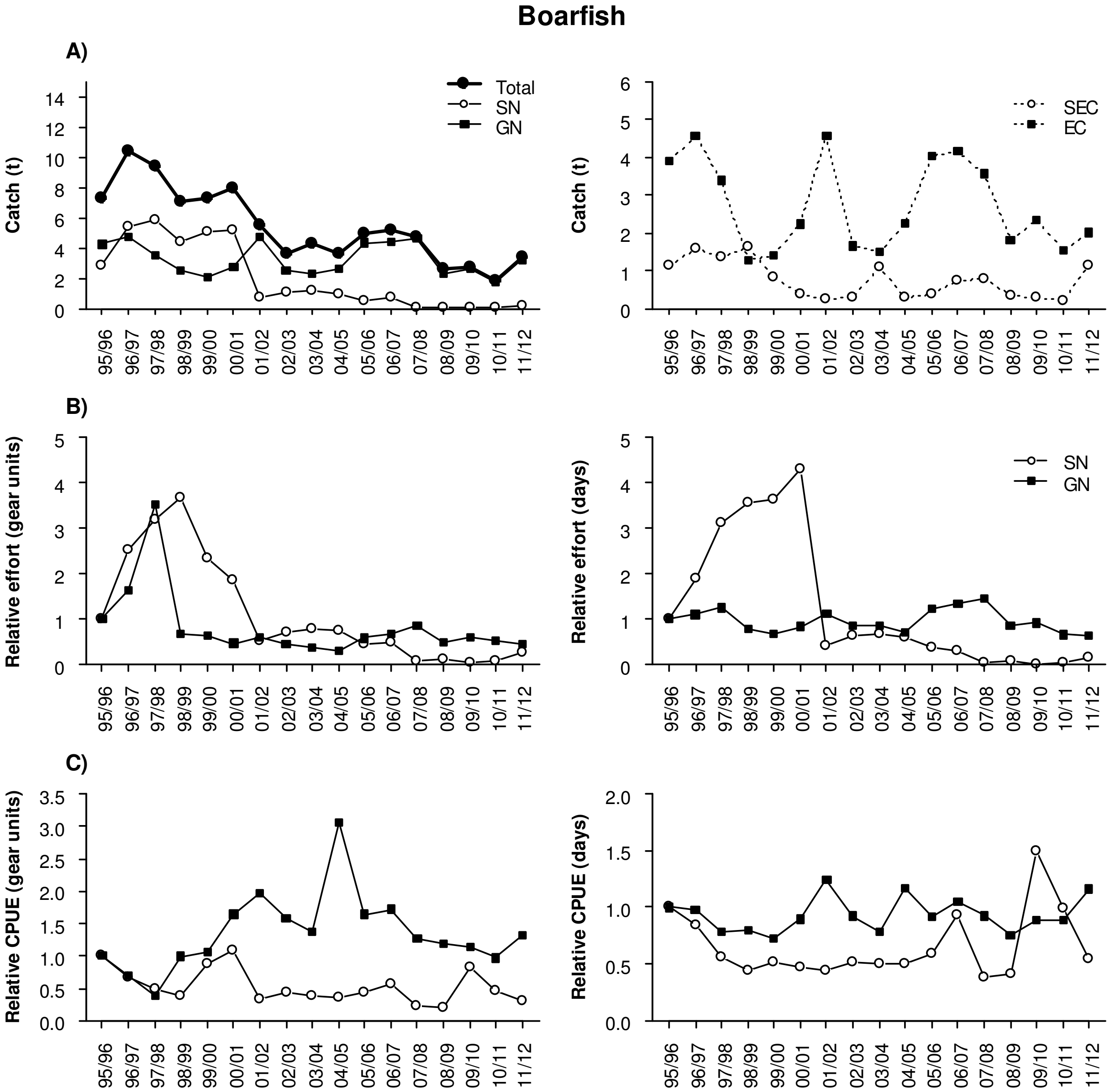
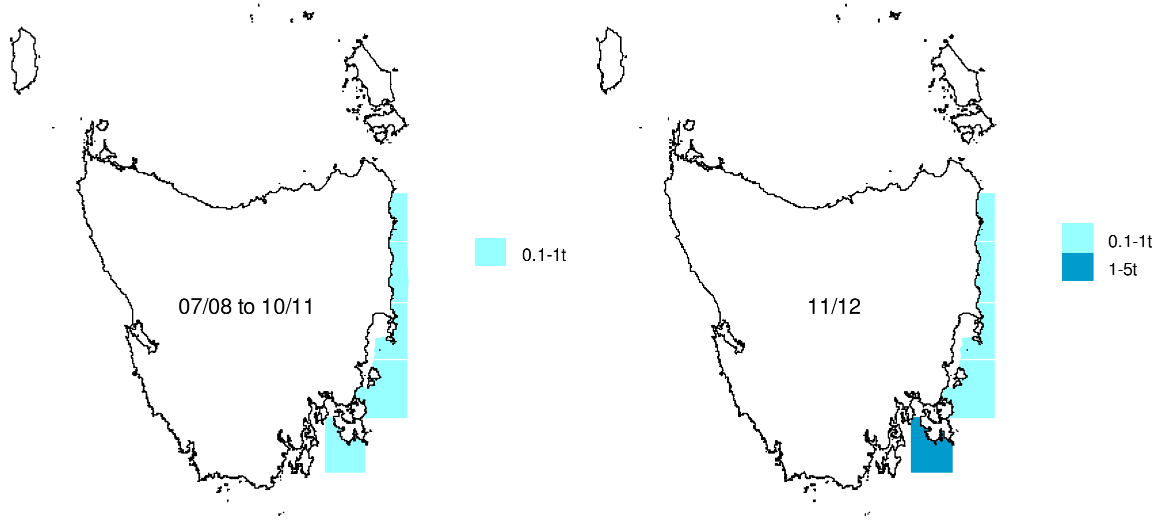


Figure 15.1 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. SN= shark net, GN= graball net, SEC= south east coast, EC= east coast.

A) Catch



B) Effort

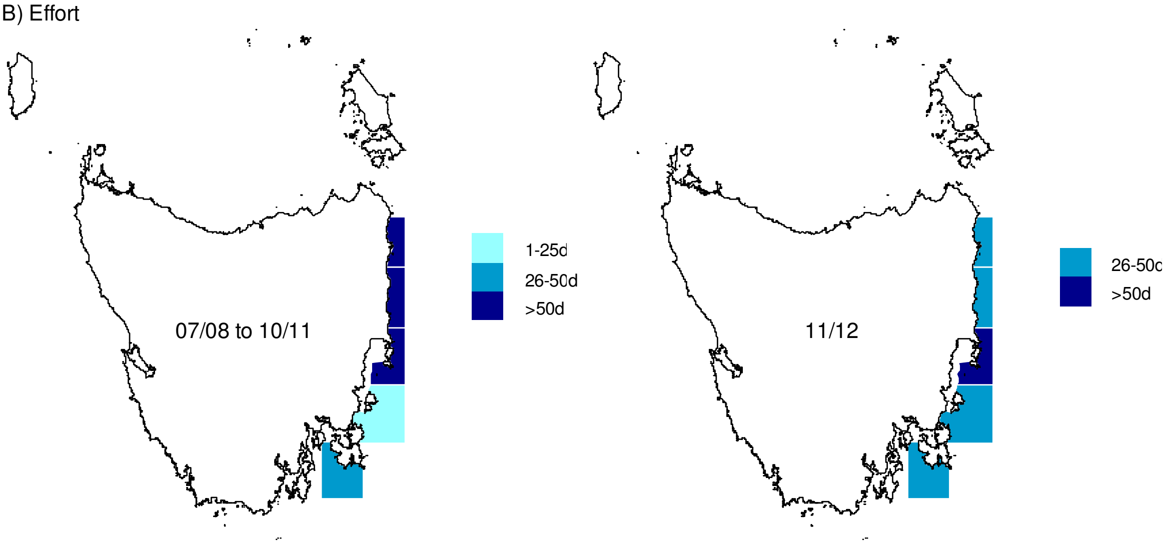


Figure 15.2 (A) Boarfish catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	• Catch > higher catch from the 1990/91 to 1997/98 range (10.4 t)	No	
	• Catch < lowest catch from the 1990/91 to 1997/98 range (7.2 t)	Yes	3.7 t (51.4%)
	• Catch increases by > 30% from previous year (>2.4 t)	Yes	1 t (41%)
	• Catch decreases by > 30% from previous year (< 1.3 t)	No	
Effort trend	• Effort >10% of highest level from 1995/96 to 1997/98 (>1334.3 days fished)	No	
Catch rates trends	• Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0029 t/days fished)	No	

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (7.9 t)	No	
	• Catch < 3rd lowest catch value from the reference period (4.3 t)	Yes	0.8 t (18.7%)
	• Latest recreational catch estimate > recreational catch estimate from the reference period	No estimates	
	• Proportion of recreational catch to total catch > previous proportion estimate	No estimates	
Biomass	• 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 stress	• Significant change in the size/age composition of commercial catches	Not assessed	
	• Significant numbers of unhealthy fish landed	No	

Stock status

NOT ASSESSED

The lowest catch reference point was breached, but there is too little information available to assign a stock status for this species. Boarfish is a non-target species 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.

16. Yelloweye Mullet

Aldrichetta forsteri

STOCK STATUS	**Not Assessed**
Commercial and recreational catches are low and at similar levels.	
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 2 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 males and females, and between locations • Growth described by 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. Parameters estimates are:	Edgar (2008) Curtis and Shima (2005) Gorman (1962) Last et al. (1983) Chubb et al. (1981)

<table>
<tr><td></td><td><table><tr><th>Sex</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 W is weight (g) and L is the fork length (cm).</td><td></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 aggregation 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>
</table>

Background

Yelloweye Mullet is a targeted species which is caught by netting, specifically beach and purse seine as well as small mesh net. The vast majority of mullet catch is Yelloweye Mullet, but there are also some minor reports of Sea Mullet (*Mugil cephalus*).

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) • Recreational gear licence (Recreational Graball and/or Mullet net) **Output control:** • Possession limit of 15 individuals combined mullet species for recreational • Minimum size: 25 cm
MAIN MARKET	Mostly local

Current assessment

Catch, effort and CPUE

Yelloweye Mullet are caught using beach seine and small mesh nets. After peaking in 1999/2000, Yelloweye Mullet catches have decreased and stabilised at less than 5 tonnes since 2007/08. The catch for 2011/12 was 2.9 tonnes (Fig. 16.1A). Yelloweye Mullet is a popular recreational species and is targeted with small mesh nets (i.e. mullet nets). Recreational catches were estimated at 6.5 tonnes in 1996/97 and 1.7 tonnes in 2009/10, the latest estimate being similar to the commercial catches (Fig. 16.1A).

Beach seine effort was relatively stable until 2005/06 after which it declined rapidly and remained at low levels (Fig. 16.1B). Purse seine effort has been more variable with no clear pattern.

Catch rates for beach seine has remained relatively constant over time, whereas catch rates for purse seine follow the effort trends and are highly variable with no apparent pattern (Fig. 16.1C).

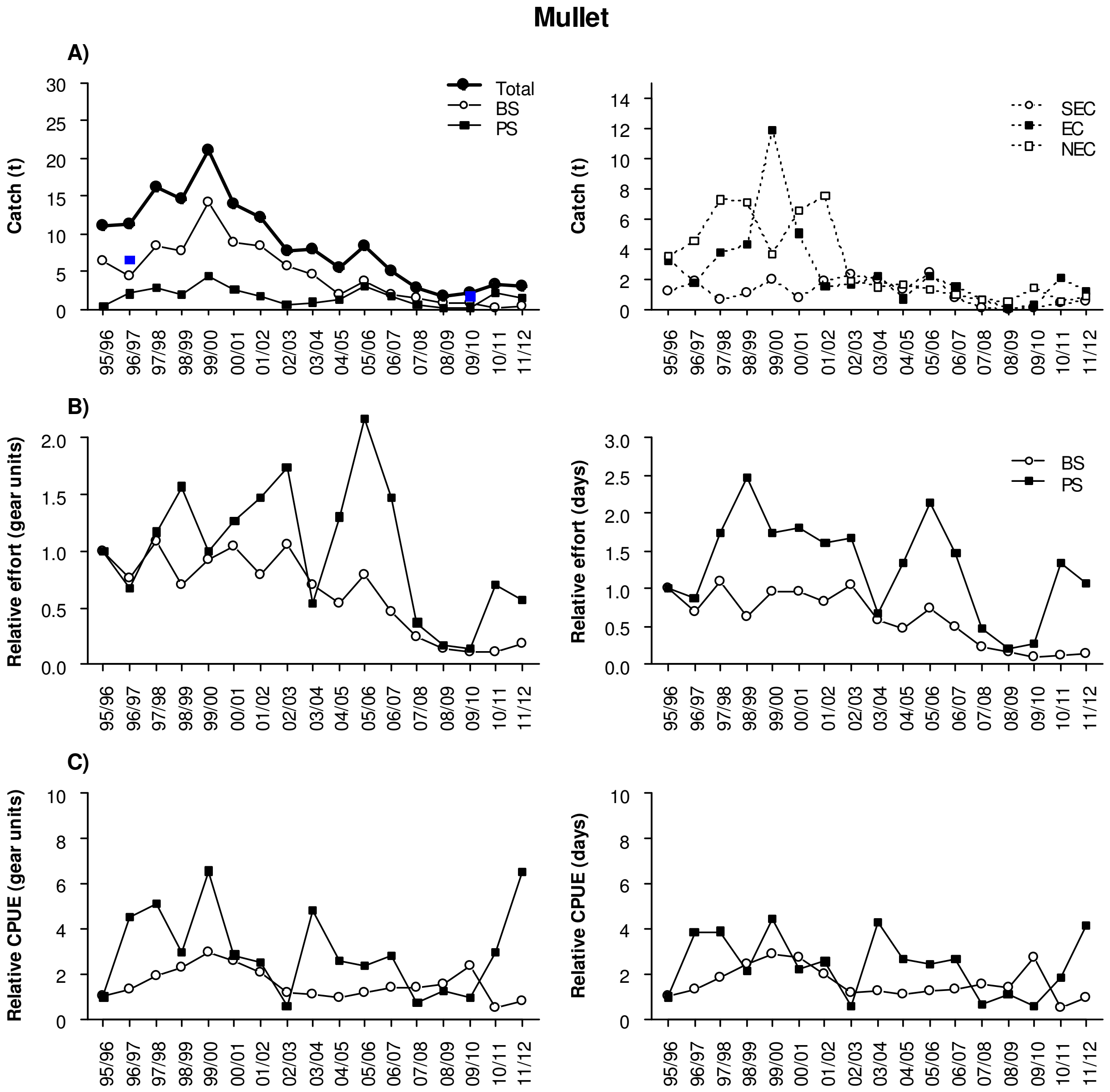
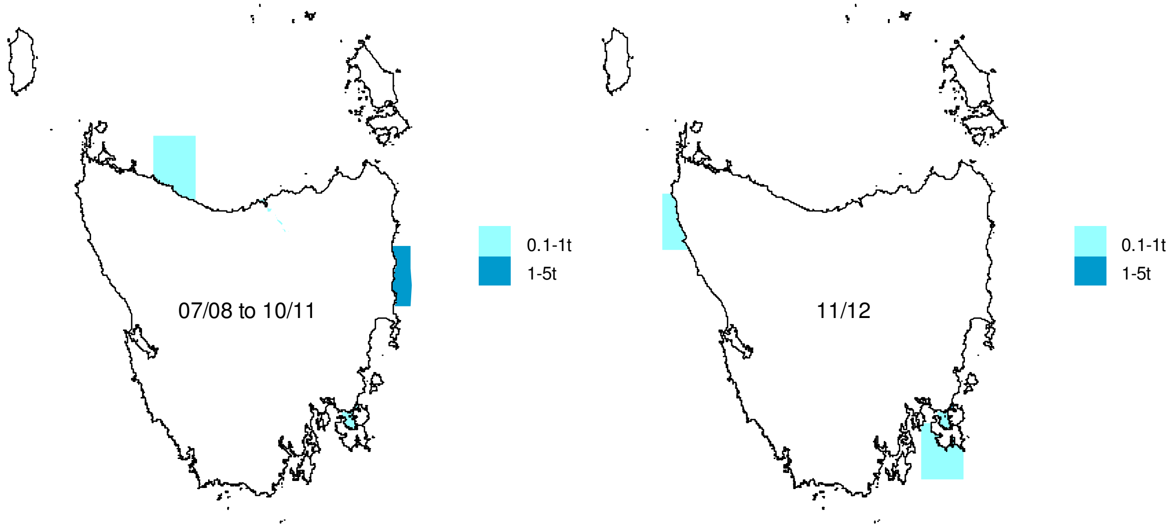


Figure 16.1 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. BS= beach seine, PS= purse seine, EC= east coast, SEC= south-east coast and NEC= north east coast.

A) Catch



B) Effort

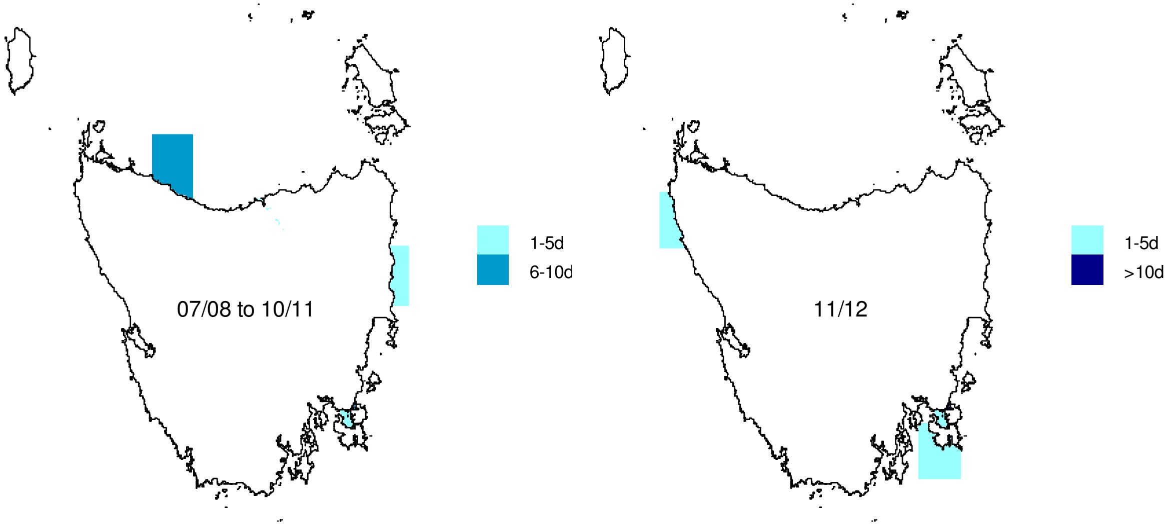


Figure 16.2 (A) Yelloweye Mullet catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	- Catch > higher catch from the 1990/91 to 1997/98 range (31.2 t)	No	
	- Catch < lowest catch from the 1990/91 to 1997/98 range (10.8 t)	Yes	9.1 t (84.3%)
	- Catch increases by > 30% from previous year (>2.9 t)	No	
	- Catch decreases by > 30% from previous year (<1.6 t)	No	
Effort trend	- Effort >10% of highest level from 1995/96 to 1997/98 (>327.8 days fished)	No	
Catch rates trends	- Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0107 t/days fished)	Yes	0.0026 t/day fished (24.2%)

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	- Catch > 3rd highest catch value from the reference period (14.5 t)	No	
	- Catch < 3rd lowest catch value from the reference period (7.3 t)	Yes	5.7 t (77.8%)
	- Latest recreational catch estimate > recreational catch estimate from the reference period (6.5 t)	No	
	- Proportion of recreational catch to total catch > previous proportion estimate (36.5%)	Yes	Last estimate: 45.9%
Biomass	- Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0061)	No	
Stock stress	- Significant change in the size/age composition of commercial catches	Not assessed	
	- Significant numbers of unhealthy fish landed	No	

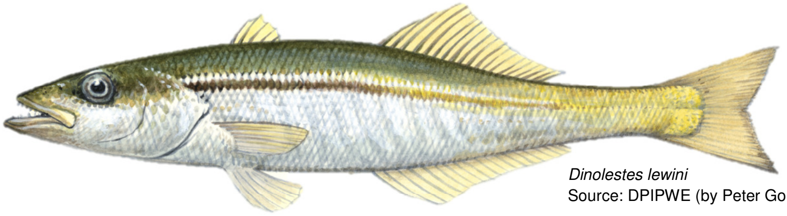
Stock status	**NOT ASSESSED**

Catches of Yelloweye Mullet have been stable at low levels for the past 5 years, following a decrease in effort in the traditional fishing grounds in northern Tasmania. The breach of one of the recreational reference point reflects the decrease of Yelloweye Mullet in commercial catches rather than an increase in recreational targeting for the species.

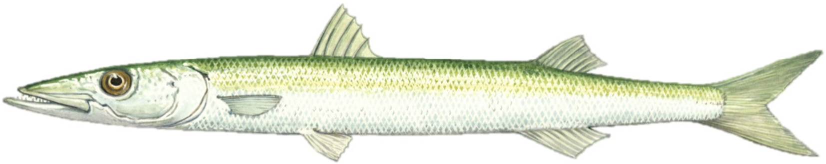
17. Pike

Longfin Pike *Dinolestes lewini*

Shortfin Pike *Sphyraena novaehollandiae*



Dinolestes lewini
Source: DPIPWE (by Peter Gouldthorpe)



Shyraena novaehollandiae
Source: DPIPWE (by Peter Gouldthorpe)

STOCK STATUS	**NOT ASSESSED**
The main species targeted is the Shortfin Pike, also known as snoek. Little information is available on either of the species.	
IMPORTANCE	Minor
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends

Species biology

Parameters	Estimates	Source
Habitat	• Longfin Pike: exposed reef. Down to depth of 60 m. • Shortfin Pike: exposed reef, sand, seagrass, offshore waters. Down to depth of 20 m.	Edgar (2008)
Distribution	• Longfin Pike: Western Australia to New South Wales, and around Tasmania • Shortfin Pike: Western Australia to southern Queensland, and northern Tasmania.	Edgar (2008)
Diet	• Both species: fish	Coleman and Mobley (1984) Scott et al. (1974)
Movement and stock structure	• Longfin Pike: no information • Shortfin Pike: highly migratory pelagic species that occurs in shoals of 50 or more individuals	Kailola et al. (1993)
Natural mortality	• Both species: no information	
Maximum age	• Both species: no information	
Growth	• Longfin Pike: Maximum length of 90 cm. • Shortfin Pike: Maximum length of 1.1m, maximum weight of 5.6 kg, maximum age of about 20 years.	Edgar (2008) Kailola et al. (1993)
Maturity	• Longfin Pike: no information	Bertoni (1995)

	- Shortfin Pike: 42 cm length	
Spawning	- Longfin Pike: no information - Shortfin Pike: assumed to take place from October to January	Kailola et al. (1993)
Early life history	- No information	

Background

While commonly referred to as pike, Longfin Pike (*Dinolestes lewini*) and Shortfin Pike (*Sphyraena novaehollandiae*, also called snoek) are not related and come from two separate families. Pikes are mainly targeted by troll and small mesh net (north coast only), and are also a by-product of beach seining and graball netting. While there is a local and interstate market for Shortfin Pike, Longfin Pike are harder to market in Tasmania. There are some uncertainties about the correct reporting of the two species in logbooks. The vast majority of pike catches is likely to be Shortfin Pike, which is confirmed by anecdotal reports from the industry.

FISHING METHODS	Troll, also beach seine, graball net and small mesh net
MANAGEMENT METHODS	**Input control:** - Gear licence (Scalefish fishing licence) - Recreational gear licence (Recreational Graball and/or Mullet net) **Output control:** - Possession limit of 15 individuals of each species for recreational
MAIN MARKET	Local and interstate (Victoria)

Current assessment

Catch, effort and CPUE

Both species were pooled together because of uncertainties in the logbook reporting. Pike catches have been variable but relatively stable since 1995/96, with catches reaching 10.8 tonnes in 2011/12 (Fig. 17.1A). Although there has been a peak in pike catches in the south-east in 1996/97 and 1997/98, catches traditionally originate from the north-west coast (Fig. 17.2). There are no estimates of recreational catches in weight of pikes but studies suggest that pike are not a major recreational target (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).

After increasing until 2001, troll effort for pike has decreased and stabilised (Fig. 17.1B). Beach seine effort in both gear unit and days fished has remained stable over time, probably because Pike are by-product rather than target species.

Catch rates in gear units have remained stable for both gear types, whereas catch rates in days fished has increased over time for troll (Fig. 17.1C).

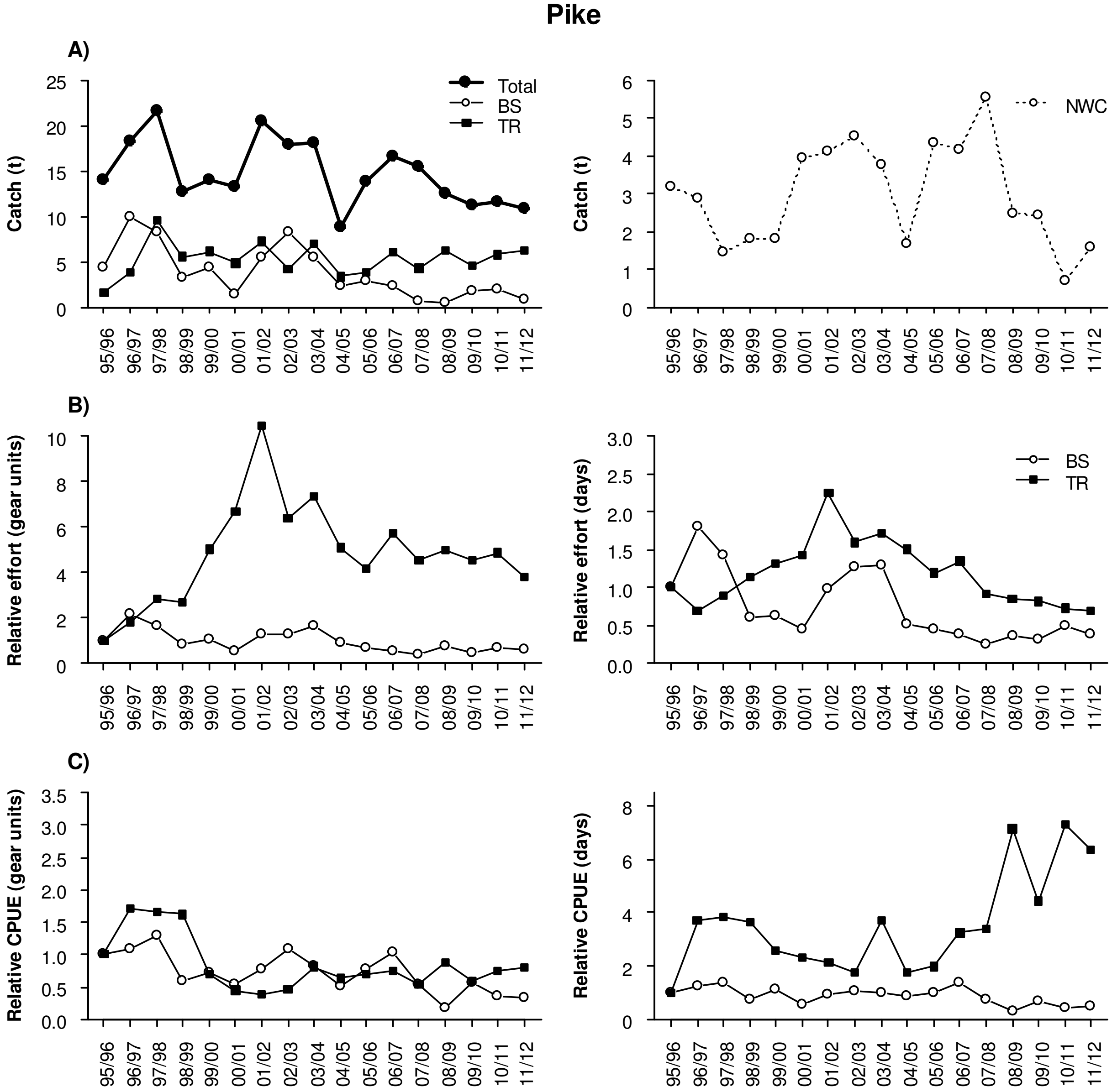
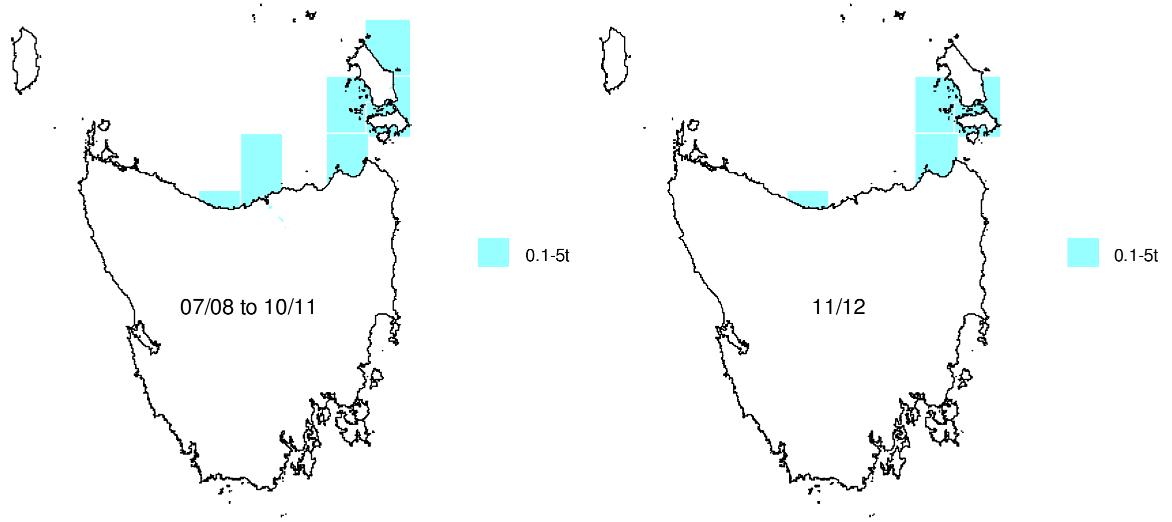
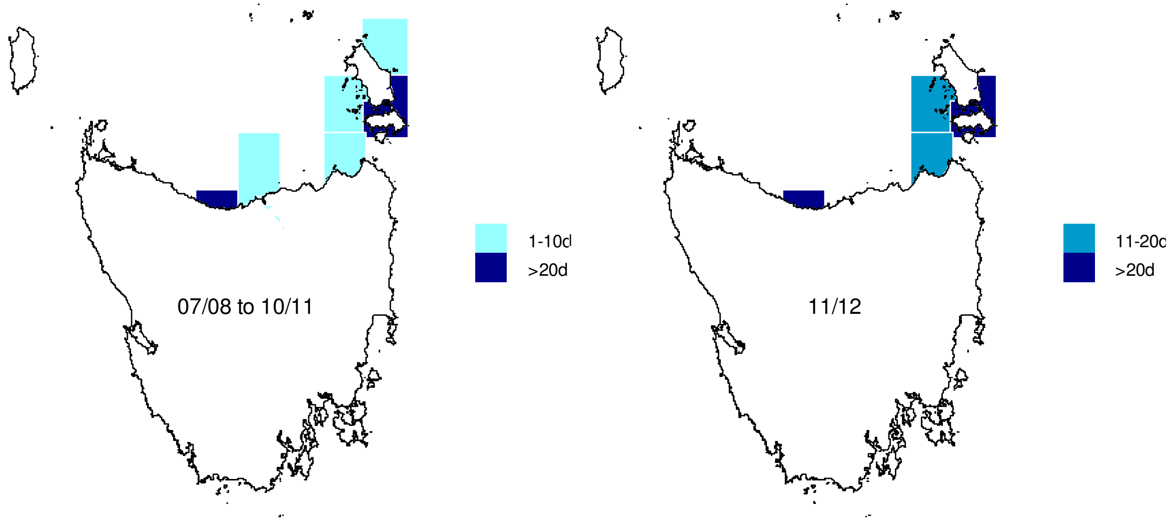

Pike

Figure 17.1 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. BS= beach seine, TR= troll, EC= north west coast.



A) Catch



B) Effort

Figure 17.2 (A) Pike catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	• Catch > higher catch from the 1990/91 to 1997/98 range (18.8 t)	No	
	• Catch < lowest catch from the 1990/91 to 1997/98 range (9.5 t)	No	
	• Catch increases by > 30% from previous year (>15.2 t)	No	
	• Catch decreases by > 30% from previous year (<8.2 t)	No	
Effort trend	• Effort >10% of highest level from 1995/96 to 1997/98 (>519.2 days fished)	No	
Catch rates trends	• Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0104 t/days fished)	No	

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (18.3 t)	No	
	• Catch < 3rd lowest catch value from the reference period (13.4 t)	Yes	2.6 t (19.5%)
	• Latest recreational catch estimate > recreational catch estimate from the reference period	No estimates	
	• Proportion of recreational catch to total catch > previous proportion estimate	No estimates	
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0024)	No	
Stock stress	• Significant change in the size/age composition of commercial catches	Not assessed	
	• Significant numbers of unhealthy fish landed	No	

Stock status

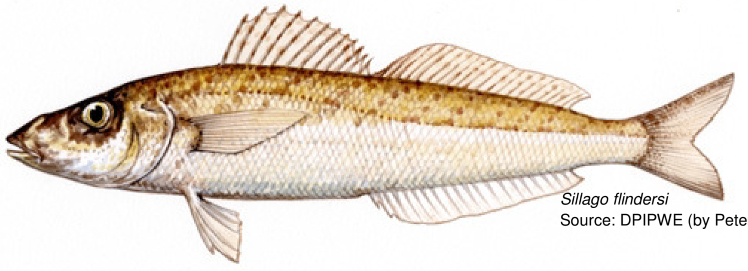
NOT ASSESSED

There is too little information available on the species which precludes assigning a stock status. The fishery for pike is however small and limited to the northern part of Tasmania. Moreover, the species are not generally targeted recreationally.

18. School Whiting

Sillago flindersi

STOCK STATUS	**NOT ASSESSED**
This species was previously commonly referred to as the Southern School Whiting (*Sillago bassensis*, also known as Western School Whiting), but the species present in Tasmania and caught commercially is in fact the Eastern School Whiting (*Sillago flindersi*).	
IMPORTANCE	Minor
STOCK(S)	Tasmanian Scalefish Fishery
INDICATOR(S)	Catch, effort and CPUE trends



Sillago flindersi
Source: DPIPWE (by Peter Gouldthorpe)

Species biology

Parameters	Estimates	Source
Habitat	• Costal lakes, estuaries and along outer coast. Down to 170 m depth.	Gomon et al. (2008)
Distribution	• Endemic to south-eastern 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 consume mostly copepods.	Burchmore et al. (1988)
Movement and stock structure	• There is evidence of 4 genetically distinct stocks (2 in New South Wales, 1 in Tasmania and 1 in Victoria)	Dixon (1987)
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 $L = L_\infty(1 - e^{-k(t-t_0)})$ 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. Parameters estimates are: **Sex** | L_∞ | *k* | t_0 Combined | 23.9 | 0.46 | -0.50	Gomon et al. (2008) Tilzey (1994)
Maturity	• Reached at 2 years and a size of 14-16 cm FL	Hobday and Wankowski (1987) Burchmore et al. (1988)

Spawning	- Spring to late summer. - Females release between 30 000 and 110 000 eggs in total during the season	Hobday and Wankowski (1987)
Early life history	- Juveniles inhabit inshore waters.	FishBase (2013)

Background

School Whiting has been exploited in Tasmania since the mid-1970's with catches ranging from 20 tonnes to 175 tonnes throughout the 1980's (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 using a smaller mesh cod end (with flathead as a by-product) or Tiger Flathead, which accounts for the opposite trends in catches for the two species. Currently, there is only one active Danish seine operator targeting School Whiting in Tasmania. School Whiting is mainly marketed and processed in Melbourne. In recent years, increasingly large catches of King George Whiting (*Sillaginodes punctatus*) have been recorded from netting operations in the north of the State (mainly small mesh and graball netting), and this species is increasingly becoming a target.

FISHING METHODS	Danish seine
MANAGEMENT METHODS	**Input control:** - Gear licence (Scalefish fishing licence, and class Danish seine) **Output control:** - Possession limit of 30 individuals for recreational
MAIN MARKET	Interstate

Current assessment

Catch, effort and CPUE

Catches have been variable but relatively stable over time, with a yearly average of 37.3 tonnes between 1995/96 and 2011/12 (Fig. 18.1A). Landings were however at their lowest for 2012/13, reaching 16.1 tonnes. Catches are concentrated on the south-east coast (Fig. 18.2). Recreational catches are low compared to commercial catches, and were estimated at 0.8 tonnes in 2000/01 (Lyle 2005) and 3.4 tonnes in 2007/08 (Lyle et al. 2009) (Fig. 18.1A).

Effort in both gear unit and days fished has been decreasing steadily over time (Fig. 18.1B). Catch rates by gear units has generally increased since 1995/96 while catch rate by days fished has slowly decreased (Fig. 18.1C).

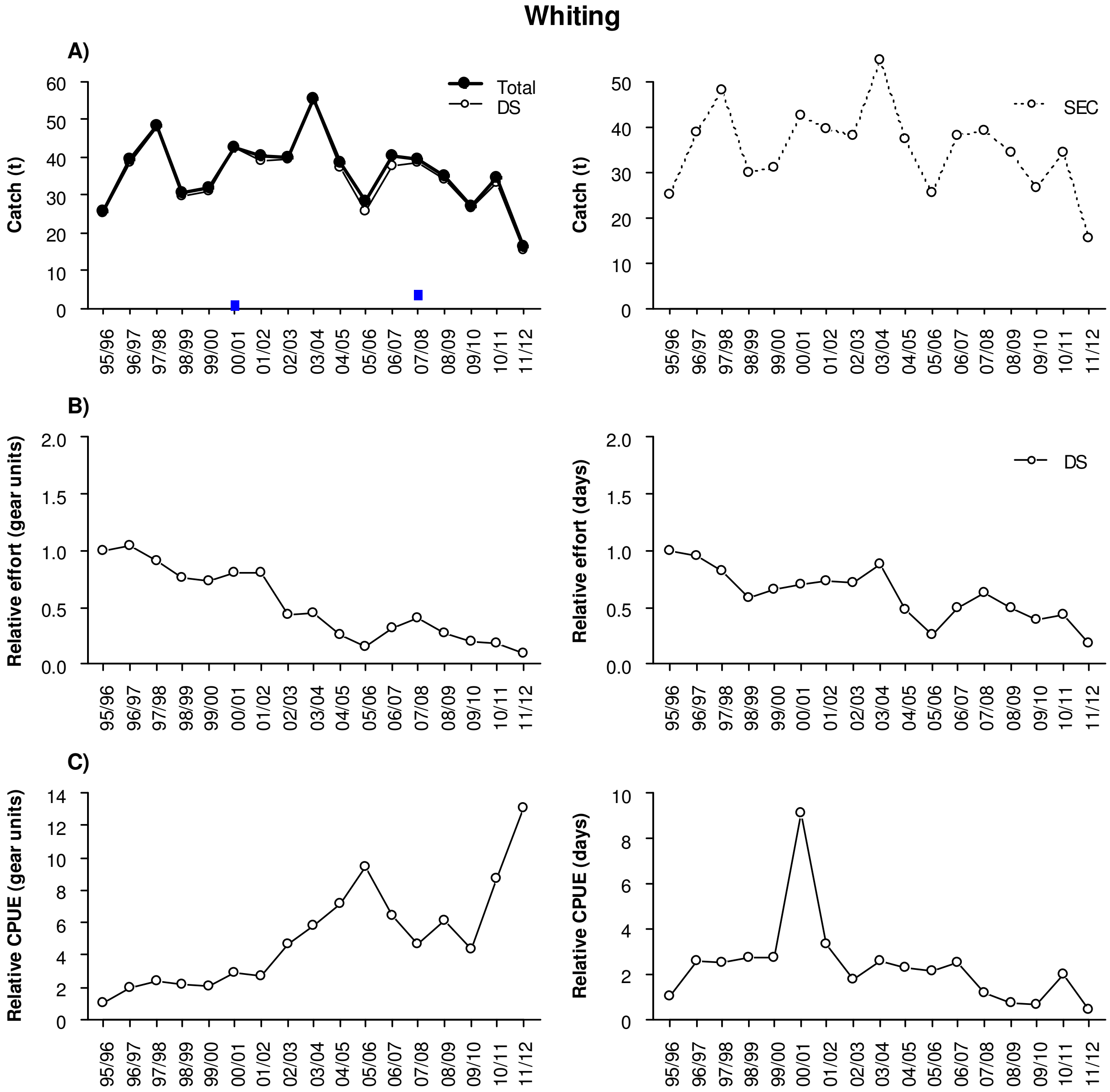
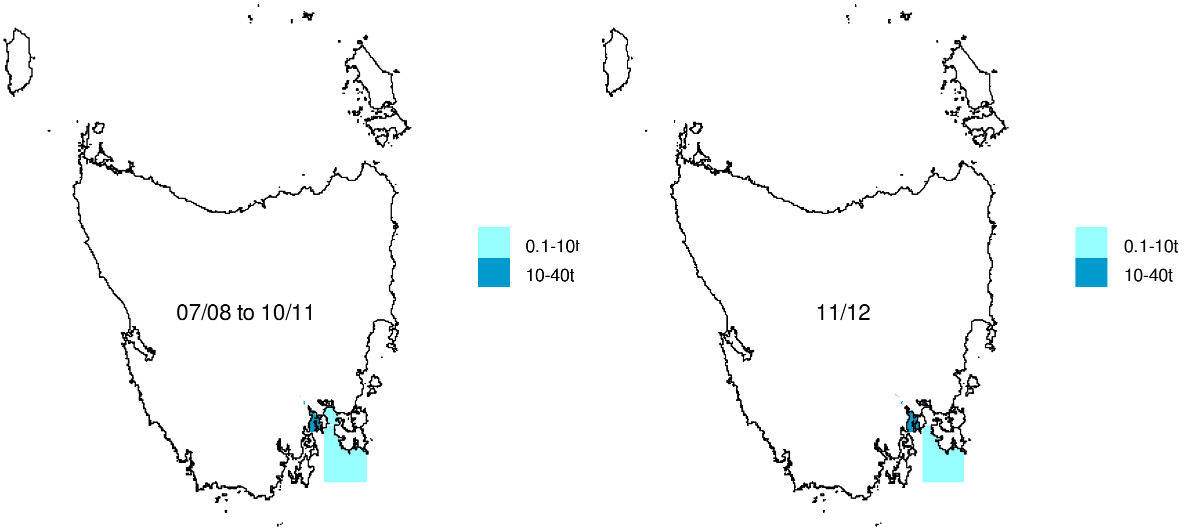


Figure 18.1 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. DS= Danish seine, SEC= south east coast.

A) Catch



B) Effort

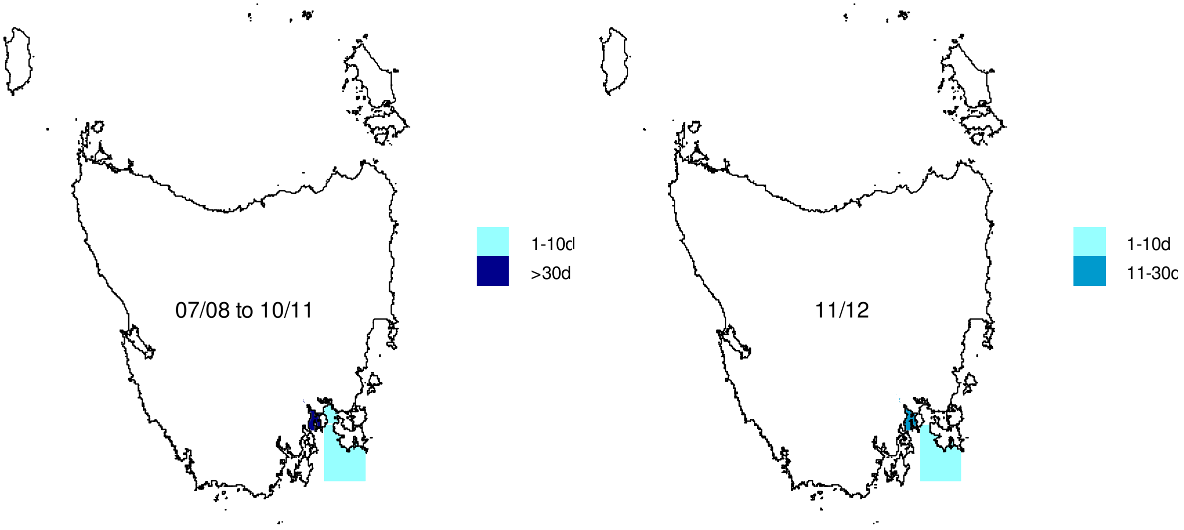


Figure 18.2 (A) School Whiting catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	• Catch > higher catch from the 1990/91 to 1997/98 range (152.3 t)	No	
	• Catch < lowest catch from the 1990/91 to 1997/98 range (25.5 t)	Yes	9.4 t (36.9%)
	• Catch increased by > 30% from previous year (>45 t)	No	
	• Catch decreased by > 30% from previous year (>24.2 t)	Yes	8.1 t (33.4%)
Effort trend	• Effort >10% of highest level from 1995/96 to 1997/98 (>210.1 days fished)	No	
Catch rates trends	• Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0145 t/days fished)	Yes	0.0071 t/days fished (48.9%)

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (42.7 t)	No	
	• Catch < 3rd lowest catch value from the reference period (30.6 t)	Yes	14.4 t (47.1%)
	• Latest recreational catch estimate > recreational catch estimate from the reference period (0.8 tonnes)	Yes	2.6 t (325%)
	• Proportion of recreational catch to total catch > previous proportion estimate (1.8%)	Yes	Last estimate: 7.9%
Biomass	• Rate of CPUE decline over last 3 years is greater than the largest 3-year CPUE decline during the reference period (-0.0664)	No	
Stock stress	• Significant change in the size/age composition of commercial catches	Not assessed	
	• Significant numbers of unhealthy fish landed	No	

Stock status

NOT ASSESSED

The lowest catch reference point was breached. However, this is unlikely to be significant in a fishery that is driven by interstate market and a single operator who does not operate and/or target this species full time.

While both reference points for recreational catch were breached, the catch of School Whiting by the recreational sector remains low.

19. Southern Calamari

Sepioteuthis australis

STOCK STATUS	**UNDEFINED**
Vulnerability of calamari to fishing pressure is unclear but probably high. High recreational interest in the species.	
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 waters	Gomon et al. (2008)
Diet	• Various crustaceans and fishes	Norman (2000)
Movement and stock structure	• Highly mobile. Undergoes migration between feeding grounds and spawning grounds. • There are a minimum of 5 genetically distinct stocks in Australia. 98% of the Tasmania population belongs to a single genetic stock which is also found in various proportions in the South Australian, New South Wales and Western Australian populations, suggesting some degree of interbreeding between these areas.	Triantafillos & Adams (2001) Triantafillos (2004)
Natural mortality	• High. • Embryo mortality rate between 5% and 25%.	Steer et al. (2004)
Maximum age	• Short-lived (<1 year). Maximum recorded ages are 275 days for males and 263 days for females.	Pecl et al.(2004)
Growth	• Rapid growth at 7-8% body weight/day in individuals <100days old, decreasing to 4-5% BW/day in squids older than 200 days. • No gender difference in growth. Growth from 80 days (when recruitment to inshore waters occurs) best described by a power function $L = 2e^{-6}t^{3.5332}$ where L is the mantle length (mm) and t is the age (days). • Extremely variable growth. Some variability may be explained by temperature and food availability (individuals hatched in warmer season/year generally grow faster) but	Pecl et al.(2004) Triantafillos (2004) Data from Pecl (2004)

	there is also a genetic component. • Length-weight relationship was set at $W = 0.00081L^{2.427}$ where W is weight (g) and L is the dorsal mantel length (mm).	
Maturity	• Size-at-50% maturity estimated at 184.5mm for females.	Data from Pecl (2006)
Spawning	• Major spawning period in spring/summer (March to July) in Tasmania, with low levels of spawning occurring all year round • Great Oyster Bay (east coast Tasmania) a known spawning ground. Spawning aggregations are male-biased. • Multiple spawners with individual spawning activity occurring over several months (up to 3.5 months). • Females deposit eggs together in collective egg masses, attaching the finger-like capsules to the substrate by small stalks.	Moltschaniwskyj & 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) swim to the surface and can be found near spawning grounds for 20-30 days. • Habitat and ecology between 20-80 days unknown. • From 80-150 days, juveniles are found in deeper water adjacent to spawning ground. • Individuals become available to the fishery between 90-120 days of age.	Steer et al. (2002) Pecl (2000) Pecl (2004)

Background

The fishery for Southern Calamari initially developed in the mid-1990s in Great Oyster Bay and then expanded rapidly to the south (including Mercury Passage, Maria Island and Tasman Peninsula) during the latter half of the 1990s—with annual catches rising from less than about 20 tonnes prior to 1995/96 to about 90 tonnes in 1998/99. Since then, catches have fluctuated between 40 and 110 tonnes. The expansion of the fishery was accompanied by a massive increase in effort, particularly hand squid jig, which has become the primary capture method in recent years. Calamari are also taken by a variety of other methods including purse seine, beach seine, spear and dipnet. Although some night fishing occurs, calamari are mainly targeted during the day over shallow areas of seagrass and macro-algae where they aggregate 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 south east waters • Temporal and spatial closures (Mid October- Mid November) of some east coast waters **Output control:** • Possession limit of 15 individuals for recreational (10 in south east waters)
MAIN MARKET	Local and interstate

Current assessment

Catch, effort and CPUE

While the main fishery is concentrated off the central east and south east coasts, catches are reported from all areas apart from the west coast (Fig. 19.2). Spawning area closures first introduced in 1999 appear to have been successful in reducing pressure on the main spawning grounds (Great Oyster Bay and Mercury Passage) and in encouraging industry to spread their effort throughout the State (Fig. 19.1A). Catches increased off the north-east coast (around Bicheno and Waterhouse Island) in 2002/03 (Fig. 19.1A) and off the north-west (mainly around Stanley) in 2007/08, with current production levels similar to that for Mercury Passage and the south-east coast (Fig. 19.2).

Effort is focused in Great Oyster Bay, Mercury Passage, off Bicheno on the east coast, around the Tasman Peninsula in the south-east, and Stanley in the north (Fig. 19.2). There has been a general shift in effort in recent years from Great Oyster Bay to Mercury Passage (Fig. 19.2) where catch rates have been more consistent over time (Fig. 19.1D). Low availability of calamari in Great Oyster Bay has been confirmed by industry reports for several years now. These observations are consistent with surveys of egg production from the main inshore spawning beds in Great Oyster Bay that indicated very low egg densities for 2011 and 2012, and continues the general decline in egg production since 2004 (Fig. 19.3). Assuming egg production is related to abundance of adults on spawning ground, then the general decline in catch rates in Great Oyster Bay (Fig. 19.1D) is likely to be influenced by both the impacts of closures during peak fishing period and by a reduced spawning stock size. Industry has however reported large number of egg masses outside the Great Oyster Bay area, e.g. around Maria Island and in the north of the State, suggesting that there are other spawning grounds providing recruitment for the calamari stock.

Effort and CPUE have been relatively stable for the north east coast since its initial increase in 2002/03, while effort and CPUE continued to increase until 2008/09 before stabilising in recent years for the north west coast (Fig. 19.1C and E).

Southern calamari

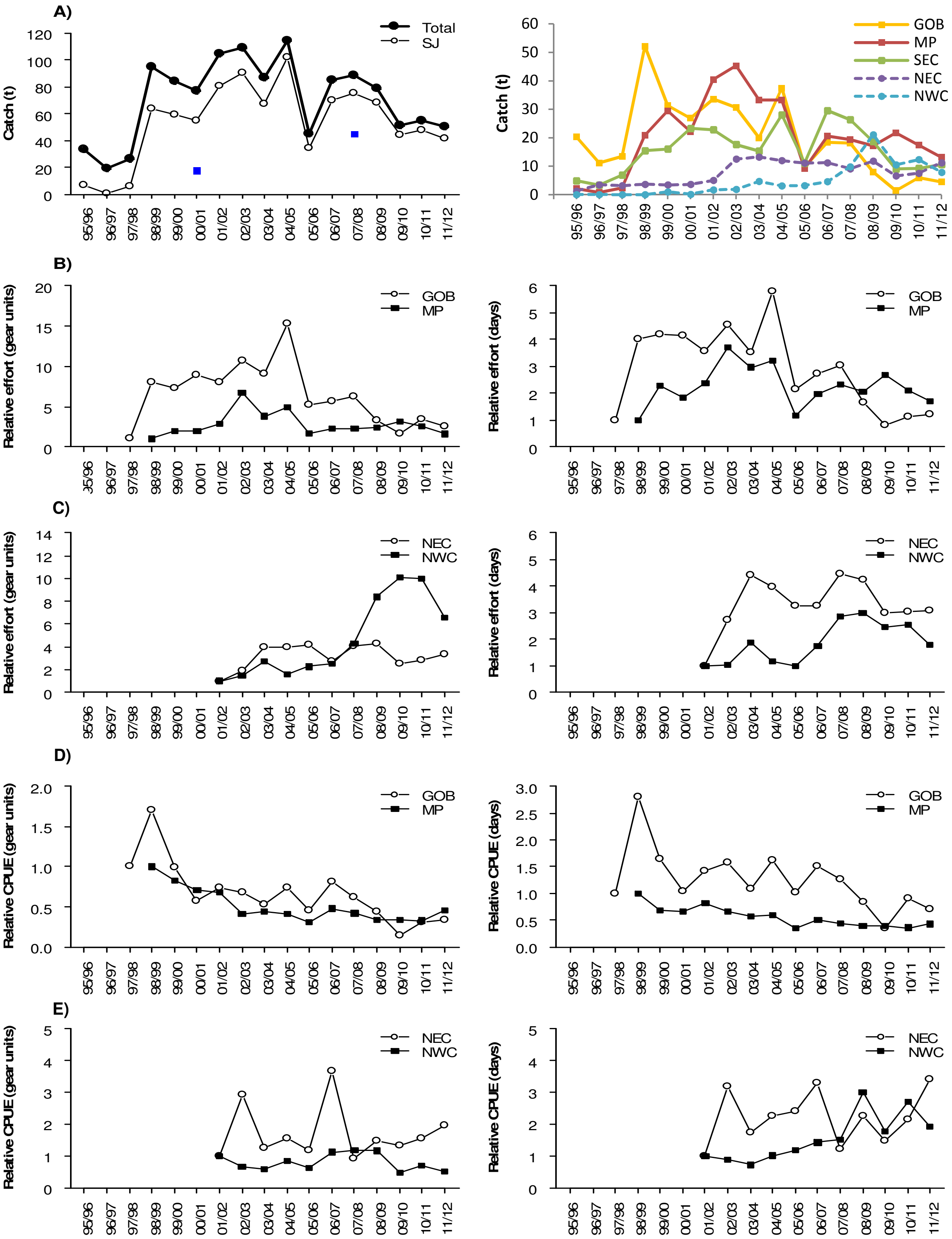
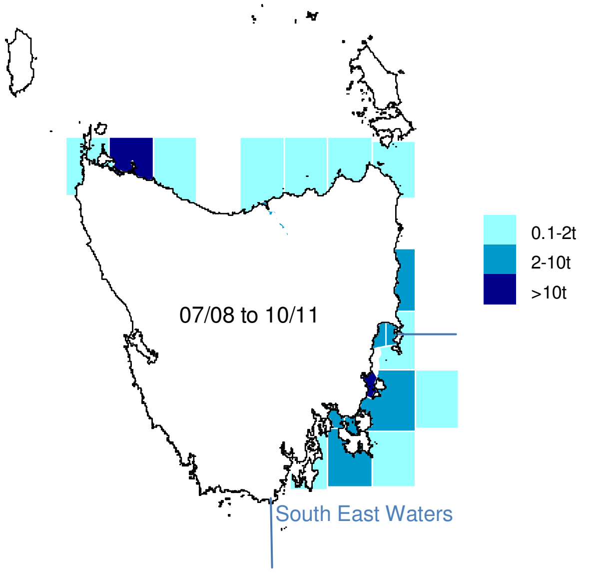


Fig. 19.1 A) Annual commercial catch (tonnes) by gear (left) and by region (right), and best estimates of recreational catches (single squares); Commercial squid jig effort based on B) gear units (left) and days fished (right) relative to 1998/99 for MP and 1997/98 for GOB and C) gear units (left) and days fished (right) relative to 2001/02 for NEC and NWC; Commercial squid jig catch per unit effort (CPUE) based on D) weight per gear unit (left) and weight per day (right) relative to 1998/99 for MP and relative to 1997/98 for GOB, and E) weight per gear unit (left) and weight per day (right) relative to 2001/02 for NEC and NWC; SJ = squid jig, DN = dipnet; NWC= north-west coast, NEC= north-east coast, SEC = south-east coast, MP = Mercury Passage, GOB = Great Oyster Bay. Only years with >5 operators are shown.

A) Catch



B) Effort

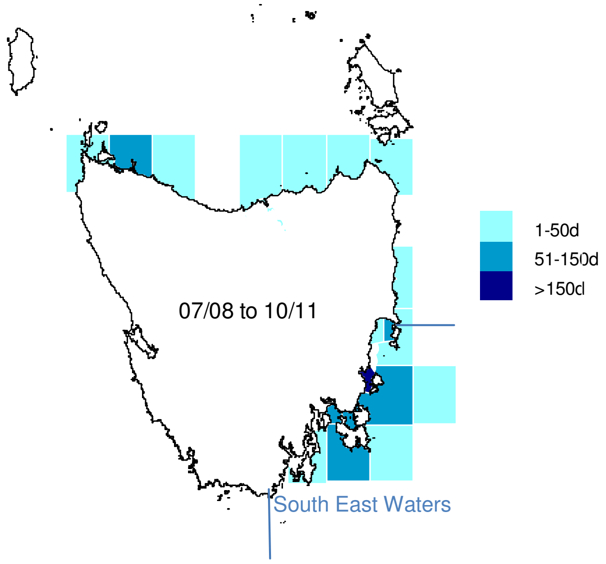


Figure 19.2 (A) Calamari catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right). South East Waters management boundaries are also displayed.

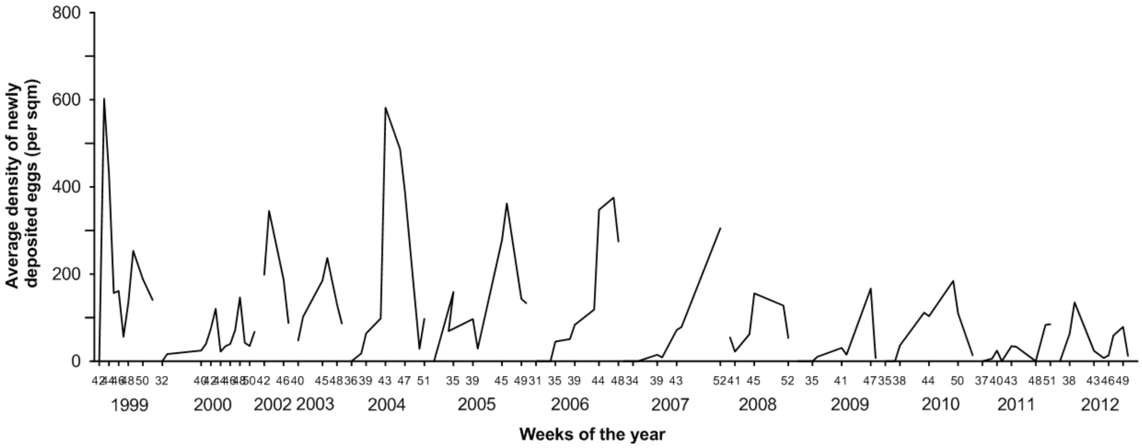


Figure 19.3 Calamari egg production estimated from dive surveys of the main inshore spawning beds in Great Oyster Bay by week of year.

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	• Catch > highest catch from the 1990/91 to 1997/98 range (33 t)	Yes	17.4 t (52.7%)
	• Catch < lowest catch from the 1990/91 to 1997/98 range (5.8 t)	No	
	• Catch increases by > 30% from previous year (>71.4 t)	No	
	• Catch decreases by > 30% from previous year (<38.5 t)	No	
Effort trend	• Effort >10% of highest level from 1995/96 to 1997/98 (>879 days fished)	Yes	223.1 days fished (27.9%)
Catch rates trends	• Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0114 t/days fished)	No	

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (104.8 t)	No	
	• Catch < 3rd lowest catch value from the reference period (33 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	26.9 t (151.9%)
	• Proportion of recreational catch to total catch > previous proportion estimate (18.8%)	Yes	Last estimate: 33.4%
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)	No	
Stock stress	• Significant change in the size/age composition of commercial catches	Not assessed	
	• Significant numbers of unhealthy fish landed	No	

Stock status

UNDEFINED

The current reference range for catch and effort are based on a period prior to the development of the fishery, and therefore result in a triggering of the reference points. The proposed reference points overcome this shortfall by using a more appropriate reference range. None of the proposed indicators were breached for commercial catches. The recreational reference points were breached, reflecting an increasing interest in the species from this sector.

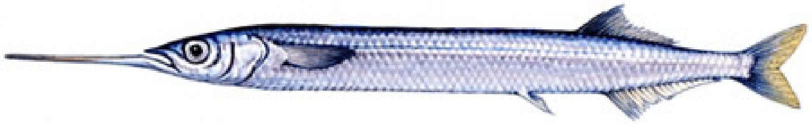
Vulnerability of calamari to fishing pressure is unclear but probably high because spawning aggregations are targeted and the species has an annual or sub-annual life span that renders the stock susceptible to spawning and/or recruitment failure. The species specific licence has effectively capped effort in the south east and, if the population is allowed to spawn (during the fishing closures) prior to the main harvest period, the population may be able to sustain high rates of fishing mortality without detrimental effects on future recruitment. There remains however a high and increasing interest in the species from the recreational sector, particularly in areas in south-eastern waters such as D’Entrecasteaux Channel, Norfolk and Frederick Henry Bay, and Great Oyster Bay. While catch rates have slightly improved in Great Oyster Bay following a strong decline in catches and catch rates in 2008/09 and 2009/10, there is a need to monitor the developments in the fishery over the coming years, especially in light of the decreasing egg production in one of the main known spawning areas. The identification of source and sink populations supporting the Tasmanian calamari fishery is critical to ensure a sustainable use of this resource.

Catch and effort have increased over time outside of the South East Waters (defined as waters between Lemon Rock to Whale Head for calamari management), particularly around Bicheno and Stanley. Virtually nothing is known about the status of the stocks off the north coast, but growing interest from commercial and recreational fishers suggests a need for at least some baseline monitoring.

20. Southern Garfish

Hyporhamphus melanochir

STOCK STATUS	**Not Assessed**
After a strong decline in catches from 2006/07 coupled with changes in population structure, which prompted management actions, the species is showing early signs of recovery.	
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	- Eden (New South Wales) to Perth (Western Australia), including Bass Strait and Tasmanian waters. Endemic to Australia.	Gomon et al. (2008)
Diet	- Predominantly herbivores (seagrass, algal filaments). Also consume 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. - School near the surface at night and close to bottom during day. - There are 4 genetically distinct populations distributed in Western Australia, western South Australia, eastern South Australia/Victoria and Tasmania. - It is likely that at least two garfish subpopulations exist in Tasmania, as suggested by the different size and age characteristics exhibited through sampling of the north and east coasts. This has not been confirmed genetically.	Grant (1991) St Hill (1996) Jones et al. (2002) Hartmann & Lyle (2011)
Natural mortality	- High. Estimated at 55% for adults of four years and over for the east coast population.	Jones (1990)
Maximum age	- Up to 9 years old. In recent years, individuals 6 years and older have been rare in catches.	Jordan et al. (1998) Hartmann & Lyle (2011)
Growth	- From 6 month onwards, growth follows a Von Bertallanffy 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 the fork length (cm).	Jordan et al. (1998) Hartmann & Lyle (2011)
Maturity	- Size-at-50% maturity estimated at 19.9cm for females and 17.1cm for males. - The relationship between batch fecundity and fork length is linear with $F = 188.75L - 3585.8$, where *F* is the fecundity (in number of eggs) and *L* is the fork length (cm).	Hartmann & Lyle (2011)
Spawning	- Spawning is concentrated in shallow (<5 m deep) over	Jordan et al. (1998)

	beds of drift algae in eastern Tasmania. It occurs over an extended period of at least five months from October to February, with peak activity occurring between October and December. • Eggs are around 2.93 mm in diameter and are negatively buoyant, sinking to the bottom after fertilisation and becoming attached to drift algae.	
Early life history	• Incubation time estimated at one month. Large hatchlings (7.8-8.5mm) are assumed to stay in shallow waters as evidenced by the presence of small juvenile (0+ cohort) in the coastal sheltered waters of east Tasmania.	Jordan et al. (1998)
Recruitment	• Variable. No-stock recruitment relationship established.	

Background

Traditionally a winter beach seine fishery, catches were initially centred off the northeast coast, including Flinders Island. More recently the fishery has extended to the east and southeast coasts and, with the introduction of dipnets, catches have increasingly been taken over the summer months. Nowadays, garfish is caught almost exclusively by beach seine on the north-east coast and mainly by dipnets off the south-east and east coasts.

FISHING METHODS	Mainly dip net and beach seine
MANAGEMENT METHODS	**Input control**: • Temporal commercial closure during spawning: mid-Nov to mid-Dec for southern waters, mid-Jan to mid-Feb for northern waters (Northern and southern waters are delineated by a line following the north coast of Tasmania, joined and bounded in the west by a line of latitude through Cape Grim and in the east by a line of latitude through Cape Naturaliste). • 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 (recreational)
MAIN MARKET	• Mainly local

Current assessment

Biological characteristics

The sharp and unexpected decline in catches in 2006/07 and 2007/08 prompted the need to better understand stock status and resulted in the introduction in 2009 of a one month commercial closed season to protect the species during the spawning season.

Size composition

Since the mid-1990's there has been a reduction of 2-3 cm in the average size of garfish in eastern Tasmania, and up to 5-6 cm in northern Tasmania (Fig. 20.3). Annual length frequency distributions tended to be unimodal with a peak between 28-33 cm in the 1990's and 27-28 cm during the late 2000's. These reductions were associated with a sharp decline in commercial catches and may be indicative of a more general change in population structure. Since 2011 however, there appears to be a recovery with average size in eastern Tasmania moving towards 30 cm.

A similar pattern is apparent in the north coast. During the mid-1990's individuals between 35 and 40 cm were relatively common in the catch but in subsequent years fish larger than about 35 cm were rare (Fig. 20.3). Since 2012, there has been an increase in the average size of garfish, and in the catch of larger fish (>35 cm).

Age composition

The age structure of east and north coast catches taken between 2008 and 2011 were similar, and both were dominated by 2-4 year old fish (Fig. 20.2). In both the east and the north coasts, these dominant classes accounted between 80 and 90% of the catch numbers in each of the years. Fish aged up to 7 years and 8 years were represented in catches from the north and east coast respectively, although individuals 6 years or older were rare (<2% numbers for the north and <8% for the east coast). By contrast, the age structure of east coast caches taken between 1995-1997 was characterised by a broader range of age classes, 3-7 year olds, with 4 and 5 year olds dominating and accounting for 43% of the total sample (Jordan et al. 1998). Over the past decade there is no evidence for changed gear selectivity (e.g. via gear modifications), nor have there been reported changes in fishing practices or market preference that would account for the shift to younger/smaller fish. The contraction in age structure and sharp fall in catches since the mid-2000s may hence reflect fundamental changes in population structure, which may have resulted from heavy fishing pressure and/or poor recruitment during the early 2000's.

In 2012 however, the age distribution changed in both regions, possibly indicating the start of a recovery (Fig. 20.2). The age distribution in the east coast is now dominated by 3-5 years old, which represented over 75% of the catch numbers. The age distribution in the north is still dominated by 2-4 years old (80% of the catch numbers) but in both regions there is an increase in the proportion of older fish, individuals 6 years or older accounting for around 13% in numbers.

Catch, effort and CPUE

After many years of relative stability in garfish catches at 80-90 tonnes per annum, catches fell sharply in 2006/07 and have fluctuated between 30-60 tonnes since that time. The 2011/12 catch was 52.9 tonnes represented an increase of almost 23% compared to 2010/11 (Fig. 20.3A). The increase in catch was evident for both gear types and particularly in the north-east coast (Fig. 20.3A and Fig. 20.4A).

Recreational garfish catches are low compared to commercial catches and were estimated around 2 tonnes in both 2000/01 and 2007/08 (Lyle et al. 2009).

Effort in both gear types has been slowly decreasing over time (Fig. 20.3B and Fig. 20.4B). Dipnet effort increased initially to a peak during 1998/99 but has subsequently decreased to a lower level (Fig. 20.3B, days fished), while beach seine effort experienced a more recent decline.

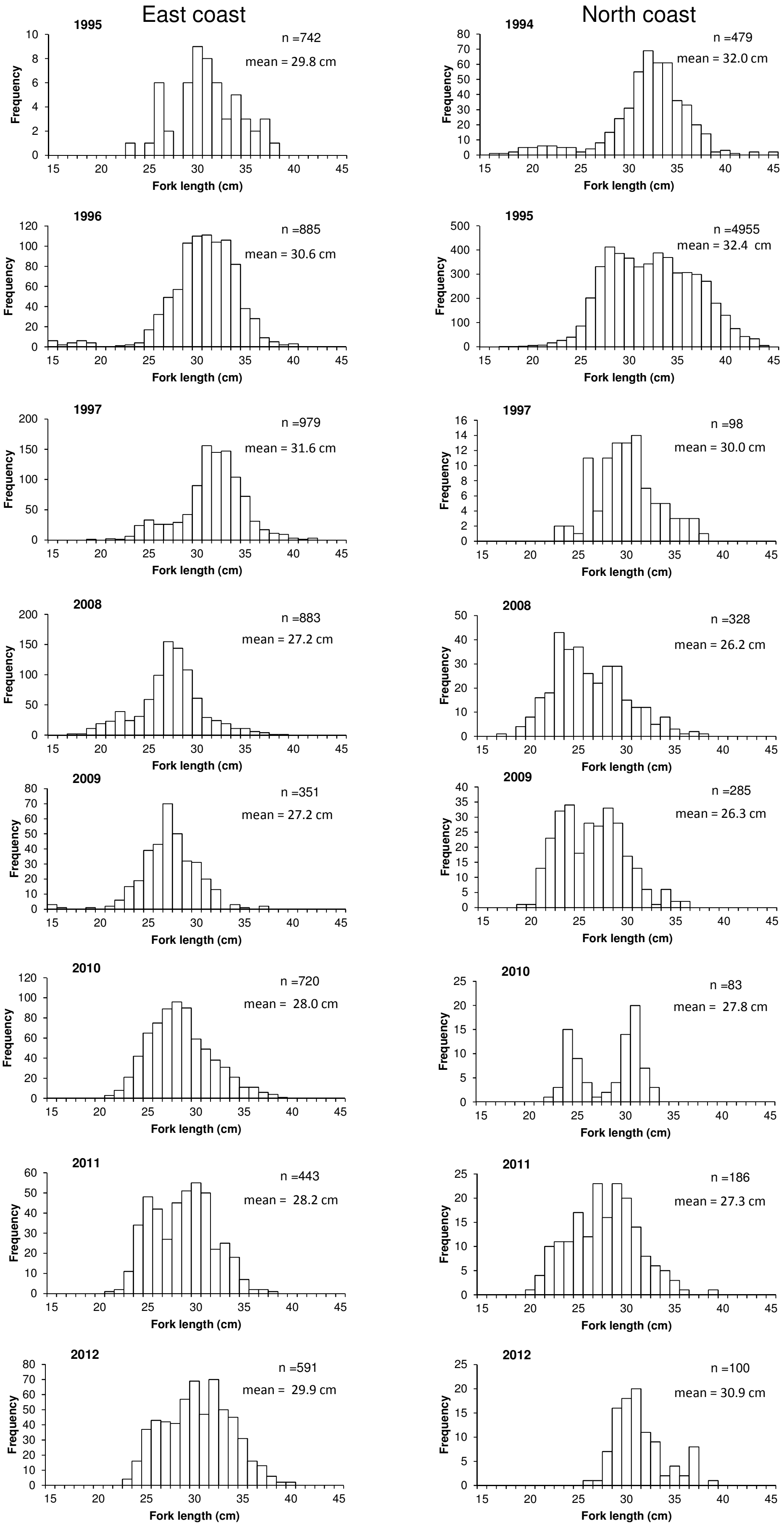


Figure 20.1. Size composition of Southern Garfish by year for east coast (left) and north coast (right) commercial catches. *n* is the sample size.

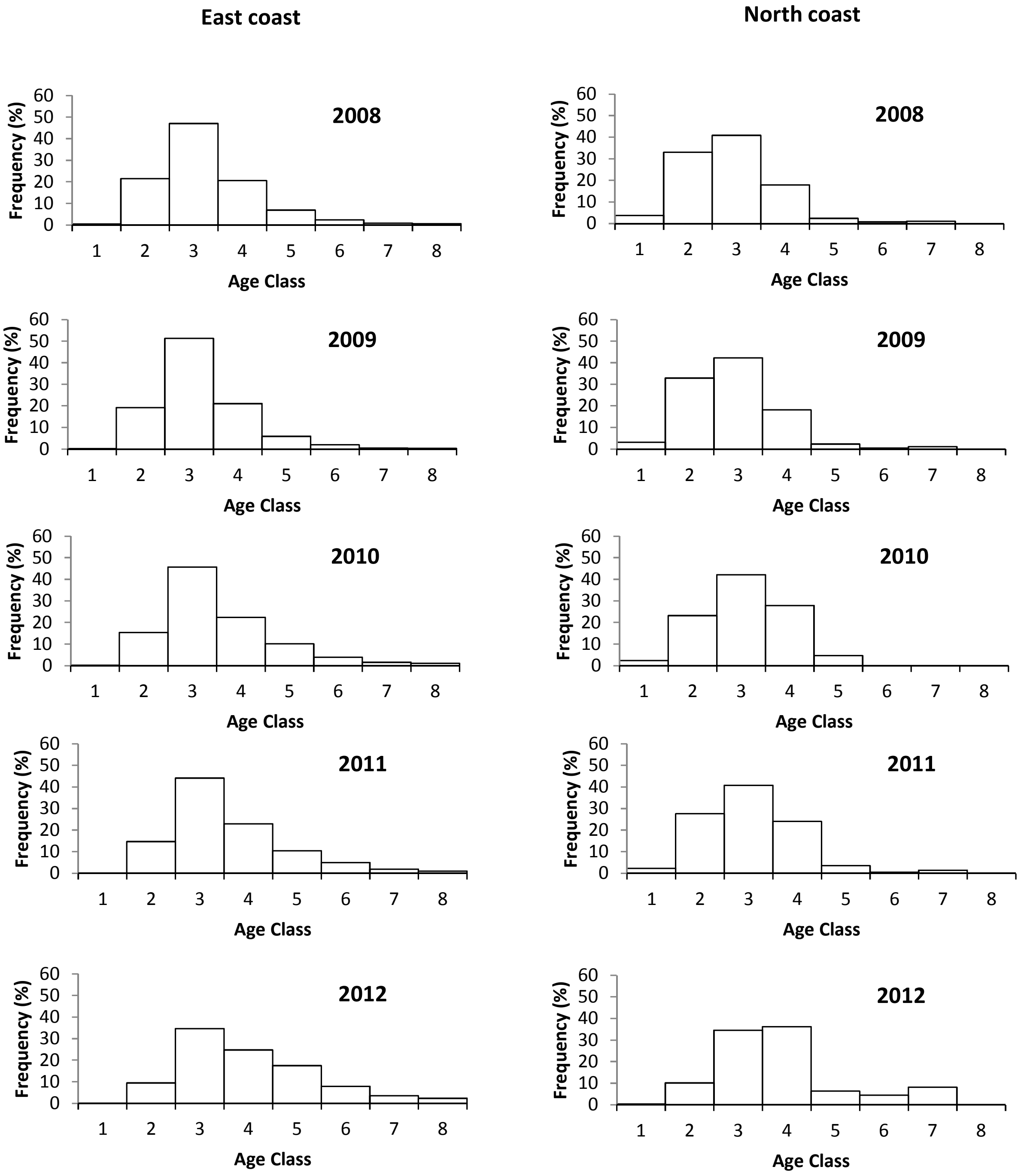


Figure 20.2. Age composition of Southern Garfish by year for east coast (left) and north coast (right) commercial catches.

Catch rates for beach seine fluctuated much more strongly over time than those for dipnet but catch rates for both beach seine and dipnet have increased in 2011/12 (Fig. 20.3C). Beach seine catch rates fluctuated at high levels until 2006/07, when they stabilised at low level until 2011/12. By contrast, dipnet catch rates have undergone two periods of decline with a recovery period in between. In the context of schooling species such as garfish, catch rates may be relatively insensitive to changes in abundance.

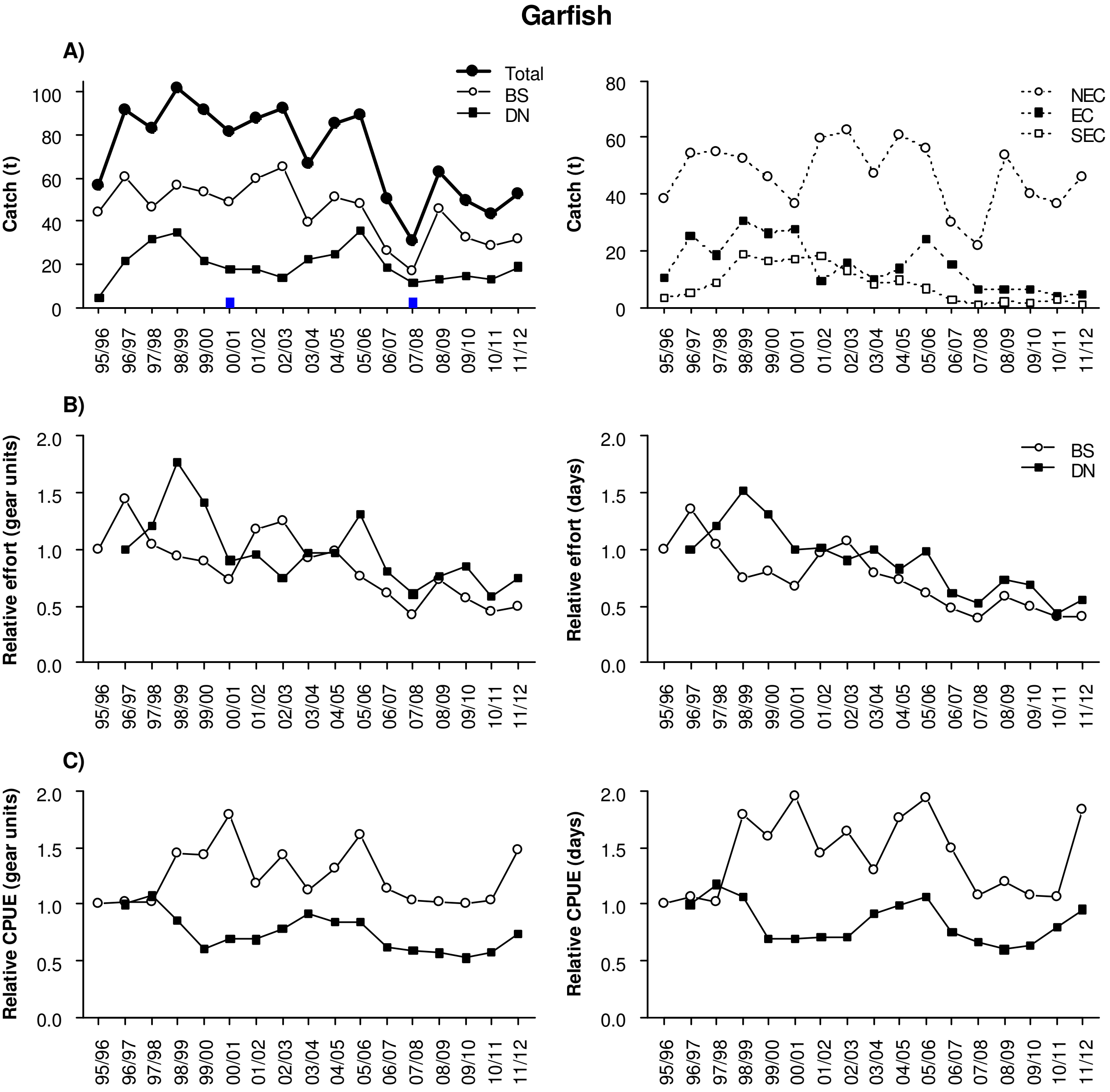


Figure 20.3 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. BS= beach seine, DN= dip net, SEC= south east coast, EC= east coast, NEC= north east coast.

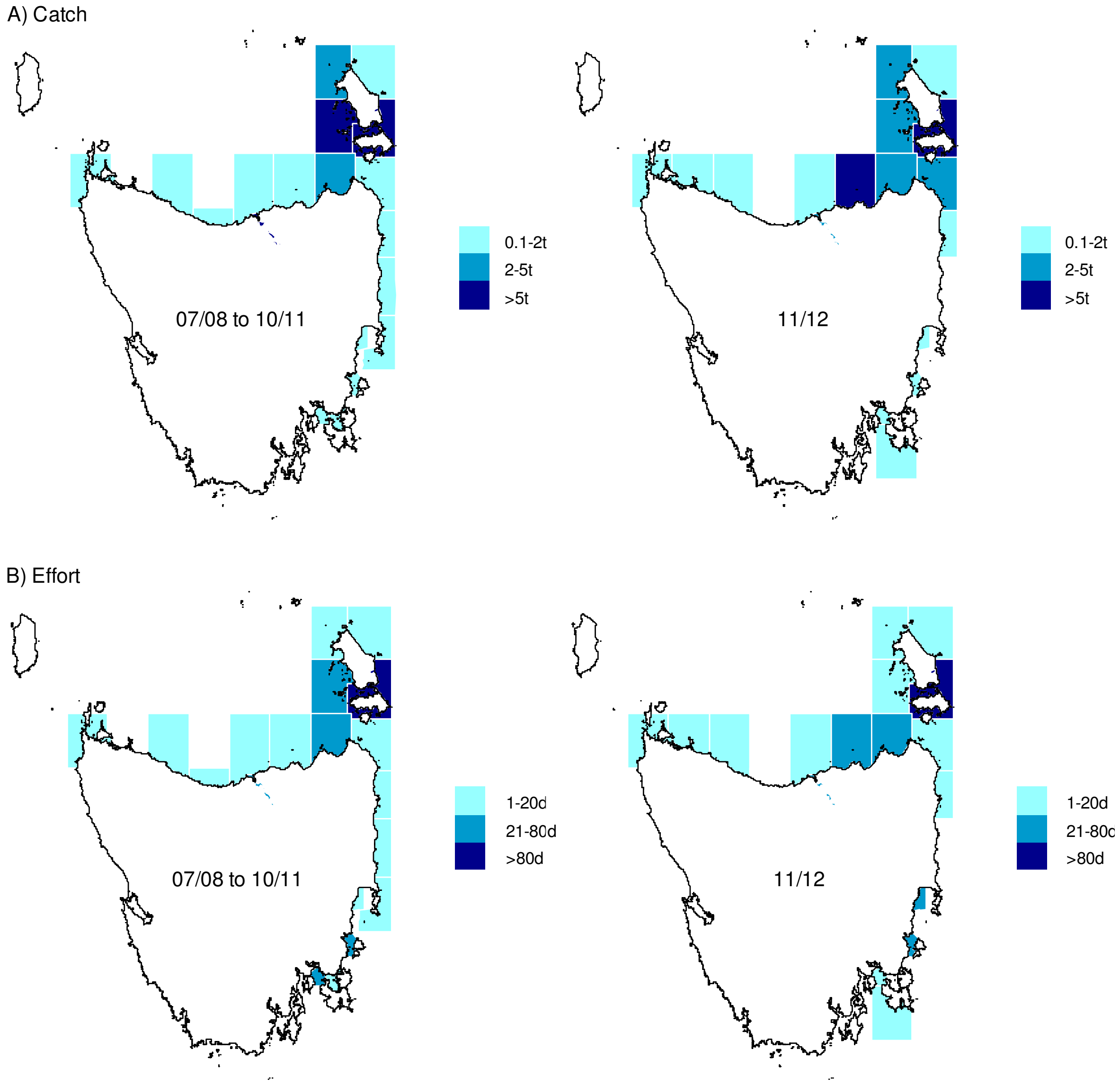


Figure 20.4 (A) Garfish catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	• Catch > higher catch from the 1990/91 to 1997/98 range (91.6 t)	No	
	• Catch < lowest catch from the 1990/91 to 1997/98 range (56.2 t)	Yes	3.3 t (5.9%)
	• Catch increases by > 30% from previous year (>56.2 t)	No	
	• Catch decreases by > 30% from previous year (<30.3 t)	No	
Effort trend	• Effort >10% of highest level from 1995/96 to 1997/98 (>1081 days fished)	No	
Catch rates trends	• Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0306 t/days fished)	No	

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (91.6 t)	No	
	• Catch < 3rd lowest catch value from the reference period (66.2 t)	Yes	13.4 t (20.2%)
	• 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)	Yes	0.1 t (5.3%)
	• Proportion of recreational catch to total catch > previous proportion estimate (2.4%)	No	
Biomass	• CPUE< 3rd lowest CPUE value from the reference period (0.0503 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 (-0.0073)	No	
Stock stress	• Significant change in the size/age composition of commercial catches	No	
	• Significant numbers of unhealthy fish landed	No	

Stock status

NOT ASSESSED

The lowest catch reference point was breached, reflecting that catches are still low compared to levels prior to the 2006/07 decline. However, catch and catch rates have risen in 2011/12. While the recreational reference was also breached, the recreational catches have remained essentially the same.

Vulnerability of Southern Garfish to fishing pressure is unclear, but is probably moderate to high because of the schooling behaviour of the species—which means the species can be effectively targeted under favourable conditions. As a relatively short-lived species, and with a population dominated by relatively few age classes, any recruitment variability is likely to have a marked impact on population size.

There was some clear evidence of a reduction in average fish size and a truncation of the age structure up to 2011 that may be indicative of a more general change in population structure from heavy fishing pressure and/or poor recruitment. There were early signs of population recovery in 2012, which may be linked to the implementation of the spawning closure for commercial operators in 2009. However, while abundance (based on catch levels) in the north-east appeared to show signs of recovery, abundance remained particularly depressed in eastern and south-eastern waters. Also, the current minimum legal length of 25 cm total length is above the size at maturity for both sexes (size at 50% maturity is 17.1 cm fork length for males and 19.9 cm for females, Hartmann and Lyle 2011).

Some industry members have expressed concern about the effects of dipnets on the schooling behaviour of garfish. Specifically, it has been suggested that intense dipnet activity tends to cause schools to break and hence reduce opportunities to use beach seines to target the species, possibly affecting catch rates. Since such interactions tend to be localised, analyses at the spatial resolution of fishing blocks are unlikely to be sensitive enough to detect such impacts.

21. Striped Trumpeter

Latris lineata

STOCK STATUS	**TRANSITIONAL – RECOVERING**
After a lack of recruitment for over a decade, Striped Trumpeter is showing signs of recovery in the last 3 years. However, the stock currently relies exclusively on recent recruits.	
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 300m 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 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 movements, remaining around shallow reefs for several years before moving into deeper offshore reefs. • Adults have the capacity to undergo wide-scale movements (e.g. Tasmania to St Paul Island in 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. (2007b)
Natural mortality	• Estimated at M=0.1.	Tracey and Lyle (2005)
Maximum age	• Estimated at 43 years.	Tracey and Lyle (2005)

<table>
<tr>
<td>Growth</td>
<td>• Maximum length: 1.2 m
• Maximum weight: 25 kg
• Rapid juvenile growth (mean FL = 28 cm after 2 years, 42 cm after 4 years). Slower adult growth (large range of size-at-age over 50 cm FL)
• Growth for both sex described by a two-phase von Bertalanffy growth function
$L = \left(1 - \int_{t=-t_0}^{+t^{\delta}} \frac{1}{\sigma\sqrt{2\pi}} e^{\left(\frac{-(t-t_{01})^2}{2\sigma^2}\right)}\right)\left(L_{\infty1}\left(1-e^{-k_{1(t-t_{01})}}\right)+\varepsilon\right) + \left(1 - \int_{t=t^{\delta}}^{+t_{max}} \frac{1}{\sigma\sqrt{2\pi}} e^{\left(\frac{-\left(t-t^{\delta}\right)^2}{2\sigma^2}\right)}\right)\left(L^{\delta}+\left(L_{\infty2}-L^{\delta}\right)\left(1-e^{-k_{2(t-t_{02})}}\right)+\varepsilon\right)$
where *L* is the length (mm), *t* is the age (years), $L_{\infty1} and\ L_{\infty2}$ are the average maximum length for the species for the 1st and 2nd growth phase respectively, k_1 and k_2 are constants, t_{01} and t_{02} are the (theoretical) age where length equals zero for the 1st and 2nd growth phase respectively, L^{δ} 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.
Parameters estimates are:
<table>
<tr><th>$L_{\infty1}$</th><th>k_1</th><th>t_{01}</th><th>L^{δ}</th><th>$L_{\infty2}$</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 sex was estimated at $W = 2E^{-5}L^{3.00}$, where *W* is weight (g) and *L* is the 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 estimated at 55.1 cm FL (60.3 cm TL, 6.8 years) for females and 53 cm FL (61 cm TL; 6.2 years) for males.
• Batch fecundity (BF) estimate:
$BF = 4.15E^{-8}FL^{4.69}$, where *FL* is fork length in cm.</td>
<td>Tracey et al. (2007a)
Tracey et al. (2011)
TAFI unpublished data</td>
</tr>
<tr>
<td>Spawning</td>
<td>• August to November
• 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>Tracey et al. (2011)
Ruwald, 1992 (1992)
Hutchinson (1993)</td>
</tr>
<tr>
<td>Early life history</td>
<td>• Complex and extended larval phase of at least 9 months before settlement.
• No information on size and timing of settlement. Juveniles of around 18 cm FL (23 cm TL) have been caught on shallow reefs off south-east coast in January.</td>
<td>Ruwald et al. (1991)
Ruwald, 1992 (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>
</table>

Background

Striped Trumpeter has a long history of commercial exploitation in Tasmania, being highly esteemed for its eating qualities. 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 hooks and gillnets being the primary methods. Juvenile Striped Trumpeter are taken predominantly by graball net in inshore waters and usually in depths <50 m, whereas adult fish are taken in deeper offshore waters by hook methods (dropline, handline, bottom longline, trotline) and as by-product in large mesh gillnets (shark nets). Catches are concentrated off the east coast, including Flinders Island, as well as off the south and south-west coasts of Tasmania.

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 accompanied the OCS, specifying trip limits for Commonwealth only fishers. As part of the Tasmanian scalefish management plan, gear restrictions for all commercial scalefish fishers operating in State waters were introduced in 1998. This however revealed that dual endorsed operators (i.e. holders of a Tasmanian licence and a Commonwealth permit for southern shark or South East Non Trawl) as well as rock lobster fishers could take unrestricted quantities of Striped Trumpeter in offshore waters using their gear allocations. In 2000, the State Government introduced a combined trip limit of 250 kg for Striped Trumpeter, Yellowtail Kingfish and Red Snapper for all fishers (Commonwealth and State) in inshore and offshore waters relevant to Tasmania to limit the potential for expansion of efforts directed at these species. Over time, there has been additional management measures targeted at the species, including a spawning closure, a decrease in the recreational possession limit and several increases in the minimum size limit for the species (currently 50 cm total length (TL), which is below the size at maturity of 60.3 cm TL for females and 61 cm TL for males). Although the Tasmanian seasonal closure is not supported by Commonwealth managed fisheries, they have recently reduced their trip limit for striped trumpeter to 100kg year round.

FISHING METHODS	Mainly handline, also graball net and drop line
MANAGEMENT METHODS	**Input control:** • Gear licence (Scalefish fishing licence) • Temporal closure (Sept-Oct). Not supported by Commonwealth managed fisheries. • Recreational gear licence (Recreational Graball net) **Output control:** • Trip limit of 250 kg (100kg trip limit year round for Commonwealth operators). • On water bag limit of 4 fish for recreational • Possession limit of 8 fish for recreational • Minimum size (500 mm TL)
MAIN MARKET	Mainly local

Current assessment

Biological characteristics

Size composition

In 1999, the size distribution was unimodal and dominated by 50 cm fish, with a tail of older fish up to 89 cm length (Fig. 21.1). Many of the subsequent sample sizes were low and sampling was opportunistic, which may not represent population size structure. Years with good samples size however suggest that no significant recruitment occurred in the fishery for about a decade during the late 1990's and early 2000's following a major recruitment event in 1993. This cohort still dominated the catches in 2009 and at this time, samples were dominated by fish around 62 cm in length. In 2010, the size distribution changed and was again dominated by 50 cm fish, suggesting a new wave of recruits had entered the fishery (Fig. 21.1). The size structure appears stable since 2010 suggesting recruitment over at least 3 consecutive years. The fishery is currently relying heavily on these recent recruits. The lack of individuals over 60 cm in 2012 is almost certainly an artefact of sampling.

Age composition

The very strong 1993 year class (5 year olds in 1999, 6 year olds in 2000, etc.) was prominent in samples obtained from research fishing and commercial catches up until 2009 (Fig. 21.2). As for size, the low sample sizes in many years may not represent population age structure. Notwithstanding these concerns, the data demonstrate a consistent lack of recent recruits (3-5 year olds) up until 2010 which, along with catch declines, imply an extended period of low recruitment. Over the past decade or so the population appears to have been sustained largely by strong year classes spawned during the 1990's.

Samples from 2010 to 2012 were dominated by 4-6 year olds (the age at which the species tends to recruit to the offshore hook fishery), providing evidence of recent recruitment success. While the relative strength of these cohorts is unknown, they provide a positive sign for the future of the stock, although caution is recommended since previous indicators have suggested that the adult segment of the population may be still in a depleted state (due to fishing and lack of recruitment over many years). No individuals older than 10 years old were detected in the 2012 samples, but this reflects the low sampling size rather than a major contraction in the population age structure.

Catch, effort and CPUE

The recent catch history in waters south of latitude 39° 12'S (i.e. waters incorporated within the OCS agreement for Striped Trumpeter), including catches reported in Victorian and Commonwealth logbooks, is presented in Table 21.1. In the early 1990's catches by Victorian vessels were significant, peaking at around 37 tonnes. Since the mid-1990's, data from this sector have been unavailable, though it is assumed that subsequent catches have been reported in Commonwealth logbooks. Apart from 1999/00 when over 14 tonnes was taken, reported Commonwealth catches have been relatively low since that time.

Annual production was high at over 110 tonnes in the early 1990's, Victorian vessels accounting for 17-39% of the total, but then fluctuated between 70-80 tonnes through the mid-1990's before increasing again to over 100 tonnes by the late 1990's (Table 21.1). Catches almost halved in 2000/01 to less than 50 tonnes and have remained low since that time. This trend was observed by all methods in Tasmania (Fig. 21.3A). The production was at its lowest in 2009/10 but appears to be on an upwards trend in the last 2 years. The reported catch of 21.2 tonnes for 2011/12 is a 7.1% increase from the 19.8 tonnes in 2010/11 and a 65.6% increase from the lowest historic catch of 12.8 tonnes in 2009/10.

Commonwealth catches are believed to be substantially underreported and the lack of precise estimates of recreational catches represent sources of uncertainty in estimating the total mortality. The latest recreational survey targeting offshore boating (Tracey et al. 2013) has however provided more detailed information. The recreational fishery has heavily targeted Striped Trumpeter in the past, with an estimated 38 tonnes in 2000/01 (Lyle 2005). Estimates of recreational catches in 2007/08 were highly uncertain but likely to be lower, with an estimated 19 tonnes for combined catches of striped and Bastard Trumpeter (Lyle et al. 2009). Estimates in 2011/12 were 31.9 tonnes for Striped Trumpeter and exceeded the commercial catch for the species (Fig. 21.3A). Recreational catch estimates only partially represent catches taken by charter boats.

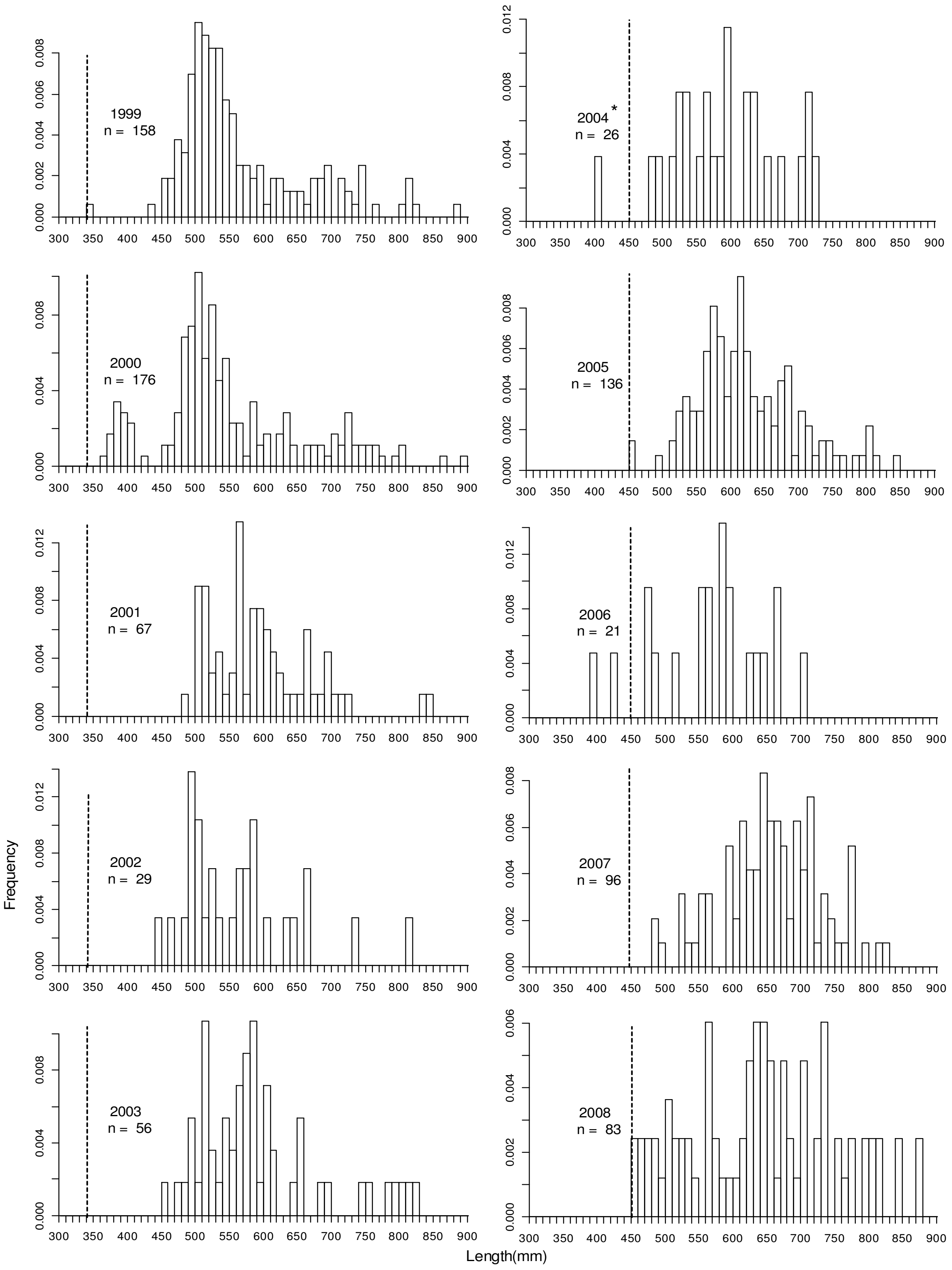


Figure 21.1 Striped Trumpeter length composition (1999–2012) from commercial catches. *n* = sample size. Dotted line indicates the minimum legal size limit and * indicate years when the minimum size limit was changed.

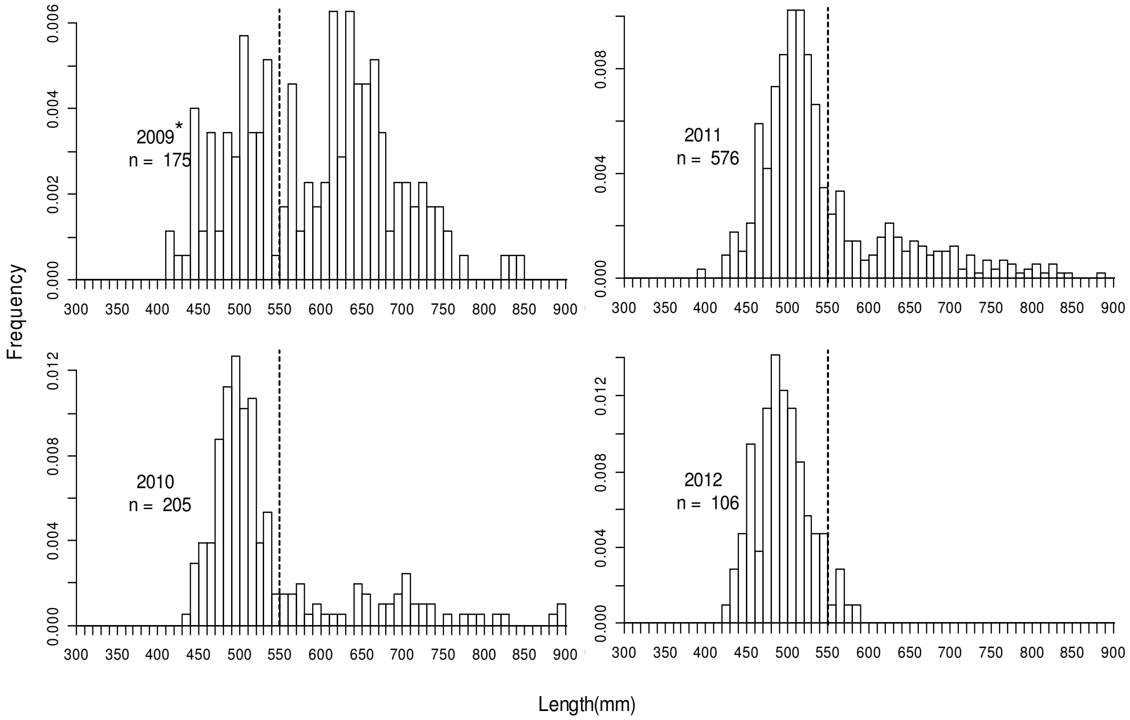


Figure 21.1 - continued

Table 21.1 Annual commercial catches of Striped Trumpeter (tonnes) south of latitude 39 12'S. Data based on Tasmanian, Victorian and Commonwealth catch returns.

	Catch (tonnes)			
Year	Tasmanian	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
1999/00	86.3		14.5	101.8
2000/01	41.2		7.5	49.6
2001/02	40.0		4.8	44.8
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	12.8
2010/11	15.0		4.8	19.8
2011/12	15.8		5.4	21.2

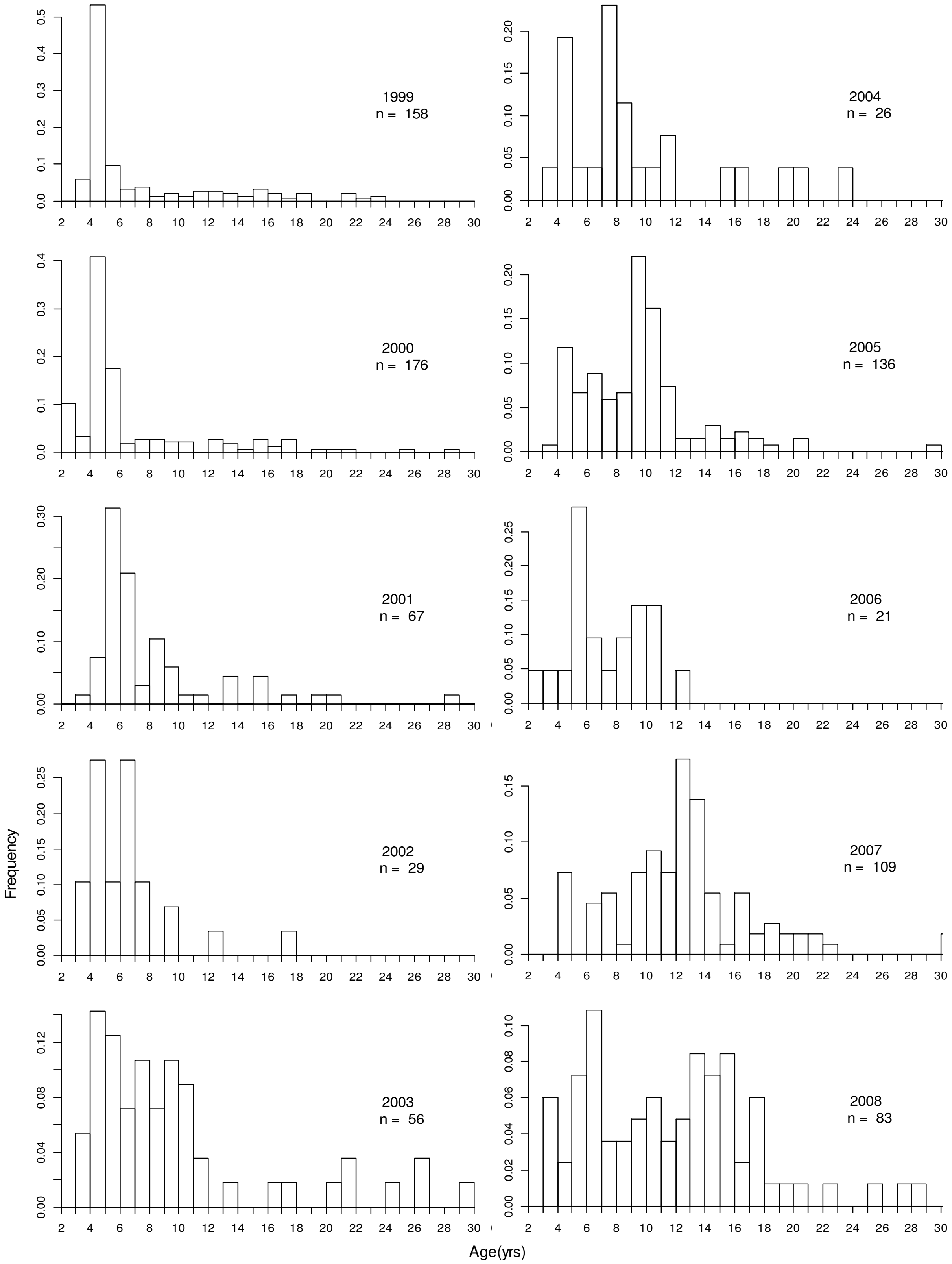


Figure 21.2 Striped Trumpeter age composition (1999–2012) from commercial catches. *n* = sample size (year 2009 to 2012 on following page).

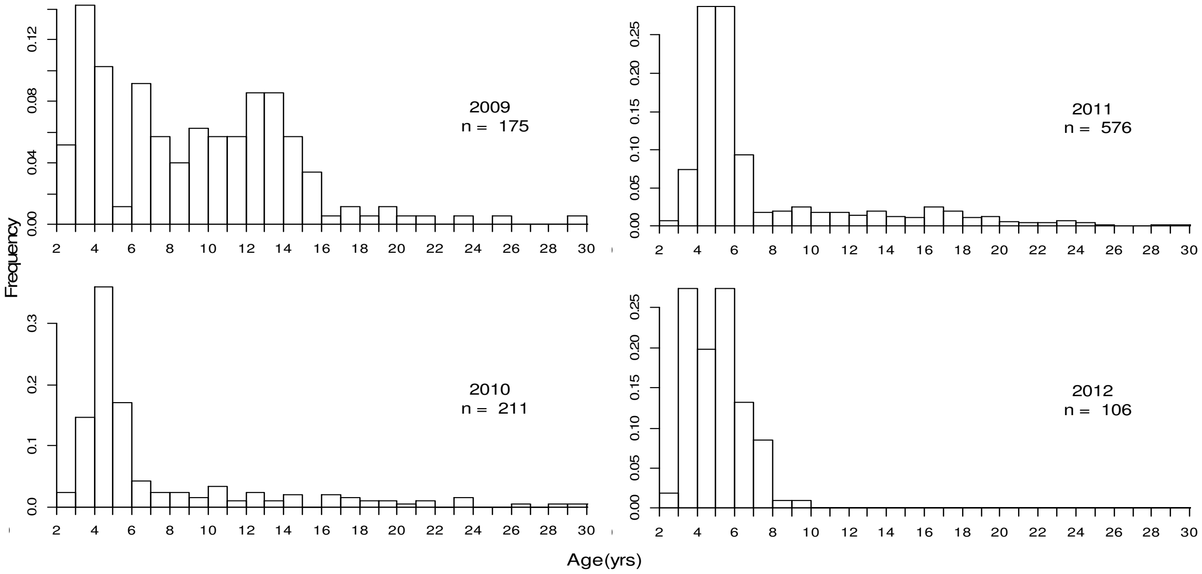


Figure 21.2 (continued)

Apart from the north coast, Striped Trumpeter catches have been reported from all areas around the state, particularly off the south-east and east coasts (Figs. 21.3A and 21.4). Catches strongly declined by 2000/01 and contracted to the south-east coast over recent years. Since 2009/10, catches in the north-west coast have increased to match those of the south-east (Figs. 21.3A and 21.4).

The observed catch trends reflect the influence of especially strong year classes that entered the fishery between 1995/96 and 1997/98. Increased graball catches in 1998/99 followed by a decline suggest that the 1996 year-class, which would have recruited to the inshore gillnet fishery in 1998/99, may also have been relatively strong. The subsequent decline in graball catches presumably reflects the movement of the relatively strong year-classes offshore but also suggests that there has been limited recruitment in recent years. Industry representatives also suggest that the trip limit of 250 kg introduced in 2000 has represented a strong disincentive for some operators to fish for the species and may have contributed to the fall in dropline and handline catches and effort since 2000/01.

Fishing effort increased during the latter part of the 1990's, presumably linked to the increased availability of Striped Trumpeter (Fig. 21.3B). Subsequently, effort for all methods has declined, handline remaining the dominant gear. Fishing activity has been focussed mainly on the south-east and west coasts and to a lesser extent off the north-east, south and south-west during the past few years (Fig. 21.3B).

Recent gear-specific trends of catch rates (including 2011/12) are based on small catches and are thus unlikely to be informative about availability (Fig. 21.3C). Graball catch rates increased steadily up until 2003/04, despite declining catches during the latter half of the period. The sharp fall in graball catch rates since 2004/05 may have been influenced in part at least by the minimum size limit increase that took effect during 2004.

Striped Trumpeter

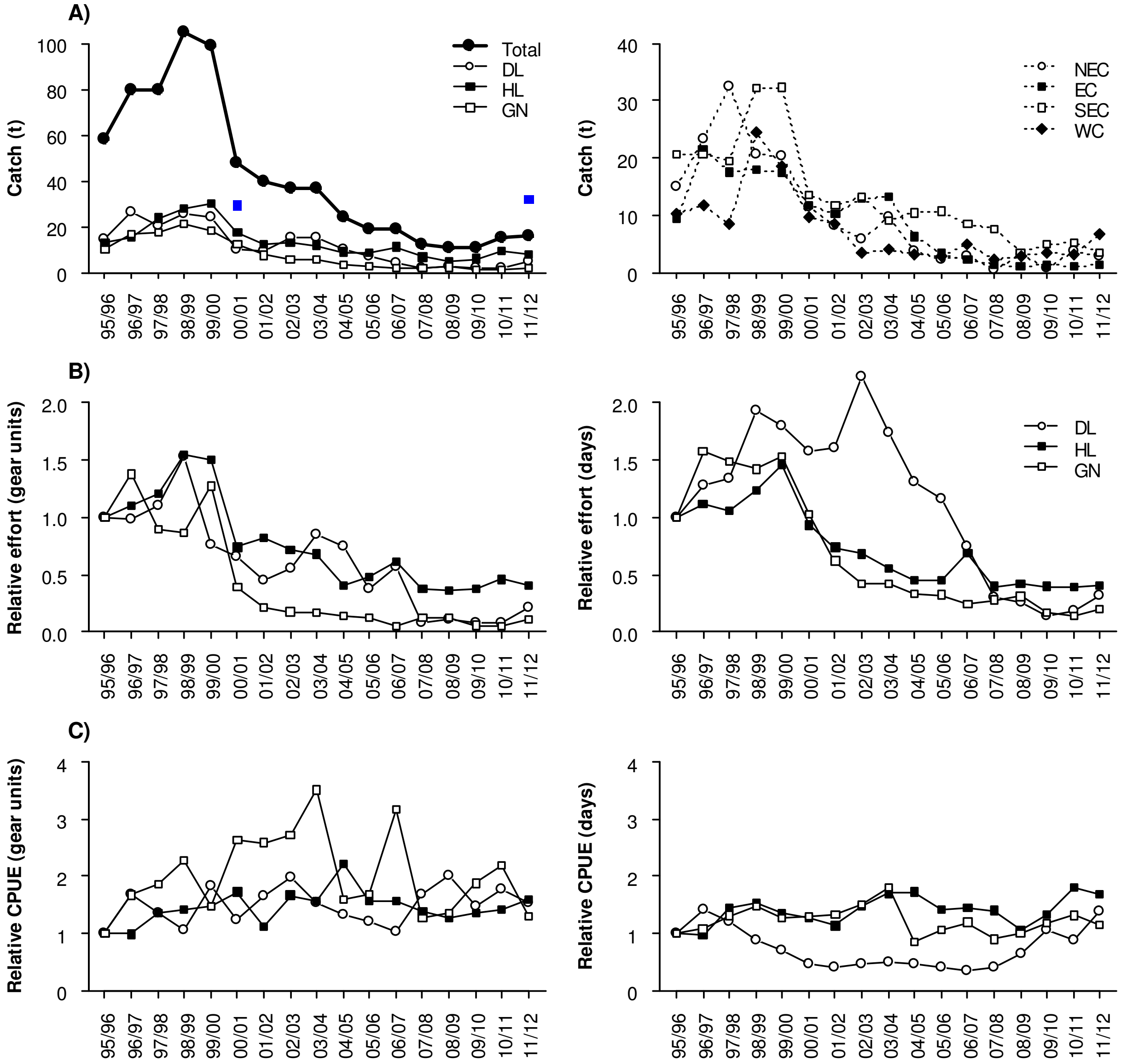


Figure 21.3 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. HL= hand line, GN= graball net, DL = drop line, SEC= south east coast, EC= east coast, NEC= north east coast, WC = west coast.

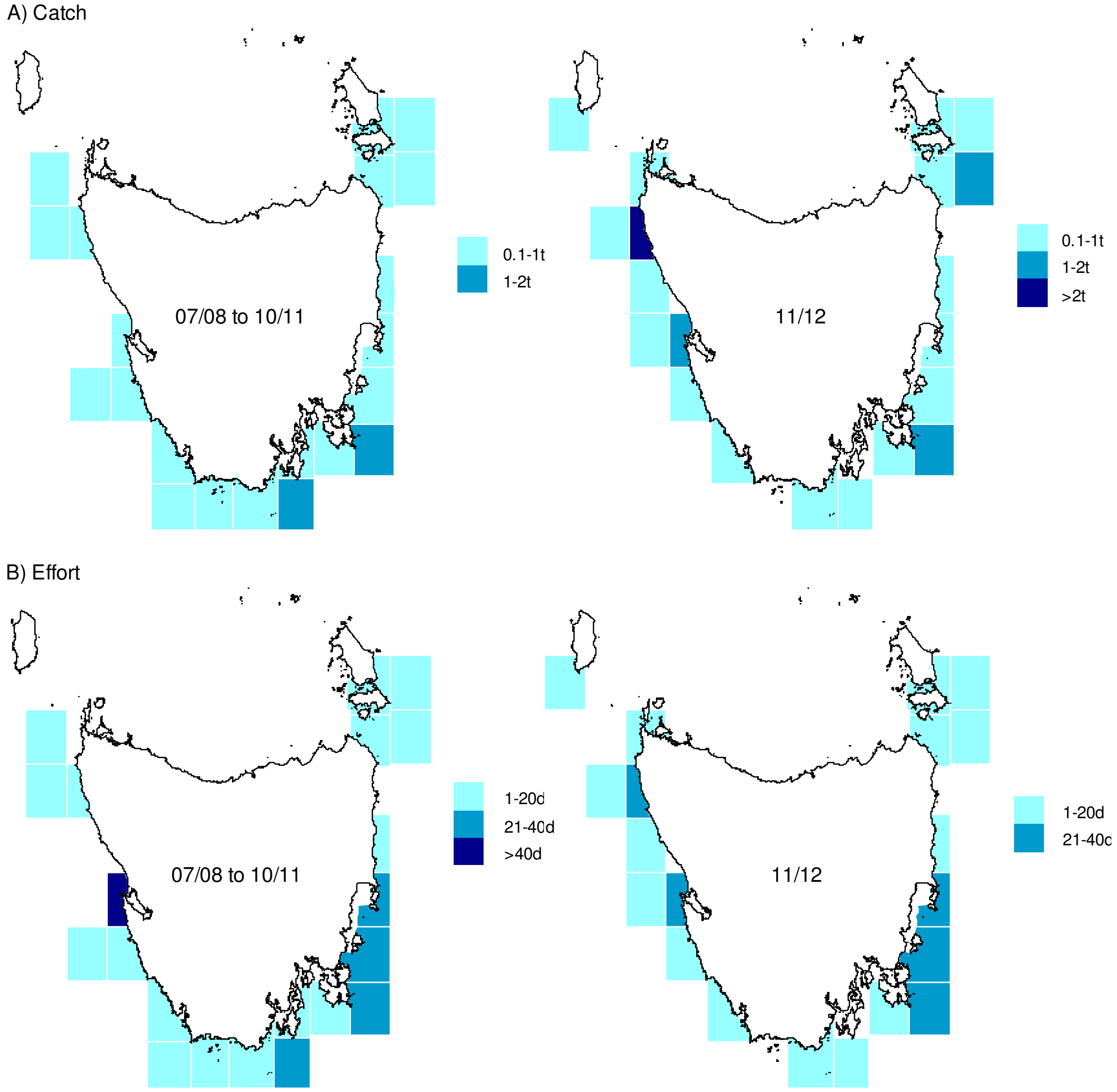


Figure 21.4 (A) Striped Trumpeter catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	• Catch > higher catch from the 1990/91 to 1997/98 range (80.4 t)	No	
	• Catch < lowest catch from the 1990/91 to 1997/98 range (52.7 t)	Yes	36.9 t (70%)
	• Catch increases by > 30% from previous year (>24.1 t)	No	
	• Catch decreases by > 30% from previous year (<13 t)	No	
Effort trend	• Effort >10% of highest level from 1995/96 to 1997/98 (>1695 days fished)	No	
Catch rates trends	• Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0171 t/days fished)	No	

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	8 t (33.5%)
	• 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	2.3 t (7.8%)
	• Proportion of recreational catch to total catch > previous proportion estimate (39.4%)	Yes	Last estimate: 60.1%
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 stress	• Significant change in the size/age composition of commercial catches	Yes	Change in age and size composition indicating recruitment
	• Significant numbers of unhealthy fish landed	No	

Stock status

TRANSITIONAL-RECOVERING

The sharp decline in commercial catches since 2000/01 gave rise to concern about the status of Striped Trumpeter stocks. As suggested in previous assessments, strong recruitment variability could result in marked variation in population size, especially if there is a prolonged period of poor recruitment. Recent sampled age composition provided some encouraging signs regarding new recruits entering the fishery, although the relative strength of the new cohorts (5-6 year olds) is unclear. These fish are primarily immature and thus have yet to contribute to the spawning stock.

Research undertaken during 2010 confirmed that the current minimum size limit is well below the size at maturity (> 60 cm cf minimum size limit of 50 cm) and that with the increasing proportion of small fish in the catch due to the recent recruitment events there is potential for growth overfishing effects if fishing pressure were to increase dramatically. However, as noted in previous assessments the impact of the 250 kg trip limit has reduced the incentive for commercial fishers to target Striped Trumpeter. By contrast, growing interest from the recreational sector suggests that recreational catches have become an increasingly important component of the total fishing mortality. While the implementation of an on water catch limit of four fish for recreational fishers may help to constrain recreational harvest, the presence of small legal sized fish may provide an incentive for some high grading as fishers seek to maximise the weight of their catch under the reduced bag limit.

Catches reported in Commonwealth returns in recent years have averaged about 3 tonnes per year, though industry reports suggest that these figures may be significantly underestimated.

There is an urgent need to ensure that catch and effort information are comprehensive and approaches have been made to the Commonwealth to this end.

A spawning season closure during September-October, when fish are particularly vulnerable to capture, was introduced for the first time in 2009, although Commonwealth managed fisheries do not recognise the closure and recently reduced their trip limit for striped trumpeter to 100kg year round. Recent fishing trials have confirmed that while there may be some variability in the timing of spawning around the state, the current closure encompasses the bulk of the spawning season in all areas. There is little obvious seasonality in catches throughout the year but commercial catch rates have been found to peak in September, possibly reflecting increased catchability as the species aggregate to spawn. The September-October spawning closure is expected to impact on the 10-25% of annual commercial production which has typically been taken during this period.

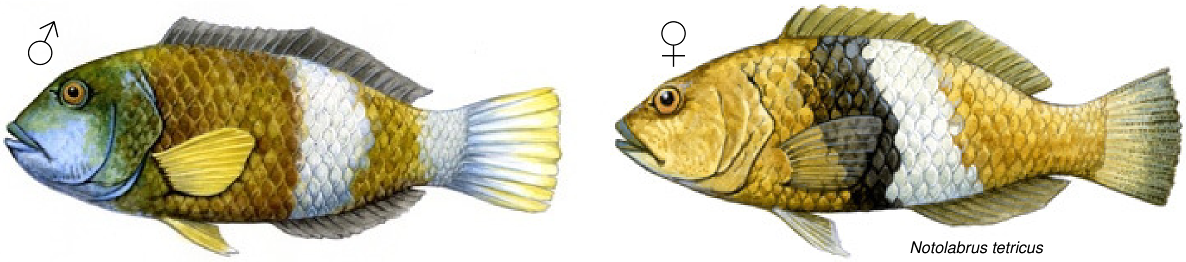
The influx of 4-6 year olds in the last 3 years provides the first positive signs of population recovery after a prolonged period of low recruitment, which has led the stock status of transitional-recovering. The relative strength of these year classes will need to be monitored over time to determine how much they contribute to population rebuilding. Further management action however is required to align the size limit with size at maturity, allowing fish to spawn before they become vulnerable to capture. This is especially important given the fact that the stock currently relies exclusively on recent recruits.

22. Wrasse

Blue-throated Wrasse *Notolabrus tetricus*

Purple Wrasse *Notolabrus fuciola*

STOCK STATUS	**NOT ASSESSED**
Both species are targeted as part as a live fishery. Recent ban on the preferred bait species in fish traps has led to a decline in the participation in this fishery.	
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 160m depth. • Purple Wrasse*:* Predominantly on exposed reefs up to 90m 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 & Clarkson (2001) Denny & Schiel (2001)
Movement and stock structure	• Bluethroat Wrasse: site-attached. Females have overlapping home ranges and males are territorial, at least during the reproductive season. No emigration of individuals between reefs has been noted for this species. • 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 the stock structure for any species	Barrett (1995b)
Natural mortality	• Low adult mortality for both species. Estimated at M =0.2 for blue-throated 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 Von Bertallanffy growth function with $L_\infty = 36.12, k = 0.2 \text{ and } t_0 = -0.35$. Length-weight relationship was set 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 Von Bertallanffy growth function with $L_\infty = 44.7, k = 0.085 \text{ and } t_0 = -3.23$. Length-weight relationship (both sexes) was set 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 32cm in Tasmania. However, not all individual 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 74500 ± 34900 eggs/kg.	Barrett (1995a) Hardwood & Lokman (2006) Unpublished data
Spawning	- The spawning season for both species extends 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 the reefs at around 10.4mm for both species.	Welsford (2003)

Background

Of the several species of Wrasse occurring in Tasmanian waters, Purple Wrasse (*Notolabrus fucicola*) and Blue-throat Wrasse (*N. tetricus*) are the main species taken commercially. Wrasse are targeted for the live fish markets as well as being sold as dead product and utilised as bait for rock lobster (bait usage is possibly under-reported). Fish marketed live are distinguished in the logbooks, and live Wrasse have 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 blue-throat Wrasse, Purple Wrasse are more robust for live handling.

FISHING METHODS	Fish trap and hand line
MANAGEMENT METHODS	**Input control**: - Gear licence (Scalefish fishing licence) - Species licence (Wrasse licence) - Recreational gear licence (Recreational Graball net) **Output control*:*** - Legal size: 30 cm. - Possession limit of 10 (recreational)

	• Sale of live wrasse restricted to holders of a wrasse licence • Possession of maximum 30kg of live or dead wrasse unless holder of wrasse or rock lobster licence (for use as bait)
MAIN MARKET	• Interstate (live trade) and local (bait and food).

Current assessment

Catch, effort and CPUE

Wrasses are targeted all around Tasmania, the west coast being the least fished area (Fig. 22.2). Wrasse catches fluctuated between about 75-110 tonnes between 1995/96 and 2007/08, peaking at 113 tonnes in 2006/07(Fig. 22.1A). Reported catches fell in 2008/09 to just 69 tonnes (42 tonnes of Blue-throat Wrasse, 26 tonnes of Purple Wrasse) and have remained at a similar level since, reaching 65 tonnes (47t blue-throat, 18t purple) in 2011/12. The decline in catches since 2006/07 can be attributed largely to the prohibition on the use of abalone guts as bait in fish traps. This prohibition was a response to the appearance of the abalone viral ganglioneuritis (AVG) in Victorian waters and has forced fishers to seek alternative but less effective baits. Catches, effort and catch rates subsequently declined for fish traps, particularly in the south-east (Fig. 22.1) where fish traps are the dominant fishing method. Hand line catch and effort has followed similar trends and may reflect the common practice of employing both methods when fishing for wrasse.

With Blue-throat Wrasse being more susceptible to line methods and Purple Wrasse more vulnerable to trap capture, Blue-throat Wrasse are taken in larger quantities in the live fishery. Gillnets account for the bulk of the remaining catch (< 5 tonnes) but because survival in nets is poor, graball caught Wrasse are rarely marketed live.

Recreational catches were estimated at 13.6 tonnes in 2000/01 (Lyle 2005) and 10.3 tonnes in 2007/08 (Lyle et al. 2009), which represent around 10% of the total Tasmanian catches for these species.

Catch rate trends imply that wrasse stocks have not been impacted significantly by the fishery until recent years. Catch rates for both gear types have stabilised at low levels since 2008/09. In the mid-1990's catch rates for fish traps gradually increased and peaked in 2004/05, but have since declined, largely influenced by changes in permissible bait types (Fig. 22.1C). Similarly, catch rates for handline had remained relatively stable since the mid-1990's prior to recent declines. These latter declines support the evidence that exploitation rates of legal-sized Purple Wrasse on some east-coast reefs are extremely high (Ewing 2004). Nevertheless, the broad-scale analyses presented here are generally insensitive to changes in abundance at the level of individual reefs at which the fishery impacts the populations. 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.

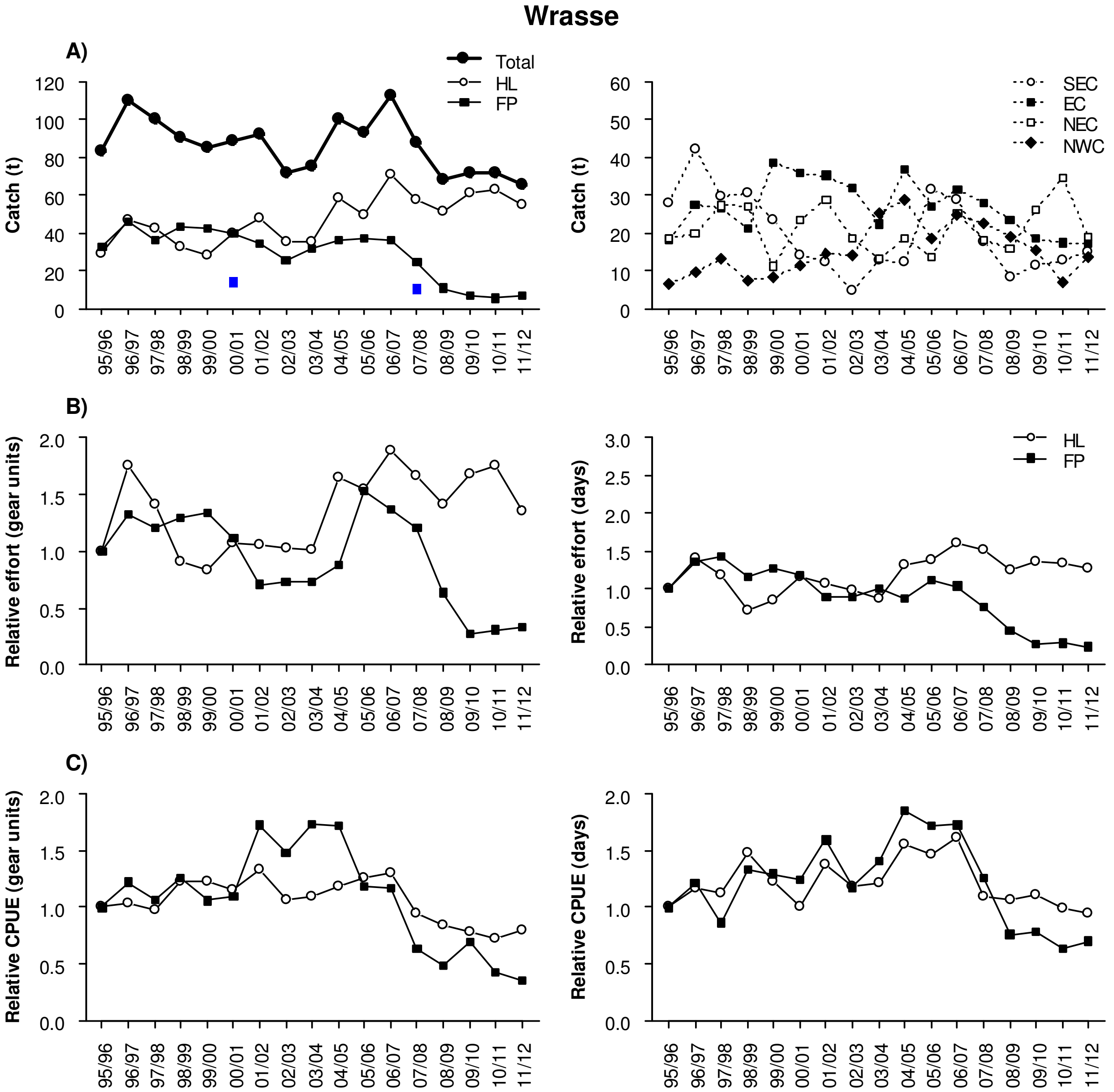


Figure 22.1 A) Annual commercial catch (tonnes) by gear (left) and region (right), and best estimates of recreational catches (blue squares). B) Commercial effort by method based on gear units (left) and day fished (right) relative to 1995/96. C) Commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. HL= hand line, FP= fish trap, SEC= south east coast, EC= east coast, NEC= north east coast, NWC = north west coast.

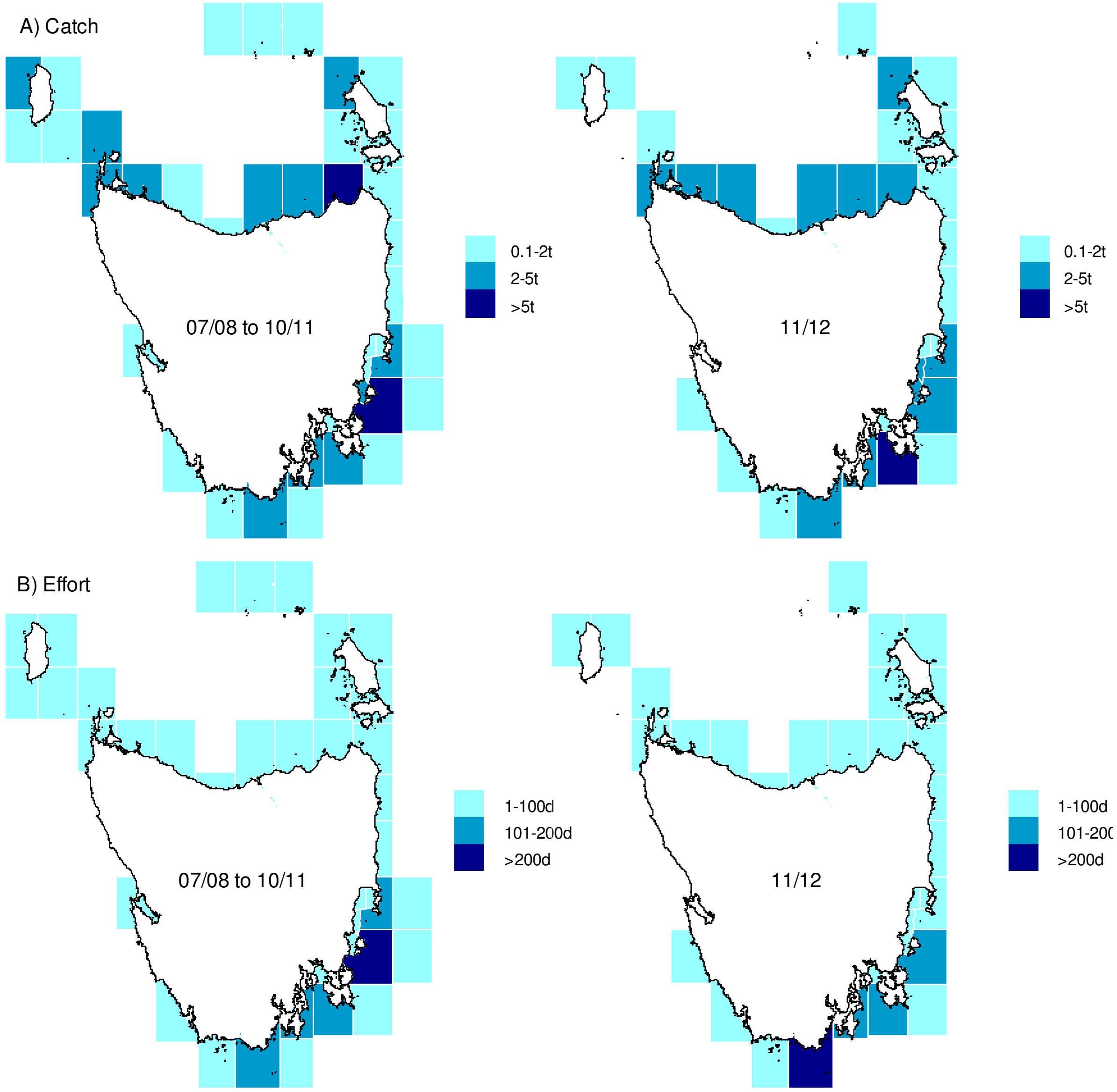


Figure 22.2 (A) Wrasse catches (tonnes) and (B) effort (days) by fishing blocks averaged from 2007/08 to 2010/11 (left) and during 2011/12 (right).

Reference points

Performance indicators	Current reference points	Breached?	By how much?
Catch	- Catch > higher catch from the 1990/91 to 1997/98 range (178 t)	No	
	- Catch < lowest catch from the 1990/91 to 1997/98 range (57.2 t)	No	
	- Catch increases by > 30% from previous year (>93.1 t)	No	
	- Catch decreases by > 30% from previous year (<50.1 t)	No	
Effort trend	- Effort >10% of highest level from 1995/96 to 1997/98 (>4464 days fished)	No	
Catch rates trends	- Catch rate < 80% of lowest levels from 1995/96 to 1997/98 (<0.0093 t/days fished)	No	

Performance indicators	Proposed reference points	Breached?	By how much?
Fishing mortality	• Catch > 3rd highest catch value from the reference period (100.1 t)	No	
	• Catch < 3rd lowest catch value from the reference period (83.4 t)	Yes	17.7 t (21.2%)
	• 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 (25.3 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 (13.3%)	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 stress	• Significant change in the size/age composition of commercial catches	Not assessed	
	• Significant numbers of unhealthy fish landed	No	

Stock status **NOT ASSESSED**

The reference for the lowest catch was breached, which most likely reflects the changes in fishing behaviour (away from traps) rather than a stock issue.

While input controls (limited entry) have capped participation in the live wrasse fishery, there is still a substantial level of latent effort. Increasing catches up to 2006/07 reflected a strong interest in the species, and there were concerns that that these levels were not sustainable. Under present arrangements, there is potential for localised depletions of legal-sized wrasse, especially if effort becomes concentrated in particular regions. There was evidence for a concentration of effort off the east coast.

The minimum size limit provides good protection (several years after reaching the size at maturity) for the spawning stock of Purple Wrasse and for female Blue-throat Wrasse. The limit does not, however, provide the same level of protection for male Blue-throat Wrasse because males are derived through sex change from mature females, typically at sizes after they have entered the fishery. This coupled with the fact that males are strongly site attached and have higher catchability (being more aggressive than females) suggests that they are vulnerable to over-fishing. In extreme situations it is possible that localised heavy fishing pressure could result in ‘sperm shortage’ that would affect spawning success even though there may be a robust population of mature (sub-legal size) females present. The removal of the maximum size limit for wrasse in 2004 may have exacerbated this potential problem. However, neither in

Victoria, where the Blue-throat Wrasse fishery has been larger, nor Tasmania are there any clear indications of spawning stock shortages.

The banning of the preferred bait for trap fishing in 2008 has however changed fisher's behaviour. Industry reported that there is no acceptable substitute for abalone guts (i.e. no other bait yields the same return) and that wrasse fishing has become unviable. As a consequence trap fishing has markedly decreased along with line fishing, which was an associated activity.

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Appendix 1- Common and scientific names of species from catch returns

Standard fish name	Scientific name	Standard fish name	Scientific name
Alfonsino	*Beryx* spp.	Red mullet	Fam. Mullidae
Anchovy	Fam. Engraulidae	Redfish	Fam. Berycidae
Atlantic Salmon	*Salmo salar*	Ribaldo	*Mora moro & Lepidion* spp
Australian Salmon	*Arripis* spp.	School whiting	*Sillago bassensis, Sillago flindersi & Sillago robusta*
Banded Morwong	*Cheilodactylus spectabilis*	Sea Mullet	*Mugil cephalus*
Barracouta	*Thyrsites atun*	Silver Dory	*Cyttus australis*
Bastard Trumpeter	*Latridopsis forsteri*	Silver Fish	*Leptatherina presbyteroides*
Blue Mackerel	*Scomber australasicus*	Silver Trevally	*Pseudocaranx dentex*
Blue Morwong	*Nemadactylus valenciennesi*	Silver Warehou	*Seriolella punctata*
Blue Warehou	*Seriolella brama*	Skate	Fam. Rajidae
Bluethroat Wrasse	*Notolabrus tetricus*	Snapper	*Pagrus auratus*
Boarfish	Fam. Pentacerotidae	Snook	*Sphyraena novaehollandiae*
Butterfish	*Scatophagus* spp	Southern Garfish	*Hyporhamphus melanochir*
Cod, unspec.	Fam. Moridae	Southern Rock Cod	*Lotella & Pseudophycis* spp
Common Gurnard	*Neosebastes scorpaenoides*	Stargazer	Fam. Uranoscopidae
Conger eel	*Conger* spp.	Striped Trumpeter	*Latris lineata*
Deepsea cardinal fish	*Epigonus* spp	Sweep	Fam. Scorpididae
Dory, unspec.	Fam. Zeidae	Tailor	*Pomatomus saltatrix*
Dusky Morwong	*Dactylophora nigricans*	Trevally	*Caranginae* spp
Flathead	Fam Plactycephalidae	Trout	*Oncorhynchus mykiss & Salmo trutta*
Flounder	Fam. Pleuronectidae	Trumpeter	*Latridopsis* spp
Grey Morwong	*Nemadactylus douglasii*	Whiptail	Fam. Macrouridae
Gurnard	Fam. Triglidae & Fam. Scorpaenidae	White Warehou	*Seriolella caerulea*
Hardyhead	Fam. Atherinidae	Wrasse, unspec.	*Notolabrus* spp.
Herring Cale	*Odax cyanomelas*	Yelloweye Mullet	*Aldrichetta forsteri*
Imperador	*Beryx decadactylus*	Yellowtail Kingfish	*Seriola lalandi*
Jack Mackerel	*Trachurus declivis*	Zebrafish	*Girella zebra*
Jackass Morwong,	*Nemadactylus macropterus*		
John Dory	*Zeus faber*	**'Commonwealth' spp**	
King George Whiting	*Sillaginodes punctata*	Blue-eye Trevalla	*Hyperoglyphe antarctica*
Latchet	*Pterygotrigla polyommata*	Blue Grenadier	*Macruronus novaezelandiae*
Leatherjacket	Fam. Monocanthidae	Gemfish	*Rexea solandri*
Ling	*Genypterus* spp.	Hapuku	*Polyprion oxygeneios*
Longfin Pike	*Dinolestes lewini*	Spikey Oreodory	*Neocyttus rhomboidalis*
Luderick	*Girella tricuspidata*		
Magpie Perch	*Cheilodactylus nigripes*	**Sharks**	
Marblefish	*Aplodactylus arctidens*	Angelshark	*Squatina* spp
Mirror Dory	*Zenopsis nebulosus*	Blue Shark	*Prionace glauca*
Morwong	Fam. Cheilodactylidae	Broadnose Shark	*Notorynchus cepedianus*
Mullet	Fam. Mugilidae	Bronze Whaler	*Carcharhinus brachyurus*
Ocean perch	*Helicolenus* spp.	Draughtboard Shark	*Cephaloscyllium laticeps*
Pilchard	*Sardina* & *Sardinops* spp	Elephantfish	*Callorhinchus milii*
Purple Wrasse	*Notolabrus fucicola*	Ghostshark	Fam. Chimaeridae
Rainbow Trout	*Oncorhynchus mykiss*	Greeneye dogfish	*Squalus* spp
Ray	*Dasyatidae, Gymnuridae, Myliobatidae & Urolophidae spp*	Gummy Shark	*Mustelus antarcticus*
Ray's bream	*Brama brama*	Sawshark	*Pristiophorus spp.*
Red Cod	*Pseudophycis bachus*	School Shark	*Galeorhinus galeus*
Red Gurnard	*Chelidonichthys kumu*	Shortfin Mako	*Isurus oxyrinchus*
Red Morwong	*Cheilodactylus fuscus*	Thresher Shark	*Alopias vulpinus*

Common and scientific names of species from catch returns, continued.

Standard fish name	Scientific name
Tunas	
Albacore	*Thunnus alalunga*
Skipjack Tuna	*Katsuwonus pelamis*
Southern Bluefin Tuna	*Thunnus maccoyii*
Yellowfin Tuna	*Thunnus albacares*
Tuna	Fam. Scombridae
Cephalopods	
Cuttlefish	*Sepia* spp.
Gould’s Squid	*Nototodarus gouldi*
Octopus	Fam. Octopodidae
Southern Calamari	*Sepioteuthis australis*

Appendix 2- Data restriction and adjustments

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 whole weight. By 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 a catch of a species is reported as gilled and gutted then the equivalent whole weight can be estimated by applying a standard 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 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 where effort (based on gear units, Table 2.1) was zero or null, or appeared to be recorded incorrectly (implausible), were flagged. The catch was included in catch summaries but the records were not included in gear unit effort and catch rate calculations. These records were, however, used in calculating days fished and daily catches.

iii) Vessel restrictions

In all analyses of catch and effort, 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.

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[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.

Commonwealth logbook data:

Commonwealth logbook data from Australian Fisheries Management Authority was included in the analyses so that the assessment 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. 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.

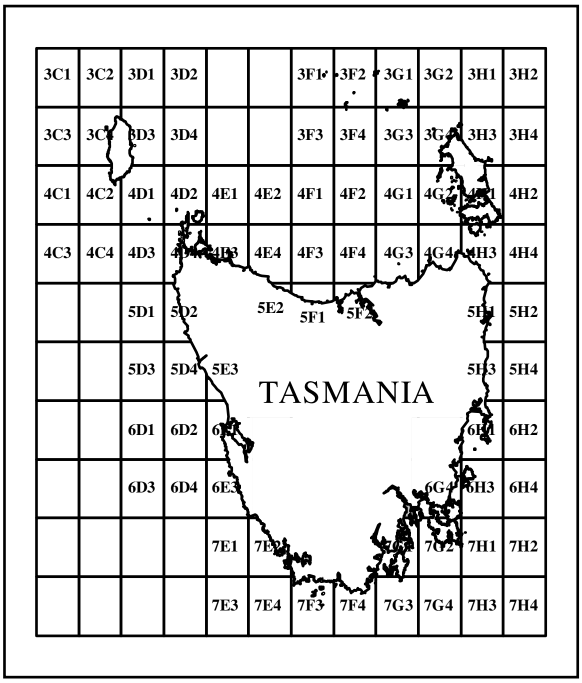

Fig. A1 Numbers for fishing blocks used in calculation of catch figures.

(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 production

Table A.1. Annual 'Tasmanian scalefish and cephalopod production (whole weight in tonnes) by fishing year since 1990/91 based on General Fishing Returns and Commonwealth (GN01, GN01A and SSJF) logbook returns. Data of the most recent years may be incomplete due to late reporting. Fishing year in this report are based on the financial year (1st July to 30th March the following year)

Species	90/91	91/92	92/93	93/94	94/95	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
Scalefish (excl. small pelagics)																						
Australian Salmon	815.9	651.9	867.0	878.8	682.1	413.2	287.3	476.0	384.7	363.7	485.0	462.1	407.2	167.2	336.5	254.2	115.0	256.1	338.8	371.7	203.5	189.4
Barracouta	351.5	268.3	205.4	59.6	25.2	19.3	53.8	65.2	27.6	25.0	15.1	132.1	65.5	85.2	97.3	60.1	26.7	13.8	13.3	7.5	5.0	4.0
Boarfish	7.2	9.4	7.6	10.1	9.1	7.3	10.4	9.4	7.0	7.2	8.0	5.5	3.6	4.3	3.6	5.0	5.2	4.7	2.6	2.7	1.9	3.5
Cod	10.0	11.3	11.6	14.5	12.7	18.6	12.8	9.5	9.8	9.0	3.8	3.0	2.2	2.1	1.6	2.0	2.9	5.4	4.8	4.6	2.8	2.3
Flathead	165.3	118.1	98.8	121.4	91.1	57.9	51.8	62.9	50.6	60.3	63.4	52.1	40.8	31.2	74.7	91.9	60.0	74.7	52.7	77.3	55.7	62.1
Flounder	44.0	36.8	31.8	27.3	27.1	33.4	29.4	29.7	25.2	18.6	12.4	13.0	12.1	15.1	14.7	10.9	13.0	7.8	5.1	5.2	5.2	4.0
Garfish	80.9	80.1	82.3	82.9	69.3	56.2	91.6	83.0	101.7	91.2	81.4	87.8	92.5	66.2	85.5	89.3	50.0	31.0	63.0	44.5	43.2	55.3
Gurnard	20.5	19.0	19.3	19.3	14.0	13.5	10.4	9.1	7.1	9.9	7.8	5.3	9.7	6.8	6.1	5.1	5.7	5.2	2.7	1.7	2.1	1.1
Leatherjacket	12.2	14.0	13.1	23.3	27.7	14.5	12.6	13.3	12.9	16.5	16.7	16.6	13.7	14.8	10.4	8.5	9.1	6.7	6.4	3.8	2.8	2.2
Ling	5.1	13.6	30.0	41.6	33.2	15.0	13.4	9.0	4.9	2.2	5.1	0.9	0.4	0.8	0.7	0.4	0.4	0.4	0.1	0.1	0.1	0.1
Marblefish	0.2	0.9	0.3	1.0	1.8	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
Morwong, banded	7.0	6.9	39.2	145.5	105.8	86.7	79.0	72.6	42.4	33.8	39.2	53.7	56.0	46.4	45.6	54.3	50.3	52.6	36.9	44.0	43.6	54.7
Morwong, jackass	136.9	111.9	83.2	117.6	63.1	27.1	19.0	34.1	18.2	16.6	13.7	14.8	14.4	16.3	17.5	13.1	11.7	4.6	5.2	5.8	3.2	2.8
Morwong, other	3.8	5.6	5.2	13.9	8.1	5.4	7.4	7.4	6.3	1.5	0.6	1.4	1.9	1.2	1.8	1.3	1.3	2.5	1.4	1.2	0.9	0.7
Mullet	31.2	22.2	26.2	19.5	23.8	10.8	11.2	16.0	14.5	21.0	13.7	12.1	7.3	7.5	5.1	7.5	4.5	2.5	1.5	1.9	2.2	1.7
Other	140.2	110.4	97.4	102.0	62.0	31.9	28.5	40.3	24.6	16.2	14.7	11.3	30.1	25.0	26.9	28.2	14.2	12.6	34.3	6.5	2.7	4.1
Pike	10.5	9.5	11.1	12.7	18.8	14.0	18.3	21.6	12.6	14.0	12.5	18.8	17.3	17.7	8.9	13.9	16.6	15.6	12.5	10.8	11.7	10.8
Trevally	20.6	13.6	12.0	8.3	21.6	5.9	4.5	7.8	8.1	3.2	1.6	4.6	5.5	3.4	3.7	6.3	3.6	8.8	4.5	3.7	1.9	2.1
Trumpeter, bastard	63.3	37.2	34.0	54.8	50.8	60.1	51.8	40.7	47.7	36.4	26.1	23.9	21.0	23.2	18.5	23.4	21.3	19.2	16.6	10.1	9.8	9.5
Trumpeter, striped	74.5	58.2	52.7	56.5	72.4	60.3	80.4	81.1	107.4	101.8	49.6	44.8	40.0	40.5	26.2	23.8	22.3	16.1	13.3	12.8	19.8	21.2
Trumpeter, unspec.	0.7	0.0	0.0	0.4	0.1	0.2	0.1	0.6	3.5	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
Warehou, blue	257.6	317.6	187.7	250.1	205.4	82.3	128.7	189.5	274.3	187.6	36.0	66.4	49.3	27.5	19.7	20.0	29.3	25.3	26.8	37.3	10.7	3.9
Warehou, other	0.7	0.4	4.2	8.8	3.4	14.6	15.6	4.8	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
Whiting	124.2	152.3	84.3	97.9	81.4	25.5	39.6	48.3	30.6	31.7	42.7	40.1	39.9	55.5	38.3	28.3	40.2	39.6	35.0	27.0	34.6	16.1
Wrasse	57.2	71.7	97.3	142.4	178.0	83.4	110.1	100.0	90.7	85.4	88.4	92.3	72.0	75.1	99.4	92.9	113.2	88.5	68.5	71.7	71.6	66.0
Total scalefish (excl. small pelagics)	**2441**	**2141**	**2102**	**2310**	**1888**	**1161**	**1173**	**1435**	**1316**	**1157**	**1041**	**1167**	**1006**	**734**	**945**	**841**	**619**	**696**	**748**	**752.7**	**535.2**	**517.7**

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

Species	90/91	91/92	92/93	93/94	94/95	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
Small pelagic species																						
Mackerel, jack	6.1	11.1	32.8	48.4	39.7	26.2	19.3	19.7	59.8	13.7	8.6	19.4	19.4	41.1	12.8	6.8	2.6	202.8	919.7	917.0	35.7	56.4
Mackerel, other	3.0	2.1	0.3	8.5	5.7	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
Sardine/Anchovy	0.1	0.0	3.8	14.6	12.1	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
Redbait	0.0	0.7	0.0	0.8	0.1	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
Total small pelagic species	**9**	**14**	**37**	**72**	**58**	**35**	**25**	**36**	**67**	**17**	**12**	**20**	**19**	**45**	**15**	**9**	**3**	**526**	**1456**	**1039.3**	**51.6**	**56.7**
Cephalopod																						
Calamari, southern	8.2	7.5	5.8	9.7	12.6	33.0	19.0	26.6	94.5	84.6	76.6	104.8	108.8	86.8	114.2	44.6	85.4	89.0	78.6	50.7	54.9	50.4
Cuttlefish	0.5	0.7	0.0	1.1	0.8	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
Octopus maorum	10.8	13.1	15.7	28.1	23.2	18.2	10.6	9.3	24.3	18.3	11.5	31.5	13.2	14.6	11.2	8.7	12.0	18.5	7.5	9.1	11.1	9.0
Octopus pallidus[4]	21.2	21.6	31.3	29.8	30.5	58.7	30.2	34.1	61.2	43.2	50.5	31.6	54.5	56.6	70.4	89.9	90.2	92.6	64.5	65.1	92.3	59.2
Squid, Gould's	35.1	7.2	7.0	7.7	8.6	5.7	7.8	12.9	79.7	480.5	39.7	2.4	1.9	2.1	2.6	1.8	694.3	45.9	47.1	151.5	2.7	161.4
Total cephalopod	**76**	**51**	**60**	**77**	**77**	**116**	**68**	**83**	**260**	**627**	**178**	**171**	**181**	**161**	**198**	**145**	**882**	**246**	**198**	**276.5**	**161.1**	**280.1**
Sharks[5]																						
Elephanfish						58.0	50.1	33.1	29.5	42.7	40.0	18.4	16.5	10.2	7.6	5.7	9.0	1.9	1.5	2.3	1.3	2.6
Gummy shark						750.5	626.6	714.7	798.3	1022	1148	23.5	14.2	24.7	41.6	12.4	13.6	14.0	9.8	9.5	9.3	7.5
Draughtboard shark						0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.7	1.0	0.8	1.3	1.4	3.5	5.5	0.8	0.3	0.0
Sawshark						127.4	88.8	113.4	86.8	109.7	127.9	21.4	20.4	20.6	23.5	5.9	3.4	0.3	0.1	0.1	0.1	0.4
School shark						252.1	196.4	216.1	150.5	136.3	72.1	2.2	1.4	7.0	2.6	0.6	1.8	1.0	0.7	1.8	1.4	1.9
Seven-gilled shark						6.1	7.9	15.6	17.6	33.5	44.5	18.8	7.4	11.5	8.4	3.8	3.9	0.6	2.3	1.1	1.4	1.1
Other shark						32.8	18.9	23.1	19.0	22.3	15.3	7.9	10.8	7.2	1.8	1.1	2.6	2.8	1.1	0.3	0.8	0.5
Total sharks						**1227**	**989**	**1116**	**1102**	**1366**	**1448**	**94**	**71**	**82**	**86**	**31**	**36**	**24**	**21**	**16.0**	**14.7**	**14.1**

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[4] Octopus catches in NWC and NEC were assumed to be *Octopus pallidus* (excluding bycatch in rock lobster traps). Catches can also include *Octopus tetricus*.

[5] Since 2001/02, shark catches have been reported in Commonwealth logbooks. Tasmania has jurisdiction of all shark species inside 3nm except gummy and school shark, and fishers are on bycatch possession limits for all species. Includes bycatch from the rock lobster fishery (separate reporting since 2007/08).

Appendix 4 - Annual catch, effort and number of vessels by fishing methods

Table A.2 Total annual catch, effort and number of vessels by fishing methods.
Effort units are defined in Table 1.1. * Catch data not shown where five or fewer vessels involved.

Gear	Year	Catch(t)	Effort#	Days fished	Vessels
Graball net	95/96	348.0	223553	5437	257
	96/97	383.3	231140	5186	232
	97/98	446.3	231412	5249	216
	98/99	493.3	166505	4689	204
	99/00	359.7	152144	4169	203
	00/01	173.4	86838	3187	186
	01/02	196.0	71109	3303	180
	02/03	231.0	85628	3395	168
	03/04	189.8	69189	2904	160
	04/05	154.4	53965	2491	137
	05/06	170.2	51591	2402	123
	06/07	170.0	56487	2543	132
	07/08	161.3	59308	2425	115
	08/09	127.1	47468	1977	95
	09/10	128.7	47049	2022	94
	10/11	98.1	45324	1770	79
	11/12	101.3	40150	1583	71
Small mesh net	95/96	38.7	10971	285	19
	96/97	27.0	7965	260	14
	97/98	21.8	7875	246	17
	98/99	31.2	7772	282	14
	99/00	22.7	6232	210	15
	00/01	20.8	8170	256	14
	01/02	24.7	9863	259	11
	02/03	22.9	10297	284	11
	03/04	23.0	7254	228	11
	04/05	15.3	5982	220	13
	05/06	21.7	5890	191	11
	06/07	16.4	7144	202	11
	07/08	15.3	6447	183	10
	08/09	9.5	4817	152	7
	09/10	9.4	4089	134	7
	10/11	7.1	2281	98	7
	11/12	10.9	4127	152	8
Dip net	95/96	5.6	320	83	5
	96/97	24.2	1518	364	10
	97/98	37.9	1903	449	21
	98/99	43.6	2784	579	29
	99/00	29.4	2319	505	35
	00/01	22.8	1430	371	27
	01/02	24.8	1561	387	27
	02/03	18.7	1259	337	20
	03/04	25.6	1557	374	19
	04/05	27.4	1521	305	16
	05/06	39.1	2167	376	18
	06/07	22.6	1308	244	18
	07/08	15.2	1057	227	17
	08/09	16.4	1229	287	14
	09/10	18.0	1376	270	14
	10/11	16.0	958	227	10
	11/12	22.5	1187	220	9

Table A.2 (continued)

Gear	Year	Catch(t)	Effort#	Days fished	Vessels
Beach seine	95/96	469.2	1086	559	53
	96/97	351.7	1355	685	50
	97/98	520.9	1206	582	44
	98/99	441.7	872	398	40
	99/00	422.9	901	430	33
	00/01	528.4	789	373	31
	01/02	572.2	1070	495	30
	02/03	490.7	1063	511	35
	03/04	238.1	1282	458	31
	04/05	397.0	975	368	27
	05/06	308.4	653	304	25
	06/07	140.6	528	234	25
	07/08	266.3	630	263	17
	08/09	382.6	620	282	12
	09/10	410.3	473	251	15
	10/11	225.3	359	200	13
	11/12	203.7	380	184	11
Danish seine	95/96	68.2	474	163	2
	96/97	70.7	360	116	1
	97/98	93.1	456	133	1
	98/99	67.6	375	94	1
	99/00	74.5	515	139	2
	00/01	101.4	589	152	2
	01/02	77.7	491	145	2
	02/03	68.1	354	129	3
	03/04	74.1	278	127	2
	04/05	95.9	282	108	2
	05/06	104.9	418	132	3
	06/07	85.8	475	157	3
	07/08	103.2	482	162	3
	08/09	72.9	387	134	3
	09/10	97.0	557	181	4
	10/11	81.9	385	155	5
	11/12	68.0	260	94	3
Purse seine	95/96	35.2	418	185	11
	96/97	30.4	336	153	10
	97/98	41.8	319	154	7
	98/99	76.9	246	150	8
	99/00	33.7	244	123	10
	00/01	24.6	224	104	4
	01/02	21.3	216	91	5
	02/03	18.7	139	76	4
	03/04	14.8	68	45	3
	04/05	17.6	130	70	5
	05/06	16.0	122	60	4
	06/07	8.1	86	41	4
	07/08	527.8	117	121	5
	08/09	1486.3	195	153	3
	09/10	1033.0	170	99	4
	10/11	53.9	32	32	3
	11/12	70.5	63	60	3
Hand line	95/96	74.3	16964	1612	147
	96/97	94.3	21542	1893	135
	97/98	97.5	21076	1702	145
	98/99	88.2	17668	1278	127
	99/00	87.8	16688	1439	134
	00/01	74.2	13585	1541	130
	01/02	87.3	15527	1603	138
	02/03	72.2	15025	1552	125
	03/04	76.4	15610	1411	127
	04/05	100.5	19953	1803	123
	05/06	82.6	20247	1884	116
	06/07	107.3	22745	2139	128
	07/08	92.0	19985	2032	119
	08/09	80.5	17930	1741	95
	09/10	84.1	17259	1601	90
	10/11	90.0	17990	1644	89
	11/12	80.4	15925	1634	82

Table A.2 (continued)

Gear	Year	Catch(t)	Effort#	Days fished	Vessels
Drop line	95/96	19.9	438	158	31
	96/97	30.0	433	203	27
	97/98	24.7	539	222	42
	98/99	31.8	666	309	38
	99/00	30.8	385	291	48
	00/01	15.8	382	248	36
	01/02	12.8	220	258	35
	02/03	18.8	264	350	43
	03/04	19.4	378	281	51
	04/05	14.1	351	219	31
	05/06	9.3	185	204	33
	06/07	7.1	259	137	28
	07/08	3.0	39	55	19
	08/09	3.1	45	41	18
	09/10	2.4	35	25	7
	10/11	3.9	53	33	13
	11/12	6.5	98	59	10
Fish trap	95/96	41.8	8264	1401	66
	96/97	57.2	10710	1796	66
	97/98	49.9	9870	1875	71
	98/99	53.7	10657	1559	56
	99/00	56.1	11030	1637	62
	00/01	54.3	9356	1548	68
	01/02	49.0	6098	1278	62
	02/03	38.2	6177	1246	58
	03/04	48.0	6308	1414	58
	04/05	46.7	7409	1222	54
	05/06	44.6	12302	1421	54
	06/07	44.2	11001	1328	47
	07/08	27.9	9761	916	44
	08/09	13.8	5316	568	29
	09/10	9.5	2257	341	23
	10/11	9.0	2696	408	22
	11/12	8.6	2934	338	18
Squid jig	95/96	10.2	5389	125	23
	96/97	5.7	640	77	14
	97/98	15.2	4381	211	18
	98/99	89.8	10200	613	53
	99/00	150.3	39240	989	64
	00/01	66.5	13173	793	53
	01/02	85.2	12544	925	65
	02/03	91.8	19220	1228	68
	03/04	69.8	15764	1223	73
	04/05	104.8	22362	1424	79
	05/06	35.4	11223	767	59
	06/07	74.4	14105	1204	67
	07/08	77.7	16220	1406	52
	08/09	71.0	15339	1079	35
	09/10	47.5	14865	920	37
	10/11	49.3	12932	866	27
	11/12	42.1	11378	753	23
Spear	95/96	14.1	1403	368	21
	96/97	19.3	1853	464	27
	97/98	16.8	1981	483	40
	98/99	19.8	1812	452	38
	99/00	19.3	2233	475	25
	00/01	14.4	1586	355	22
	01/02	13.1	1296	279	19
	02/03	10.3	1366	247	22
	03/04	10.5	1446	289	22
	04/05	13.5	1609	357	24
	05/06	7.9	1009	271	22
	06/07	15.4	1414	362	20
	07/08	9.8	957	255	21
	08/09	5.6	886	181	14
	09/10	5.0	663	168	14
	10/11	4.0	626	178	15
	11/12	5.0	622	167	12

Table A.2 (continued)

Gear	Year	Catch(t)	Effort#	Days fished	Vessels
Troll	95/96	19.6	3497	358	55
	96/97	62.1	9755	600	88
	97/98	76.2	13318	685	83
	98/99	46.1	9307	480	73
	99/00	39.7	6184	420	51
	00/01	36.5	7913	440	48
	01/02	141.1	18664	1033	93
	02/03	82.8	8510	676	75
	03/04	87.7	8995	793	89
	04/05	87.7	6797	758	77
	05/06	63.4	5019	491	54
	06/07	30.3	4664	341	53
	07/08	13.3	2648	172	30
	08/09	20.0	3007	175	28
	09/10	12.3	2487	137	22
	10/11	10.9	2358	110	19
	11/12	10.4	2103	93	11
Automatic squid jig	95/96	0.4	3000	2	1
	96/97	1.3	14560	14	3
	97/98	2.5	3040	8	1
	98/99	49.7	133728	66	3
	99/00	386.9	899711	369	13
	00/01	28.1	280200	115	10
	01/02	0.9	10220	7	3
	02/03	0.6	9000	5	1
	03/04	0.1	3000	2	1
	04/05	0.1	500	1	1
	05/06	–	–	–	–
	06/07	681.9	395762	155	10
	07/08	44.4	55657	21	3
	08/09	42.4	22966	12	3
	09/10	118.5	3329	68	5
	10/11	2.3	98	7	5
	11/12	159.5	2454	60	7
Hand collection	95/96	7.0	1198	433	6
	96/97	2.5	298	154	5
	97/98	4.2	261	214	4
	98/99	11.5	918	267	4
	99/00	7.2	947	228	3
	00/01	5.7	1008	272	3
	01/02	19.5	1185	318	4
	02/03	6.6	625	160	3
	03/04	5.9	678	184	3
	04/05	3.1	400	128	3
	05/06	2.0	226	97	4
	06/07	4.5	439	201	5
	07/08	8.4	571	207	10
	08/09	1.0	122	52	4
	09/10	0.8	124	55	4
	10/11	4.9	403	120	8
	11/12	1.6	177	99	3