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TASMANIAN SCALEFISH FISHERY - 2009/10

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This assessment of the Tasmanian scalefish fishery is produced by the Institute of Marine and Antarctic Studies (IMAS) and uses input from the Scalefish Fishery Assessment Working Group (SFAWG).

SFAWG met on 26 November 2010 to consider the draft assessment report and provide input into the assessments. The Working Group participants were:

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Tasmanian Scalefish Fishery - 2009/10

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 (revised in 2004), provides the management framework for the fishery. An important element of the management plan is the explicit identification of performance indicators and reference points that have two primary functions:

- monitor 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

In this assessment the scalefish fishery is described in terms of species composition, catch and effort. The commercial catch history for the period 1990/91 to 2009/10 is presented, with more detailed analyses of catch and effort by method for the period 1995/96 to 2009/10. In addition to information provided in Tasmanian catch returns, data from Commonwealth logbooks for dual endorsed operators fishing in Tasmanian waters and for species managed under Tasmanian jurisdiction (*i.e.* striped trumpeter and bastard trumpeter) have been incorporated in the analyses.

Dipnet, dropline and squid jig effort expanded to historically high levels following the introduction of the management plan, whereas effort for other methods tended to remain relatively stable or decline over time. By 2009/10, effort levels for all methods, apart from squid jigs and Danish seine, had fallen to within or below reference levels.

Although effort performance indicators were not triggered for most methods, there are continuing concerns regarding the level of latent capacity within the fishery from licence-holders who are currently either not active or participating at low levels.

Species assessments

Species assessments evaluate fishery-dependent information against agreed reference points for the performance indicators detailed in the Scalefish Management Plan (Table 1). These reference points relate mainly to catch, effort and catch rates in reference years from earlier periods of the fishery (typically 1989/90 to 1997/98 for catch and 1995/96 to 1997/98 for effort and catch rates). The management plan also provides for biological characteristics to be used as performance indicators against which fishery status can be evaluated and, where such data are available, they have been updated in this assessment.

The fishery has additionally been assessed against an alternative set of reference points (first proposed for the 2007/08 fishery assessment) which account for recent developments in the fishery (Table 3). These alternative performance indicators are intended to replace the existing indicators but have yet to be formally adopted.

Banded morwong

The total commercial catch in 2009/10 was 42.2 tonnes.

Exceeded reference points:

- State-wide commercial catches as well as catches in the assessment regions 1 (NEC), 2 (EC) and 3 (SEC) were below the 1994/95 to 1997/98 range.

Alternative reference points:

- TAC-related reference points were not assessed.
- Catch rates were above 90% of the average catch rate from 2000/01 to 2006/07.

Resource status:

- The stock assessment model suggested banded morwong stocks are currently not overfished. Mature biomass in 2009 relative to 1990 in region 2 (EC) and 3 (SEC) was estimated at 42% and 55%, respectively. Nevertheless, the structure of the fished population has changed substantially in both regions, and the fishery is now largely recruitment-driven.
- Exploitation rates of recent years do not appear sustainable, implying that the risk of overfishing is high. Current catch levels are likely to continue to reduce spawning biomass, even though stocks are now more productive (faster individual growth and earlier maturity of females) than at the start of the fishery.
- The TAC is set as a tonnage but implemented in numbers. There are indications of high grading (selectively retaining larger individuals) resulting from this system both through catch records and anecdotal reports. Apart from the obvious implications of exceeding quota when numbers are converted to weight there may be implications for population structure from selectively targeting larger individuals.
- Model predictions show that maintaining the current TAC of 44.4 tonnes is likely to result in a decline in catch rates and spawning biomass within the TAC region. Assuming average recruitment, the model predicts that the TAC would need to be more than halved (reduction to 20 tonnes) to sustain mature biomass levels and catch rates.

Management advice:

- Despite uncertainties in the model it strongly suggests that mature biomass and catch rates are unsustainable. This together with the observation that the fishery is recruit driven suggests that the TAC should be lowered to reduce the risk of overfishing.
- There is an urgent need to review the appropriateness of the current average weight to better reflect actual fishing practices.

Southern calamari

The total commercial catch in 2009/10 was 50.7 tonnes.

Exceeded reference points:

- State-wide commercial catches was above the reference range.
- State-wide catch decreased by more than 30% from the previous year (-35%)
- State-wide fishing effort was above reference levels.
- State-wide catch rates are below reference levels.

Alternative reference points:

- Regional commercial catches were within the reference ranges.
- Catches decreased in 2009/10 and exceeded the reference point for consistently declining catch over 3 years by >40% in SE and E waters.

Resource status:

- There is considerable uncertainty about stock status due to the dependence of stock size on annual recruitment.

Management advice:

- Extended closure of the major spawning grounds and the newly-introduced fishing licences appear to be effective in protecting the main known spawning event. However, catches have increased substantially off the north coast. The further catch development in these areas should be therefore monitored closely.

Striped trumpeter

The total commercial catch in 2009/10 was 12.8 tonnes.

Exceeded reference points:

- State-wide commercial catches were below the reference range.

Alternative reference points:

- The 50 tonnes commercial catch reference point was not exceed.
- Catch curve assessment was not assessed.

Resource status:

- Resource status is uncertain though potentially depleted due the combined effects of fishing and apparent poor recruitment since 1993/94. For the first time in over a decade, however, there was strong evidence of an influx of recent recruits (5-6 year olds), though the relative size of these cohorts and implications for stock rebuilding is uncertain. The lack of information on the recreational catch and the magnitude of the catch taken by Commonwealth operators remain uncertainties.

Management Advice:

- Despite the absence of a rigorous assessment, available data suggest that the stocks have declined and may continue to do so without a period of sustained good recruitment. Further management action is required to align the size limit with size at maturity allowing fish to spawn before they become vulnerable to capture.
- The reduction of the recreational on-water possession limits and introduction of a spawning closure should help to reduce fishing pressure, but may not be enough to lessen the fishing mortality given the likely expansion of the recreational sector in the future.

Sea garfish

The total commercial catch in 2009/10 was 44.5 tonnes.

Exceeded reference points:

- State-wide catches were below the reference range
- State-wide catches decreased by 29% from the previous year (almost triggering the reference point of 30%).
- State-wide commercial effort for dipnet (gear units) was above the reference limit.

Alternative reference points:

- State-wide catches were below reference levels from 1998/99 to 2006/07.

Resource status:

- Uncertain, but the recent decline in catches appears to be caused by a lack of resource despite high abundance of undersized fish. In 2009/10, stock abundance appeared to be higher in the north-east, but remained depressed in south-eastern waters.

Management advice:

- Since it is unknown whether present catch levels are sustainable and to clarify effects of dipnetting on the schooling behaviour of garfish, research on the fishery and stock dynamics is underway. It also would be prudent to consider management options that limit further expansion in this fishery until more is known about the stock dynamics.

Bastard trumpeter

The total commercial catch in 2009/10 was 10.1 tonnes.

Exceeded reference points:

- State-wide commercial catches were below the reference range.
- State-wide catches decreased by 39% from the previous year.
- State-wide catch rates (both gear units and days fished) were below the reference level.

Alternative reference points:

- Pending

Resource status:

- Resource status is uncertain though potentially depleted due to the effects of fishing coupled with apparent poor recruitment in recent years.

Management advice:

- The effectiveness of recent management changes (trip limits of 200 kg, increase of size limits to 380 mm, recreational possession limit of 10 fish) should be evaluated.

Wrasse

The total commercial catch in 2009/10 was 71.7 tonnes (46 tonnes of blue-throat wrasse, 26 tonnes of purple wrasse).

Exceeded reference points:

- State-wide commercial catches were below the reference range.
- Catch rates for fish traps (gear units) were below the reference levels.

Alternative reference points:

- Catches were within the reference range from 1998/99 to 2006/07.

Resource status:

- The resource status is unknown though the two species are vulnerable to localised economic depletion of legal-size biomass. Increasing catches in previous years indicated continued strong interest in the species, while the catch decline in 2008/09 could be attributed largely to the prohibition of the use of abalone guts as bait in fish traps.

- Minimum size limits provide considerable protection to purple wrasse and female blue-throat wrasse spawner biomass, but not for male blue-throat wrasse which derive from mature females after a sex change, typically at sizes after they have entered the fishery.

Management advice:

- Because there is still a high level of latent effort in the fishery, management options should be considered that limit further expansion in this fishery.

Blue warehou

The total commercial catch in 2009/10 was 37.3 tonnes.

Exceeded reference points:

- State-wide commercial catches were below the reference range.
- State-wide commercial catches increased by 39% from the previous year

Alternative reference points:

- The historic commercial catch level of 318 tonnes was not exceeded.

Resource status:

- Stocks are considered to be overfished and availability of blue warehou in Tasmanian waters continues to be low.

Management advice:

- Management action for stock rebuilding of the major component of the blue warehou fishery has been implemented in the Commonwealth fishery.

Australian salmon

The total commercial catch in 2009/10 was 371.7tonnes.

Exceeded reference points:

- None

Alternative reference points:

- The commercial catch limit of 435 tonnes for Australian salmon A licences was not exceeded.

Resource status:

- Catch rates may not be good indicators of abundance for schooling species such as Australian salmon and in any case commercial production is known to be strongly influenced by market demand. While stock status is unknown, the species has sustained substantially higher catches in the past and current commercial and recreational catches would appear sustainable.

Management advice:

- The *status quo* appears to be acceptable.

Flathead

The total commercial catch in 2009/10 was 77.3 tonnes (predominantly tiger flathead, as distinct from the sand flathead that forms the bulk of the recreational catch).

Exceeded reference points:

- State-wide commercial catch increased by 47% from the previous year.
- State-wide effort for Danish seine (gear units) was above reference levels.

Alternative reference points:

- The regional catches levels of 45 tonnes in the south-east and 63 tonnes in the east were not exceeded.

Resource status:

- Stocks of tiger flathead are classified as not overfished. The stock status of sand flathead is not known, though undersized fish appear to be highly abundant and the size limits are above size at maturity.

Management advice:

- *Status quo* appears to be acceptable. As further expansion in the Danish seine fishery is likely, it would be prudent to consider spatial management options that avoid the regional concentration of operators.

Table 2 Summary assessment of existing performance indicators and reference points for key species with risk assessment if no management action (i.e. *status quo*) is taken.
Catch history reference period is *1994/95 to 1997/98 and ** 1995/96 to 1997/98; *** main fishery managed by Commonwealth; Y triggered, N not triggered, arrows indicate direction, na not assessed, H high risk, M medium risk, L low risk, U uncertain. Changes since previous year in bold.

Species	Catch below or above 90-97 range	Catch decline or increase by >30%	Effort >110% of maximum 95-97 range	Catch rate < 80% of minimum 95-97 range	Biological indicators of stock stress	Risk if no management action
Banded morwong*	Y↓	Y↓	N	N	Y	H
Southern calamari	Y↑	Y↓	Y	**Y**	N	L
Striped trumpeter	Y↓	N	N	**N**	Y	M
Bastard trumpeter	Y↓	**Y↓**	N	**Y↓**	na	M
Garfish	**Y↓**	**N**	**N**	**Y↓**	na	M
Wrasse**	Y↓	N	N	Y↓	na	L
Blue warehou***	Y↓	**Y↑**	N	N	na	-
Australian salmon	**N**	**N**	N	N	na	L
Flathead	N	**Y↑**	Y↑	N	na	L

Table 3 Summary assessment of alternative reference points for key species.

[##] Main fishery managed by Commonwealth; Y triggered, N not triggered, arrows indicate direction of change, na not assessed, [#] applies only to particular methods or regions.

Reference point	Banded morwong	Southern calamari	Striped trumpeter	Bastard trumpeter	Garfish	Wrasse	Blue warehou[##]	Australian salmon	Flathead
Commercial catch in Region 1 > 30% of TAC Region 2 > 65% of TAC Region 3 > 40% of TAC Outside TAC area >10t	na								
Commercial catch is < 90% of TAC	na								
Catch rates are below 0.9 * average from reference period 2000/01 to 2006/07	**N**								
Commercial catch for GOB & MP > 50t Remainder SE > 30t Outside GOB, MP & SE > 25t		N N Y[#]							
Declining catch trend over 3 consecutive years by a total of > 40% in south-east Tasmanian waters		N							
Commercial catch is > 50t			N						
Catch curve estimated every 3 years as an index of fishing mortality from all sectors: Target: Fishing mortality $F \leq$ Natural mortality M Limit: F = 1.5*M			na						
Pending				-					
Catch outside reference range from 1998/99 to 2006/07 (66-102t)					Y↓				
Catch outside reference range from 1998/99 to 2006/07 (72-99t)						N			
Commercial catch limit of 318 tonnes as per Memorandum of understanding (MOU)							N		
Commercial catch limit of 435 tonnes as per Ministerial decision								N	
Catch by Danish Seine > 1.3* the maximum catch from reference period 1998/99 to 2006/07: South-east coast: 45t East coast: 63t									**N** N
Any indicator of stock stress	Y	N	Y	na	na	na	na	na	na

1 Management objectives and strategies

The Scalefish Management Plan was first introduced in 1998 (DPIF 1998) and was reviewed in 2001, 2004 and again in 2009. The primary issue tackled in the latest review related to gillnet fishing practices and involved the introduction of maximum soak times for most areas. Other changes included the introduction of a recreational set line licence and changes to trip and size limits for selected species including striped trumpeter.

The management plan provides the regulatory framework for the fishery, which covers commercial and recreational components. The plan contains the following objectives, strategies and performance indicators.

1.1 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.

1.2 Primary strategies

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

1.3 Performance indicators

In the absence of more quantitatively rigorous stock assessments, the Scalefish Fishery Management Plan 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 are exceeded when one or more of the following criteria are met:

- total catch of a key target species is outside the range from 1990/91 to 1997/98; or when total catch of a key target species declines or increases in one year more than 30% from the previous year;
- fishing effort for any gear type, or effort targeted towards a species or species group, is above 10% of the highest levels from 1995/96 to 1997/98;
- catch rates for a key target species are less than 80% of the lowest levels from 1995/96 to 1997/98;
- a significant change in the size composition of commercial catches for key target species; or when monitoring of the size/age structure of a species indicates a significant change in the abundance of a year class (or year classes), with particular importance on pre-recruit year classes;
- a change in the catch of non-commercial fish relative to 1995/96 to 1997/98 records; or when incidental mortality of non-commercial species or undersized commercial fish is unacceptably high;
- significant numbers of fish are landed in a diseased or clearly unhealthy condition; or when a pollution event occurs that may produce risks to fish stocks, the health of fish habitats or to human health; or when,
- any other indication of fish stock stress is observed.

The fishery has also been assessed against an alternative set of reference points which account for recent developments in the fishery. These alternative reference points are expected to be further refined and are intended to replace the existing indicators over the next few years.

2 Fishery assessment

2.1 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. For many operators, scalefish represent an adjunct to other activities, for instance rock lobster fishing.

This report covers the assessment of key scalefish and cephalopod fisheries under Tasmanian jurisdiction. Other species, such as tiger flathead, blue warehou, jackass morwong, ocean perch, blue eye trevalla, blue grenadier, school and gummy shark, are managed under Commonwealth jurisdiction. Formal assessments for these species are undertaken by the Southern and Eastern Scalefish and Shark Fishery Assessment Group (SESSFAG; *e.g.* Tuck 2006) and are summarised in fishery status reports produced by the Bureau of Rural Sciences (e.g. Wilson *et al*., 2009).

This report continues the series of annual assessments of the scalefish fishery and incorporates catch and effort information available up to and including June 2010. Copies of previous assessment reports are available on the TAFI web page - http://www.utas.edu.au/tafi/TAFI_Download.htm.

2.2 Data sources

Commercial catch and effort data are based on Tasmanian General Fishing Returns, and Commonwealth non-trawl (GN01 and GN01A) and Southern Squid Jig Fishery (SSFJ) logbook returns. Unless noted otherwise, catch and effort data reported in this assessment relate to the commercial sector. Catch and effort information are not routinely collected for the recreational sector.

2.2.1 General fishing returns

General Fishing Returns prior to 1995 provided only monthly summaries of landed catches and limited effort information that was of little value for effort and catch rate analyses (Lennon 1998).

During 1995, a revised General Fishing Return was introduced, replacing the monthly return with catch and effort information reported on a daily basis for each fishing method used. The revised returns provide greater detail about fishing operations, including more explicit specification of fishing method, greater spatial resolution (30nm or ½ degree rather than 1 degree blocks), plus details about effort and depths fished.

Amendments in 1999 included provision to nominate target species and an option to indicate interference to fishing operations from marine mammals (*e.g.* seals or killer whales). During late 2007, a new logbook was introduced providing finer spatial and greater operational detail. In analysing General Fishing Returns some data manipulation has been undertaken, details of which are provided in Appendix 2.

2.2.2 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 General Fishing Returns. 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.

2.2.3 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 2010. All catch returns from within this period and available as at October 2010 have been incorporated in the analyses.

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 have been identified, *viz*. 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. 2.1).

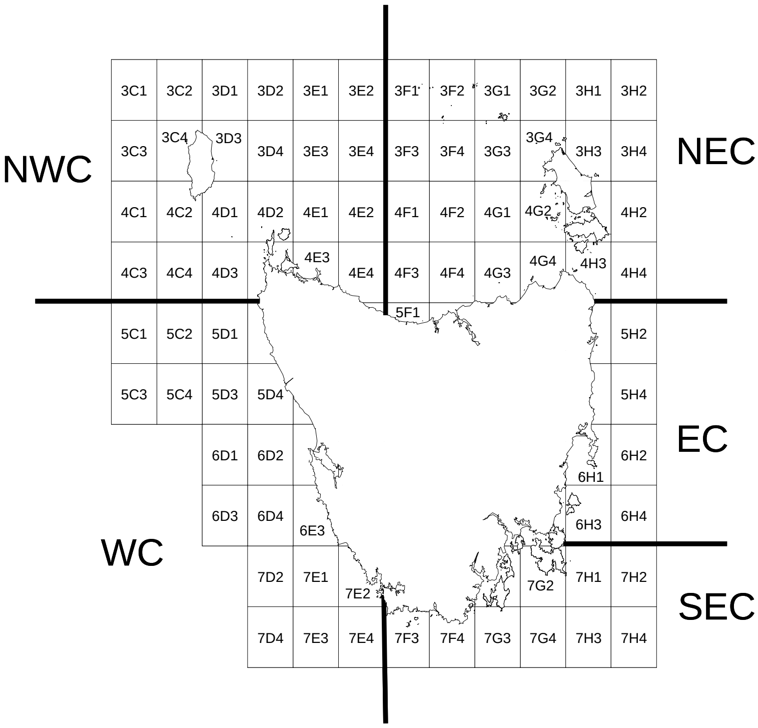

Fig. 2.1: Map of Tasmania with 30 nm fishing blocks and the assessment regions. SEC is south-east coast, EC is east coast, NEC is north-east coast, NWC is north-west coast, and WC is west coast.

Two measures of effort have been examined in past assessments: (i) days fished (*i.e.* number of days on which a method/gear type was reported); and (ii) quantities of gear/time fished using the method. Since a diverse range of gear types are utilised in the fishery, appropriate measures of effort differ with gear type. For instance, gillnet effort has been calculated as a function of the quantity of net set and fishing duration, dropline and longline effort is expressed in terms of number of hooks set, while handline fishing is reported as the product of the number of lines fished and fishing duration. Measures of effort by fishing method are presented in Table 2.1. However, because effort reporting has changed for some gears with the introduction of a new logbook during 2007, some gear related effort measures since 2007/08 are not directly comparable to those in the previous years. Also, confusion about the new reporting requirements may have biased some effort measures.

Table 2.1. 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
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 2009/10 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 n^{th} 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:

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

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.

2.2.4 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.

2.3 Commercial fishing licences

The number of fishing Scalefish licences A, B and C has slowly declined from a peak in 2000 to 115 active and 333 total licences in 2010 (Table 2.2). The decline was mainly due to a reduction in Scalefish C fishing licences, 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 17% of all C licences active in 2010 (down from 35% in 2000). The proportion of actively fished Scalefish A and B licences has also dropped in the last two years, from around 70% up to 2007 to only around 45% in 2010.

In addition to these fishing licences, separate fishing licences allow the use of beach seine (a total of 51 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 2.2. 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
FLA	50	44	51	48	46	38	43	47	37	33	28
FLB	109	104	111	110	109	101	105	105	93	88	71
FLC	79	62	63	52	47	34	36	33	23	16	16
Total	238	210	225	210	202	173	184	185	153	137	115

No of total licences	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
FLA	69	67	70	70	70	66	66	66	66	65	65
FLB	166	165	164	165	165	162	162	160	159	159	157
FLC	226	214	205	185	173	152	137	129	120	112	96
Total	461	446	439	420	408	380	365	355	345	336	318

2.4 Commercial catch trends

2.4.1 General fishery

Annual commercial scalefish catches have been quite variable since 1990/91 (Table 2.3) and since the early 1990s catch trends for the major species have generally been declining (Fig. 2.2). Overall, total scalefish production (excluding small pelagic species) declined from over 2000 tonnes in the early 1990s to around 600-800 tonnes in recent years. Recent fluctuations in total catches have been mainly driven by variability in landings of Australian salmon.

The 2009/10 scalefish catch of 753 tonnes was almost equal to the 2008/09 catch of 748 tonnes. Catch increases of Australian salmon (+33t), flathead (+25t) and blue warehou (+11t), banded morwong (+7t) and wrasse (+3t) offset catch decreases across most other species. Catches of barracouta, gurnard, leatherjacket, striped trumpeter, bastard trumpeter and uncategorised species were at record low levels in 2009/10 (since 1990/91). Garfish and whiting catches were the second lowest since 1990/91. Catches of other scalefish species were within ± 2 tonnes of 2008/09 levels (Table 2.3 and Fig. 2.2).

In state waters, purse seine catches of jack mackerel remained high at 917 tonnes, whilst redbait catches dropped by 400 tonnes to 122 tonnes and pilchard/anchovy catches were negligible (0.4 tonnes). Total cephalopod production increased from 2008/09, a consequence of increased catches of the sporadically occurring Gould’s squid (+ 104 tonnes), with octopus catches remaining stable while southern calamari catches declined (-28 tonnes).

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, the trumpeters, 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.

Catch trends for the key species including banded morwong, southern calamari, striped trumpeter, bastard trumpeter, garfish, wrasse, blue warehou, Australian salmon, and flathead will be discussed in separate chapters.

Table 2.3. 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.

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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
Total scalefish (excl. small pelagics)	**2441**	**2141**	**2102**	**2310**	**1888**	**1161**	**1173**	**1435**	**1316**	**1157**	**1041**	**1167**	**1006**	**734**	**945**	**841**	**619**	**696**	**748**	**753**

Table 2.3. 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
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
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
Pilchard/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
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
Total small pelagic species	**9**	**14**	**37**	**72**	**58**	**35**	**25**	**36**	**67**	**17**	**12**	**20**	**19**	**45**	**15**	**9**	**3**	**526**	**1456**	**1039**
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
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
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
Octopus pallidus[1]	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
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
Total cephalopod	**76**	**51**	**60**	**77**	**77**	**116**	**68**	**83**	**260**	**627**	**178**	**171**	**181**	**161**	**198**	**145**	**882**	**246**	**198**	**276**
Sharks[2]																				
Elephant shark						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
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
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
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
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
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
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
Total sharks						**1227**	**989**	**1116**	**1102**	**1366**	**1448**	**94**	**71**	**82**	**86**	**31**	**36**	**24**	**21**	**16**

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

[2] 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).

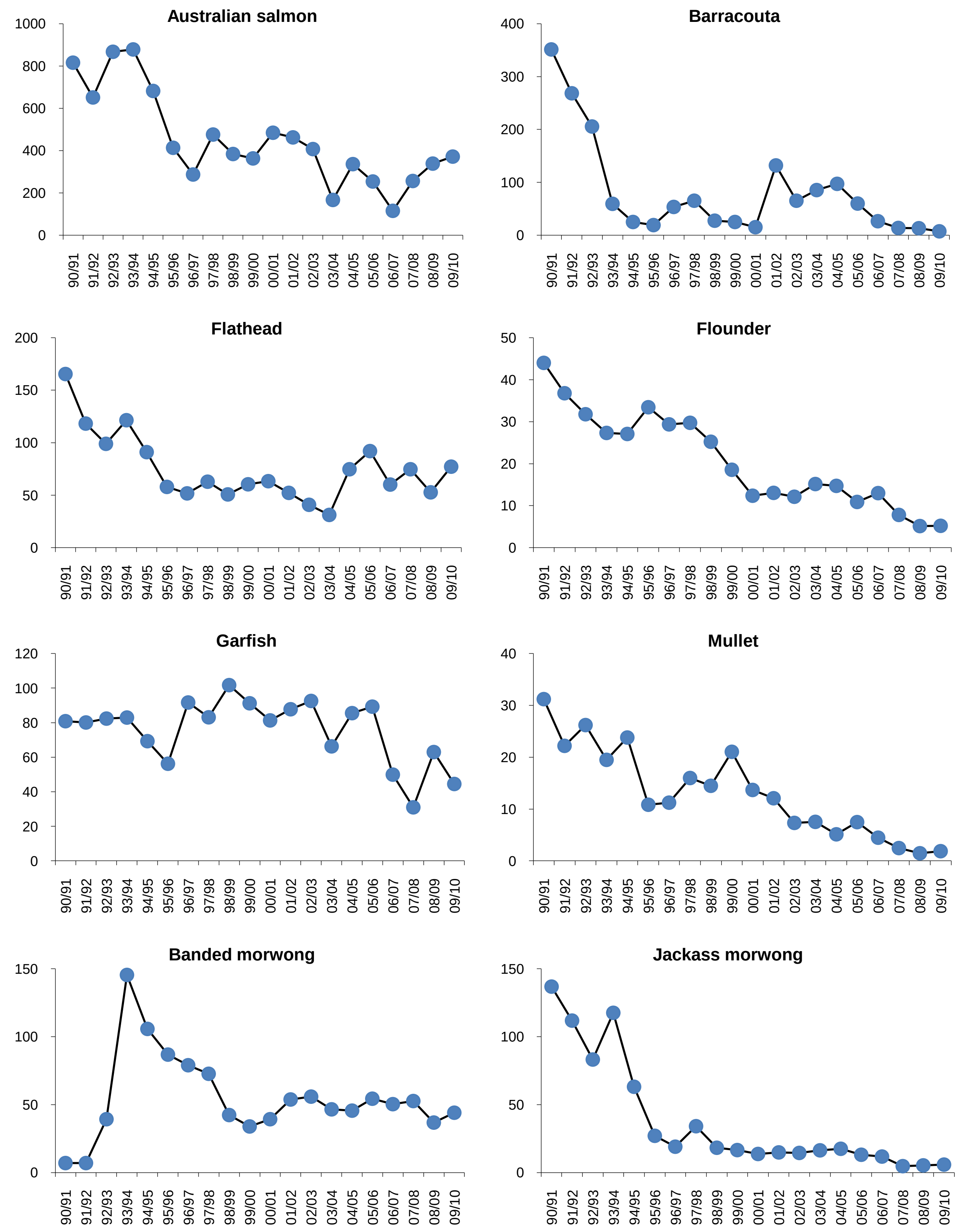

Fig. 2.2. Annual catches for key scalefish species since 1990/91.

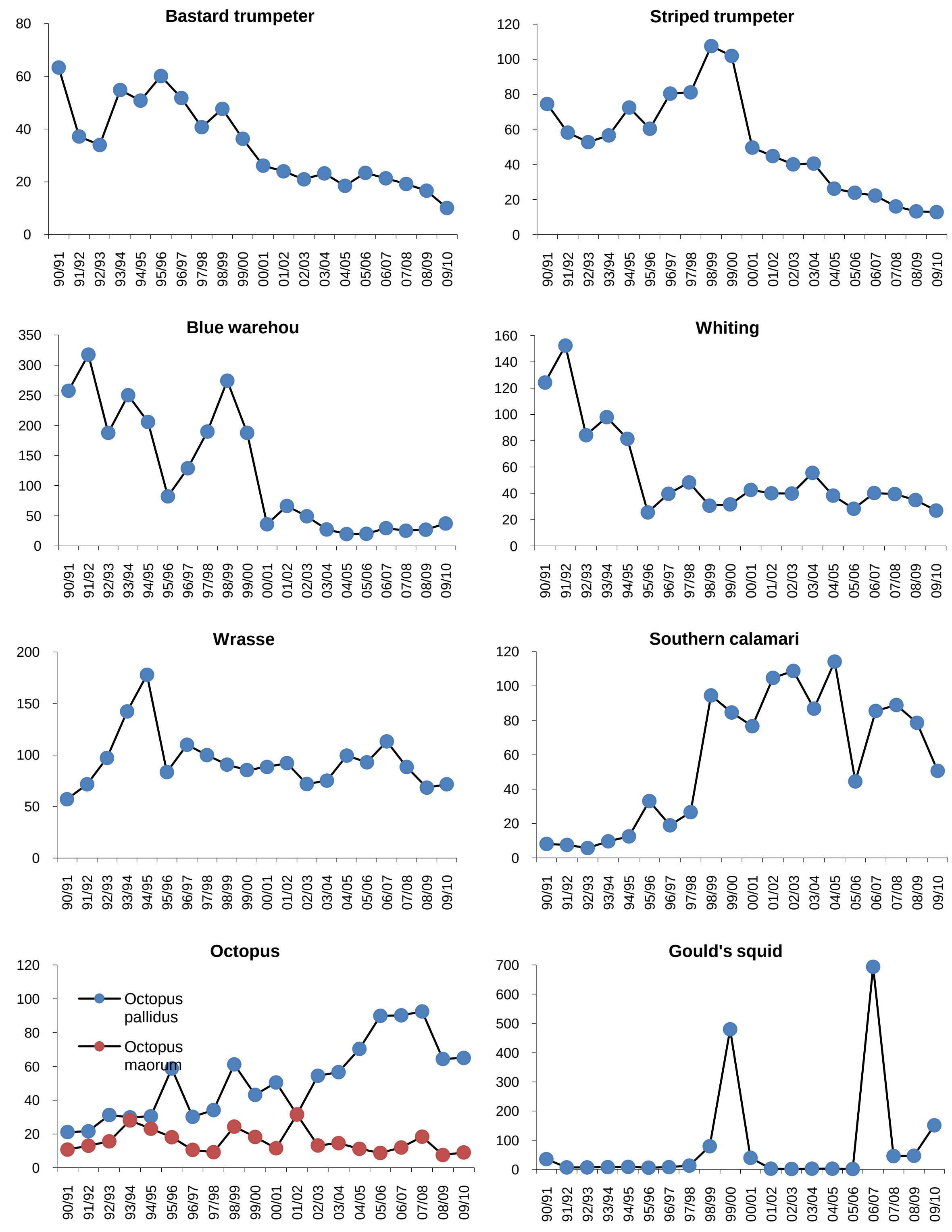

Fig. 2.2. Continued.

2.4.2 Estuarine production

Estuarine production (a subset of the whole general fishery) totalled 71.6 tonnes in 2009/10 (Table 2.4). 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, calamari, jack mackerel and garfish were the main species.

Table 2.4: Total commercial catches (in tonnes) by species in estuaries around Tasmania (a) by fishing year and (b) by species in 2009/10.

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	0.0	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	0.0	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		0.0	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	0.0	3.2			17.9		0.0	13.0	26.9	12.3	0.9	113
08/09	33.7		1.1		0.2	22.2		0.0	8.4	15.7	10.5	2.1	93.9
09/10	26.9		0.7		0.5	17.5	0.0	0.0	3.9	15.6	4.4	2.1	71.6

ES	Description
ES1	Derwent River
ES6	Port Davey
ES7	Macquarie Harbour
ES8	Mersey River
ES9	Port Sorrell
ES10	Tamar River
ES11	Ansons Bay
ES12	Georges Bay
ES17	Blackman Bay
ES18	Norfolk Bay
ES19	Frederick Henry Bay
ES20	Pitt Water

b) By species in 2009/10	ES01	ES06	ES07	ES08	ES09	ES10	ES11	ES12	ES17	ES18	ES19	ES20	Total
Australian salmon					0.3	2.3			0.5	0.1			3.2
Blue warehou						0.7				0.3			1.1
Calamari					0.1	1.8		0.0	0.9	3.6	1.6		8.0
Flathead	0.3					0.1			0.0	2.4	0.3	0.1	3.2
Flounder	0.0		0.7			0.7			0.4	0.4	0.6	1.9	4.8
Garfish						5.4			1.9	0.3	1.2	0.1	8.8
Jack mackerel						0.1				6.8			6.9
Mullet						1.1			0.2	0.0	0.0		1.4
Octopus										1.6	0.0		1.6
Other	0.0				0.0	3.5	0.0		0.0	0.1	0.1		3.7
Pilchard/Anchovy													
Redbait													
Trevally					0.0	0.5			0.0	0.0			0.5
Whiting	26.6					0.0							26.6
Wrasse						1.3					0.6		1.8
Total	**26.9**	**0.0**	**0.7**	**0.0**	**0.5**	**17.5**	**0.0**	**0.0**	**3.9**	**15.6**	**4.4**	**2.1**	**71.6**

2.5 Commercial effort trends

The Scalefish Management Plan contains two trigger points that pertain to fishing effort, one based on effort relating to a particular gear type and the other based on effort directed towards a species or species group. A trigger point is reached when effort exceeds the peak level for the period 1995-1997 by at least 10% (for the present analysis the reference period is taken as 1995/96 to 1997/98).

Catch and effort by the main fishing gear types are presented in Table 2.5. Since a variety of gear types are represented, it has been necessary to express effort in units appropriate to each specific fishing method (Table 2.1). 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 exacerbated with the introduction of the new logbook in 2007. Days fished overcomes any uncertainty about the accuracy of reporting effort units.

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

Since the mid 1990s effort for the major gear types either declined (beach seine, purse seine, graball and small mesh nets), increased or remained stable initially but has then undergone declines (dipnet, dropline, spear and fish trap), or increased over time (handline and squid jig; Table 2.5 and Fig. 2.3). Following the introduction of the new management arrangements in November 1998, effort based on beach seine, purse seine, graball and handline 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 a shift to and increase in effort for less regulated methods (hooks, jigs and dipnets; i.e. gear that is equally available to all licence-holders).

Effort levels during 2009/10 were generally similar to or lower than in 2008/09 for most gear types, except for dip net, squid jig and Danish seine. The effort performance indicator of 110% from the highest of the 1995 to 1997 levels was only exceeded for squid jig and Danish seine. 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.

Table 2.5. Total annual catch, effort and number of vessels by fishing methods.
Effort units are defined in Table 2.1. * 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	126.6	46969	1991	94
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	8.7	4109	130	7
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	15
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	404.8	448	243	15

Table 2.5. Continued

Gear	Year	Catch(t)	Effort#	Days fished	Vessels
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
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
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	82.9	17330	1584	94
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	2.1	31	21	5

Table 2.5. Continued

Gear	Year	Catch(t)	Effort#	Days fished	Vessels
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	9.4	2241	339	23
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	58.8	30137	929	40
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	170	15

Considering effort by gear type alone can mask important dynamics within the fishery itself, such as shifts in species targeting. This is particularly pertinent where individual species may be targeted using a variety of gear types and where a given gear type can be used to target a number of different species. For instance, the decline in purse seine effort until 2006/07 (Table 2.5) was driven largely by falls in effort directed at calamari, whereas there was only minor variation in purse seine effort for garfish. Since then, purse seine has been used to target and catch large quantities of jack mackerel and redbait.

Beach seines are used primarily to target Australian salmon or garfish (Fig. 2.3). While effort for Australian salmon has remained relatively stable since 1995/96, fluctuations in effort for garfish have had the greatest influence on overall beach seine effort.

Within the graball fishery, there are effectively three main sub-fisheries targeting blue warehou, banded morwong and flounder (Lyle 1998, Fig. 2.3). A variety of other species are also commonly taken as by-product of these sub-fisheries. By analysing graball effort based on the occurrence of these species in the catches, an initial increase in effort for blue warehou was evident. The effort peaked in 1997/98 (gear units) and 1998/99 (days fished) and then declined rapidly, especially between 1999/00 and 2000/01. Effort directed at banded morwong declined up until the late 1990s, but then expanded slightly between 2000/01 and 2002/03 and has stabilised at a lower level in recent years. By comparison, effort directed at flounder decreased steadily through time and is now at a low level.

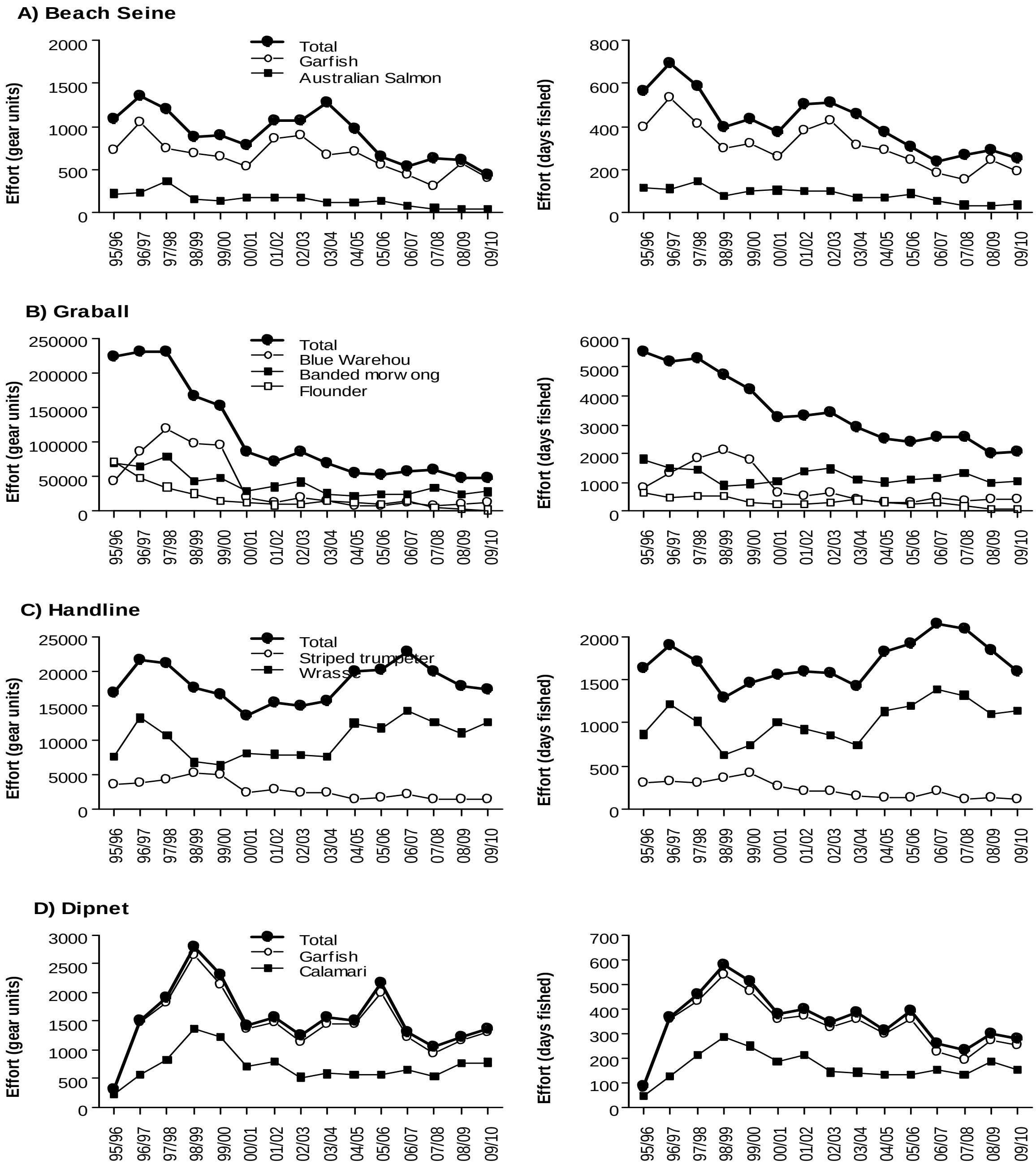

Fig 2.3. Annual effort by selected methods for key species, expressed as gear units (refer Table 2.1) and days fished.

Striped trumpeter and wrasse are the two main species targeted by handline and these gear types demonstrate different trends in effort (Fig. 2.3). Handline effort for striped trumpeter increased up until 1999/00 but has fallen gradually since that time. This contrasts the pattern for wrasse, where effort rose to an initial peak in 1996/97, declined to 1998/99 and then climbed gradually to levels higher than the peak reported in the mid 1990s.

Garfish and calamari are the main species captured by dipnet (Fig. 2.3). The overall effort trend closely follows that for garfish, implying that garfish are the main target species and that calamari are taken more as by-product than target species or at least opportunistically.

A significant expansion in jig effort (particularly evident in days fished; Table 2.5), initially directed at calamari, commenced in 1998/99 and continued up until 2004/05, fluctuating strongly since. During 1999/00 there was also a dramatic increase in effort (primarily automated jig) targeted at Gould's squid (graph not shown), repeated again in 2006/07 and 2009/10. .

The remaining methods are used primarily to target single species and as such effort trends tend to reflect the fishery dynamics for the target species, i.e. dropline for striped trumpeter, spear for flounder and fish traps for wrasse. Species-based effort trends are also considered in more detail in Chapters 3 to 9.

2.6 Catch rates

Catch rate or catch per unit effort (CPUE) is often used in fisheries assessment as a relative index of stock abundance. In the context of the scalefish management plan, a catch rate performance indicator is triggered when catch rates fall below 80% of the lowest value for the reference period (i.e. 1995/96 to 1997/98 unless otherwise specified). Catch rate trends for key species and species groups are considered in some detail in Chapters 3 to 9.

2.7 Recreational fishery

2.7.1 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).

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 2.6). For instance, recreational catches exceeded commercial catches for flathead, black bream[3], 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

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

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 2.6 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 Lyle et al. 2009).
Note: the survey periods do not correspond with fishing years; 2000/01 represented the period May 2000 to Apr2001, and 2007/08 represented the period Dec 2007-Nov 2008.

	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*				
Bastard trumpeter	29,130	37.0	26.2	*58.5*				
Trumpeter (grouped)					17,321	19.1	29.3	*39.4*
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*

2.7.2 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.

The number of net licences issued rose rapidly from around 8900 in 1995 to over 11000 in 1999/00, licence numbers then stabilised at between 8000-9000 for several years before climbing again to around 10000 in 2007/08. (Table 2.7). However, as indicated by the number of Graball 1 licences issued, the actual number of gillnet licence-holders varied only slightly (~7000 persons) between the late 1990s and 2003/04. Night netting was banned for recreational fishers (with the exception of Macquarie Harbour) in late 2004 and, although this was a common and popular practice amongst recreational fishers (Lyle 2000), it is significant that the ban had little discernable impact on licence numbers. Gillnet fishing practices were further restricted in 2009 with the introduction of maximum soak times; it is unclear whether the slight reduction in licence numbers in 2009/10 occurred in response to this management measure.

Table 2.7. 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
Graball 1	5615	6290	6685	6709	7477	7401	6960	7695	7313	7408	8054	8677	9185	9172	8960
Graball 2	2612	2678	2683	2426	2652	2515	1841	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
Total	**8883**	**9652**	**10106**	**9874**	**11008**	**10761**	**9409**	**8449**	**8066**	**8162**	**8870**	**9554**	**10180**	**10252**	**9882**

With the exception of gillnet surveys conducted between 1996-98 (Lyle 2000) there have been no targeted assessments of recreational net catch or effort in Tasmania. Although not a direct index of fishing effort, the increase in licence numbers imply that netting effort may have increased in recent years. However, general fishing surveys in 2000/01 (Lyle 2005) and 2007/08 (Lyle et al. 2009) provide some limited information about recreational gillnetting and suggest that there has been a significant (40%) reduction in gillnet effort since the early 2000s (Lyle et al. 2009). A targeted survey of recreational gillnetting is being undertaken during 2010 and findings will be incorporated in future assessments.

2.8 Uncertainties

While considerable attention has been directed at ensuring comparability of commercial data over time (refer Appendix 2), it is acknowledged that some recent administrative changes relating to the reporting of catches may have, nonetheless, 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 a new logbook during the 2007/08 season has helped to clarify reporting, but there continues to be an ongoing 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. The inclusion of catch disposal records in the new logbook may improve the accuracy of catch reporting.

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 will be flawed.

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 (Goldsworthy et al. 2003).

2.9 Implications for management

In the short to medium term, uncertainty will continue to be associated with the scalefish fishery primarily because of the uncertain data quality (lack of verification) and lack of information about recreational catches. There is also a need to review the present ‘generic’ performance indicators to ensure that they are appropriate for each species and that the fishery is managed in accordance with the principles of ecologically sustainable development. For this purpose alternative performance indicators are suggested in this report.

3 Banded morwong (*Cheilodactylus spectabilis*)

3.1 Life-history and stock structure

Banded morwong is a highly sedentary rocky reef species with an unusual combination of high longevity and fast growth:

Parameter	Estimates	Source
Habitat	Rocky reef down to about 50 m, with females and juveniles inhabiting the relatively shallow sections of the reef and males tending to dominate deeper reef regions. Highly territorial adult males. Depth stratification of populations in southern Tasmania may be less pronounced than in NZ due to large depth changes occurring over short distances.	McCormick 1989a McCormick 1989b
Distribution	From around Sydney south to eastern Victoria and around Tasmania, New Zealand.	Gomon *et al*. 1994
Movement and Stock structure	In tagging studies, movement of juvenile and adult banded morwong was limited and generally restricted to within 5 km of the release site. No known information on the stock structure of banded morwong and thus the relationships of populations throughout the range.	Murphy and Lyle 1999 Ziegler *et al*. 2006
Natural mortality	Low Estimated at $M = 0.05$	Murphy and Lyle 1999
Maximum age	Females: 93 years Males: 96 years	Ewing *et al.* 2007
Growth	Males grow to larger sizes than females Growth accelerated between 1996 and 2007 Schnute & Richards (1990) growth parameters:	Ziegler *et al.* 2007a

	Females						*Males*					
	$L\infty$	*a*	*b*	*c*	α	σ	$L\infty$	*a*	*b*	*c*	α	σ
1996	429	11.9	3.8E-08	0.08	0.01	18.0	525	2.4	0.022	0.28	0.4	20.3
1997	446	19.7	4.7E-08	0.04	18.9	20.5	522	2.7	0.044	0.27	1.0	22.7
2001	418	13.8	1.2E-05	0.08	11.2	19.2	520	10.3	0.0002	0.08	8.2	20.5
2002	433	20.4	1.1E-07	0.05	75.3	17.6	538	11.3	0.0001	0.07	11.0	18.2
2003	427	20.1	1.3E-07	0.05	69.2	19.3	522	7.3	0.0037	0.11	6.8	18.2
2004	438	20.1	1.3E-07	0.05	68.2	19.5	526	5.9	0.0097	0.15	4.4	21.2
2005	452	22.7	1.3E-08	0.04	93.0	17.9	547	7.9	0.0022	0.10	8.1	17.2
2007	442	18.8	3.3E-07	0.05	51.4	16.2	516	2.3	0.0088	0.33	0.1	19.4

Parameter	Estimates	Source
Maturity	Early age and small size at onset of maturity Onset of maturity in 2005 at smaller sizes and younger ages than in 1996 Age at maturity modelled by logistic function:	Ziegler *et al.* 2007a

	B_0	B_1	*50% maturity*
F1996-97	-3.09	0.78	4 years
F2001	-2.93	1.08	2-3 years
F2002-03	-5.11	1.94	2-3 years
F2005	-5.26	1.94	2-3 years

Parameter	Estimates	Source
Spawning	In a spawning condition between mid to late February to early May, with the size distribution of oocytes in the ovaries indicating they are serial spawners	Murphy and Lyle 1999
Larval phase	Eggs and larvae are concentrated on the surface. Considerable numbers of *Cheilodactylus spp.* larvae have been caught some distance off the shelf break of eastern Tasmania, suggesting that banded morwong have a pelagic stage that is distributed in offshore waters.	B. Bruce pers. comm.
	Juveniles appear in shallow water on rocky reefs and tide-pools between September and December after a pelagic phase of around 4-6 months.	Wolf 1998

3.2 The fishery

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. Reported landings increased from 7 tonnes in 1991/92 to over 145 tonnes in 1993/94, though the latter figure is considered to be highly unreliable (Ziegler *et al.* 2006). Between 1994/95 and 1999/00, catches declined steadily from over 100 tonnes to just 34 tonnes, before increasing to over 50 tonnes in 2001/02 (Fig. 3.1). Since then, catches have stabilised around 40-50 tonnes.

Banded morwong are targeted almost exclusively for the live fish market with large mesh gillnets, primarily 130-140 mm stretched mesh. 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. 3.2). 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.

3.3 Management background

On 31 May 1994, a Ministerial warning was issued explaining that any catches of banded morwong and wrasse taken after that date would not be used toward catch history, should previous catches be used to determine future access to the live fishery. In the same year, minimum and maximum size limits (330 and 430 mm fork length) were introduced for banded morwong in an attempt to maintain adequate egg production by protecting large adults and to reflect market requirements by restricting the size range to that of highest value. Subsequent research indicated that these size limits offered minimal protection to mature females, since few females actually exceeded the upper size limit and the lower size limit was set close to the size at 50% maturity (Murphy and Lyle 1999). For these reasons, the size limits were revised in 1998 and minimum and maximum sizes were both increased by 30 mm to 360 and 460 mm fork length.

From 1995 onwards, a closed season (March and April inclusive) was introduced to coincide with the peak spawning period. The primary objectives of the closure were to protect spawning fish and to minimise wastage of fish at a time when they are most vulnerable to mortality in captivity.

In addition to the closed season, an interim live fish endorsement to take banded morwong and wrasse was introduced in 1996. Eligibility was based on a demonstrated history of taking one or both of these species (at least 50 kg between 1 January 1993 and 31 May 1994) and around 90 endorsements were issued. These arrangements continued until the scalefish fishery management plan was implemented in late 1998. Under the plan, a specific licence was introduced for the banded morwong fishery (live or dead) in State waters. To qualify for a banded morwong fishing licence, a more stringent catch history requirement was applied (minimum of two tonnes of banded morwong during the period 1 January 1993 to 31 May 1994) that resulted in 29 fishing licences for banded morwong. As the result of concerns about a potential unsustainable expansion of the fishery, a quota management system with a Total Allowable Catch (TAC) along the east coast from Whale Head in the south to Low Head on the north coast (excluding the Furneaux Group) was introduced in October 2008 (Fig. 3.1).

In November 2001, largely as a result of concerns about stock status, a daily bag limit of two fish was introduced for recreational fishers. This was amended in 2004 to a possession limit of two fish.

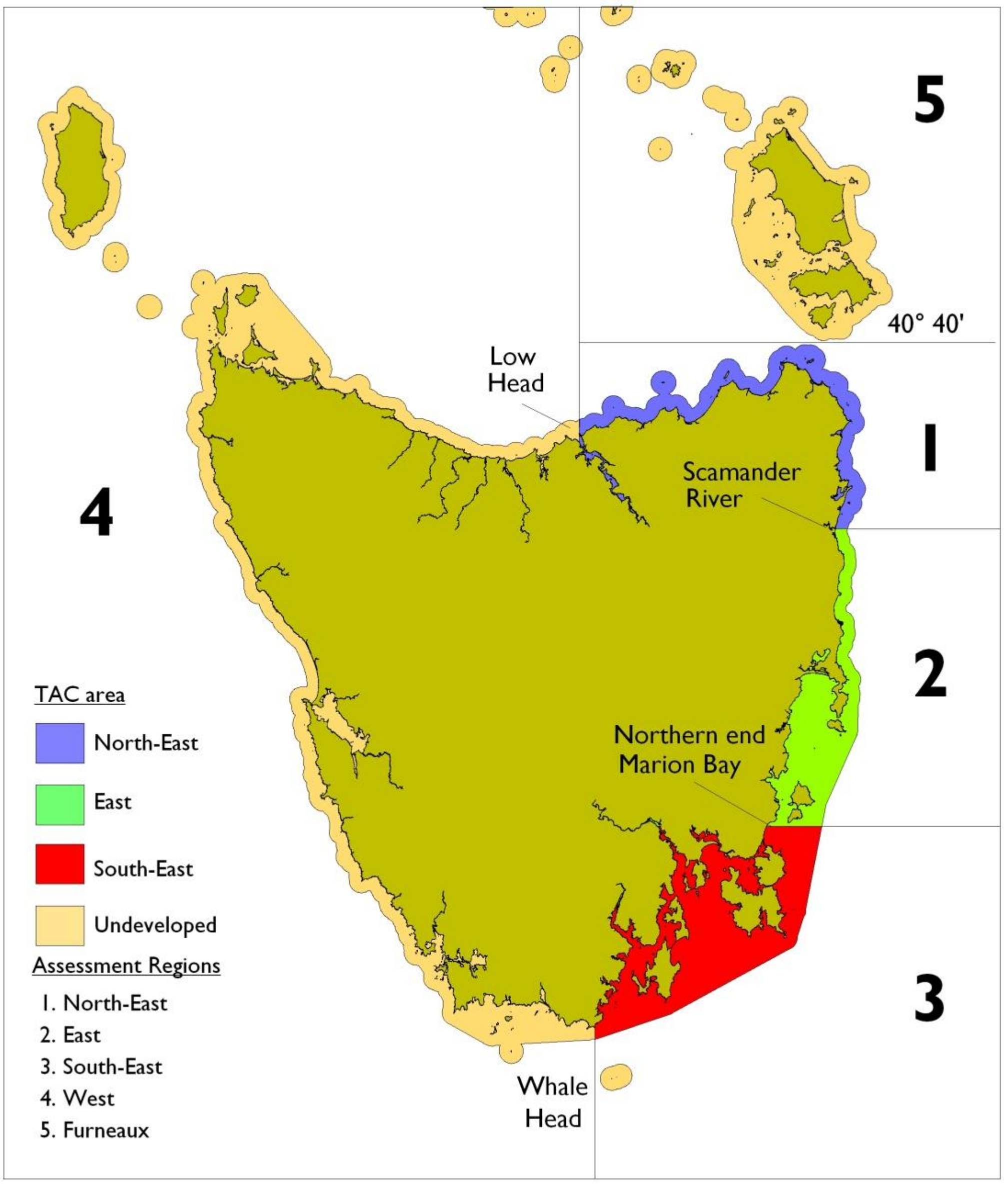

Fig 3.1. Designated TAC areas for banded morwong (Areas 1, 2 and 3) from Low Head on the north coast to Whale head in the south, and the five assessment regions separated by the dotted lines.

3.4 Management objectives and strategies

The generic management objectives for the Tasmanian scalefish fisheries apply, although with reference period 1994/95 to 1997/98 for catch and effort.

The species is currently managed by a combination of individual transferable catch allocations, limited licences, gear limitations (maximum of 1000 m graball nets), size limits (360-460 mm fork length) spawning closure (March-April), and limits on recreational catch (2 fish possession limit).

3.5 Relative vulnerability to fishing

Banded morwong show an unusual combination of high longevity, fast initial growth and early maturity. The high plasticity in growth and onset of maturity, if proven to be a response to high levels of exploitation (Ziegler *et al.* 2007a), would indicate a resilience of the fish stocks to overfishing. However, such significant changes also strongly indicate that stocks have experienced heavy fishing pressure and potentially unsustainable fishing mortality levels. This is particularly important because the species remains site attached after settlement and so is highly vulnerable to localized overfishing and serial depletion.

3.6 Current assessment

Since juvenile and adult banded morwong are largely site attached, populations on individual reefs will remain relatively discrete and therefore catch and catch rate trends should ideally be evaluated at this spatial scale. However, for practical reasons, primarily the spatial resolution of the data (½ degree fishing blocks), analyses have been undertaken at the block level or for the five assessment regions that have been defined for the fishery (Fig. 3.1). Collectively, catches from the three regions within the TAC area have averaged over 90% of the total banded morwong production each year since the mid-1990s (Fig. 3.2).

As a consequence of the introduction of the quota system, the current assessment is based on the quota year (1st March to end of February in the following year) rather than fishing year. This assessment presents an analysis of catch, effort data and catch rate standardisation based on commercial logbook returns which are evaluated against performance indicators specified in the scalefish management plan and detailed in Section 1.3. They are also evaluated against a new set of alternative performance indicators which are intended to replace the existing ones over the next few years.

Biological sampling was not undertaken in 2010 and therefore the stock assessment model for banded morwong was not updated.

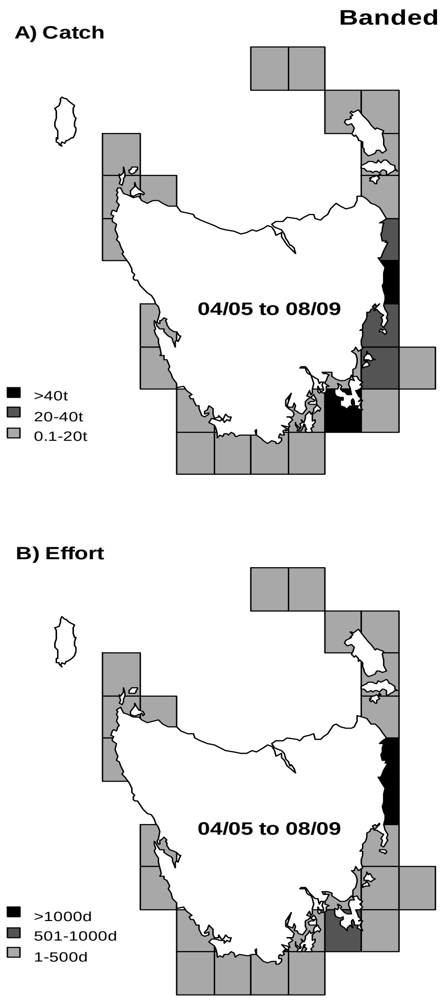

Fig 3.2. (A) Banded morwong catches (tonnes) and (B) effort (days) by fishing block pooled from 2004/05 to 2008/09 (left) and during 2009/10 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

3.6.1 Catch, effort and catch rates

Catches in the new logbook are reported as number of fish rather than weight. Hence, total catches in 2009/10 were estimated at 42.2 tonnes based on an average weight of 1.3 kg per fish.

State-wide catches have been relatively stable at 44-55 tonnes since 2001/02 with the exception of a 36.9 tonne catch in 2008/09 (Fig. 3.3). Industry stated that issues related to structural adjustment to the new quota system was the main reason for this shortfall. Quotas were not transferrable during that period because the legislation had not yet passed parliament, and leasing practices had not been established between fishers.

Catches increased slightly in the both assessment regions 2 and 3 and fell in assessment region 1 (Table 3.1 and Fig. 3.3). Assessment area 2, between Scamander River and the northern end of Marion Beach, continued to dominate the catches, representing just under 50% of the TAC. None of the regional reference points were reached. Catches from outside the proposed TAC areas were relatively low (5.3 tonnes) and thus below the 10 tonnes reference point per assessment area.

Results of the recreational surveys indicated that the recreational catch of banded morwong is low at around or less than one tonne (Lyle 2005, Lyle et al. 2009). Thus, recreational catches represent less than 2.5% of the commercial catch.

Total effort expressed as days fished or gear units (100m net hour) remained stable when compared with 2008/09 (Fig 3.4). Fishers have progressively reduced their fishing activity and deployed less gear on average for each day fished over the last 10 years, indicated by a stronger decline of effort by days fished compared to gear units. There have also been numerous industry reports of increasing levels of seal interference over time that has meant that affected fishers have often resorted to fishing with less gear or doing fewer sets each day to reduce losses to seals (Ziegler *et al.* 2006).

Regionally, the most conspicuous trend in effort (days fished) was the drop in effort in assessment region 1 (NEC) that continues a general decline, arrested briefly in 2008/09, since the early 2000s. Effort in the other two assessment regions increased only slightly over 2008/09, returning to levels experienced during the mid-2000s.

Table 3.1: Catches in tonnes for 2008/09 and 2009/10 inside and outside the designated TAC area.

Assessment Region		Description	Catch		% 09/10 Catch within TAC area
			08/09	09/10	
Within TAC area	1	North-East coast (NEC): Low Head to Scamander River	7.9	6.1	16%
	2	East coast (EC): Scamander River to Marion Bay	16.6	19.4	53%
	3	South-East coast (SEC): Marion Bay to Whale Head	9.4	11.4	31%
	Total		33.9	36.9	
Outside TAC area	4	West coast & North cost west of Low Head	1.6	1.2	
	5	Furneaux Group	4.9	4.1	

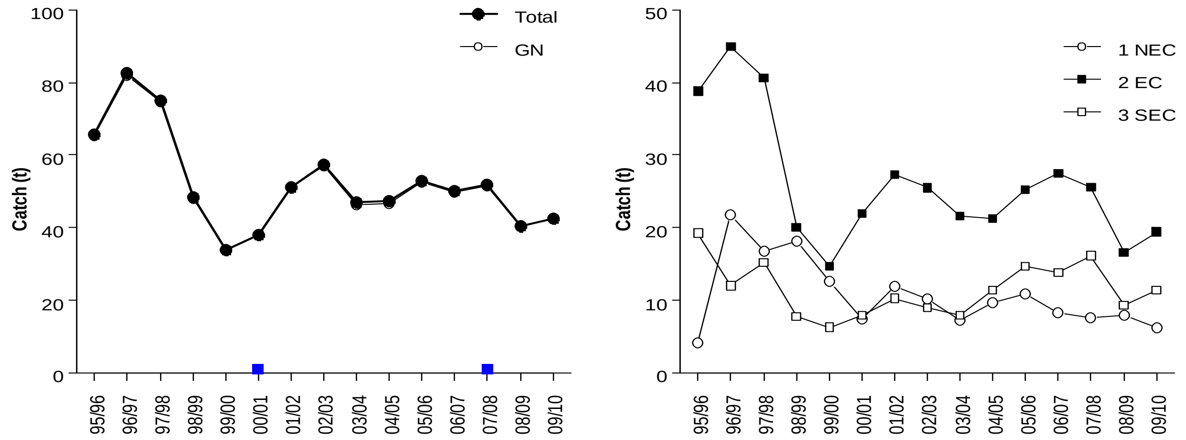

Fig 3.3. Banded morwong catches (tonnes) since 1995/96. Total catches State-wide for all gear types (Total) and by graball net (GN, left); and regional graball catches in the TAC areas 1 NEC, 2 EC and 3 SEC (right). Recreational catch estimates are indicated by the solid square symbols.

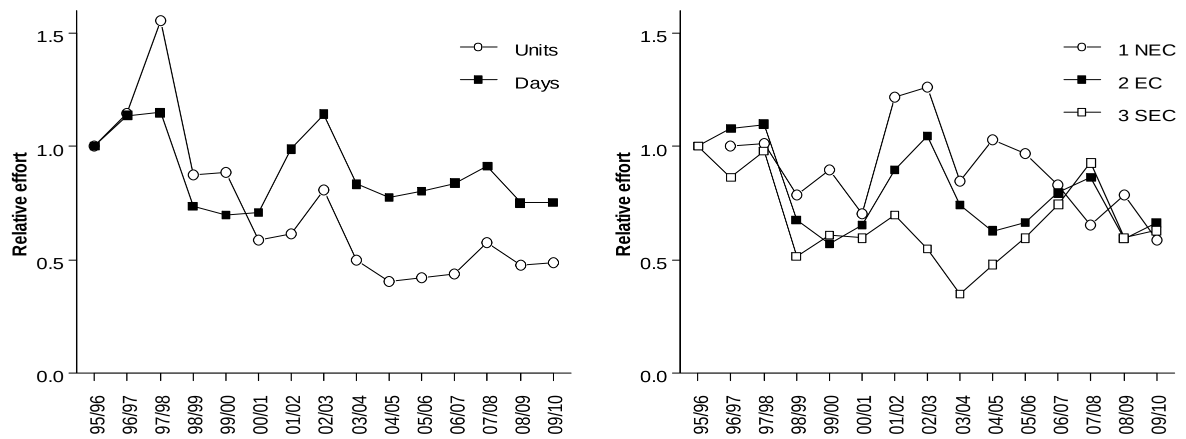

Fig 3.4. Banded morwong graball effort relative to 1995/96 levels. State-wide relative effort based on gear units (Units) and days fished (Days) (left); and relative effort in days fished in the TAC areas 1 NEC, 2 EC and 3 SEC (right).

Catch rates of banded morwong have been standardised using generalized linear models (GLM) to reduce the impact of obscuring effects such as fishing block, depth, season or skipper on the underlying trends (Kimura 1981, 1988). However, while standardised catch rates are preferred over the simple geometric mean, there remains no guarantee that a direct relation exists between the standardised catch rates and stock size, as other factors may have effects on changes in biomass that are unaccounted for by the statistical model.

Standardisation of catch rates was conducted for an annual time scale (the quota year), at both the scale of the whole TAC area and for three separate assessment regions within the quota area (Table 3.2). The data was selected with respect to skippers who had reported catches for at least two years and who had a median catch of at least 500 kg of banded morwong across all of the years they were active in the fishery. These restrictions selected data that accounted for 92% of the total catch reported since 1995/96. Nevertheless, the number of skippers was relatively low in each assessment region over the entire time series (31 in region 1, 54 in region 2, 28 in region 3, 58 in the entire TAC area).

The generalized linear models of catch rate were fitted to different combinations of various factors for which information were available, viz. vessel, skipper, fishing block, depth zone fished (<10 m, 10-20 m, 20-30 m, and >30 m), bimonthly period, and reported seal interference. A bimonthly rather than monthly period was included as a temporal factor because there would have been too few records each month to give reliable results. Due to the annual spawning season closure in March and April, only five bimonthly categories were investigated. Seal interference was a relatively influential factor, despite very inconsistent reporting. Fishing trips with seal interference and very low catches may not be reported at all, and a report of seal interference (‘occurrence’) does not in any way allow quantification of the severity of the interaction in terms of lost catch or impacts on fishing activity.

Standardised catch rates for banded morwong were fitted to natural log-transformed catch rate data (assuming a lognormal distribution), using a normal distribution family with an identity link. All models were fitted using a forward approach by manual stepwise addition of each factor starting with the time-step. Some interaction terms between various factors were also considered, but these were limited to combinations for which sensible interpretations could be ascribed. The optimal model was chosen based on minimization of the Akaike’s Information Criterion (AIC; Burnham and Anderson 2002).

Table 3.2: Generalized linear models (GLM) for the catch rates of banded morwong across the whole east coast of Tasmania, and in the separate St. Helens, Bicheno, Maria and Tasman regions. The adjusted R^2 has been used for the Variation described.

Region		Model	Variation described
Whole TAC area	Ln cpue =	Constant + year + vessel + seals + bimonth + block + skipper +depth + vessel*bimonth	40.3%
1 NEC	Ln cpue =	Constant + year + vessel + bimonth + seals + block + depth + vessel*bimonth	45.6%
2 EC	Ln cpue =	Constant + year + vessel + bimonth + seals + block + skipper + depth + vessel*bimonth	41.2%
3 SEC	Ln cpue =	Constant + year + vessel + bimonth + block + skipper + seals + vessel*bimonth	42.4%

Overall standardised catch rates in the whole TAC area fell between 1995/96 and 1999/2000, accompanying the declines in catch and effort (Fig. 3.5). Since 1999/2000 catch rates have risen back to 1995/96 levels. Catch rates in region 1 (NEC) and region 2 (EC) fell in the late 1990s, but have since stabilised at around 70% of 1995/96 levels. Catch rates in region 3 (SEC) decreased initially to 1999/2000, then increased to levels well above those of 1995/96 by 2005/06. Subsequent catch rates have stabilised but at a lower level. Alternative reference limits have not been triggered in any of the assessment regions, while catch rates were below the existing reference limits in the regions 1 and 2.

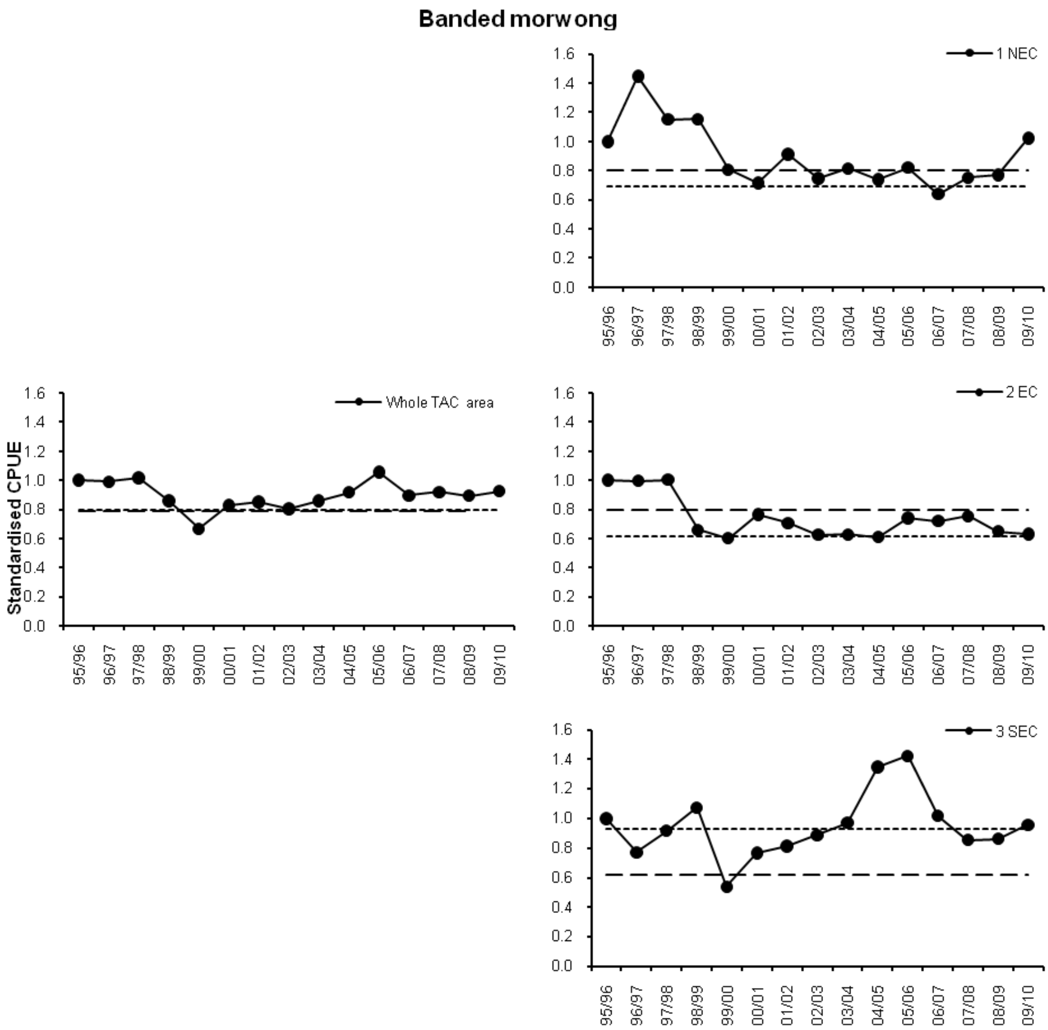

Fig 3.5. Banded morwong standardised graball catch per unit effort (CPUE by days fished) relative to 1995/96 levels from the whole TAC area (left), and in the TAC areas 1 NEC, 2 EC and 3 SEC (right). Dashed lines mark existing reference limits, dotted lines mark alternative reference limits (refer section 3.8).

3.7 Reference points

Existing reference points	Exceeded?	Alternative RP	Exceeded?
State-wide or regional catches outside the 1994/95 to 1997/98 range (73t-106t)	Yes: ↓ Statewide ↓ Region 1 (NEC) ↓ Region 2 (EC) ↓ Region 3 (SEC)	Commercial catch in Region 1 > 30% of TAC Region 2 > 65% of TAC Region 3 > 40% of TAC Regions 4 or 5 > 10t	No
Catch increase or decline by over 30% from previous year	Yes: Region 2 (-35%) Region 3 (-42%)	Commercial catch is less than 90% of TAC	Not assessed
State-wide or regional effort over 10% of the highest for the period 1995/96 to 1997/98	No	-	
State-wide or regional catch rates less than 80% of the lowest annual value for the period 1995/96 to 1997/98	Yes: Region 1 (NEC) Region 2 (EC)	Catch rates are below 0.9 * average from reference period 2000/01 to 2006/07	No
Others: - Significant change in size/age composition of catch - Change in catches of non-commercial fish relative to 1990/91 to 1997/98 or high incidental / undersized mortality - Significant catch of unhealthy fish - Any other indicator of stock stress	Yes: Significant changes of age/size composition, acceleration of growth & earlier maturity (see Ziegler et al. 2008)	Any indicator of stock stress	Yes: Significant changes of age/size composition, acceleration of growth & earlier maturity (see Ziegler et al. 2008)

3.8 Implications for management

The combination of estimates for mature and exploitable biomass and harvest rates indicates that banded morwong stocks in both regions are currently not overfished. The fishery with larger catches in the 1990s has reduced stock biomass, but substantial recruitment pulses in the mid 2000s have managed to stabilise mature and exploitable biomass at lower levels. Overall, the model estimated a decrease in mature biomass between 1990-2009 in region 2 (EC) from around 511 tonnes to 216 tonnes or 42% of the initial levels, and in region 3 (SEC) from around 255 tonnes to 141 tonnes or 55% of the initial levels.

Nevertheless, 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. For the current TAC of 44.4 tonnes or more, the model predicted a close to 100% probability that mature biomass and catch rate will decline. Only with a TAC reduction to around 20 tonnes, the model predicted that the probability for sustained mature biomass and catch rates over a 5-year period would increase to above 50%.

Therefore, the TAC should be lowered to reduce the risks of overfishing. However, 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. These are important issues that need to be taken into consideration in and future management action.

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. 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 additional impact is difficult to quantify and will need to be considered carefully for the next stock assessment.

3.9 Research needs

The Scalefish Fishery Research Advisory Group has accorded stock assessment of banded morwong a high priority. Biennial spawning season surveys and stock assessments should continue into 2011 and are expected to provide further insights into the impact of fishing on the size, age and sex structure. However, while sampling needs to be focussed regionally to account for the level of spatial structuring in the fish populations (at the reef level), this degree of sampling intensity is difficult to achieve and justify in a fishery of this size.

Information about the character or relative abundance of populations in the deeper reef areas or potential mixing rates with the shallower areas is still rare. Fishing surveys of such areas and an understanding of the size and distribution of suitable deep reef habitat relative to the shallow fished reef areas could prove informative in evaluating the potential importance of depth refuges.

The impact of high grading needs to be carefully considered and taken into consideration in the next stock assessment.

4 Southern calamari (*Sepioteuthis australis*)

4.1 Life-history and stock structure

Southern calamari is a very short-lived, fast-growing cephalopod species with spawning aggregations in inshore waters:

Parameter	Estimates	Source
Habitat	One of the most common cephalopods in coastal shallow waters of southern Australia.	
	Important component of the coastal ecosystem as primary consumer of crustaceans and fishes, and as a significant food source for numerous marine animals.	Gales *et al.* 2003
Distribution	Endemic to southern Australian and northern New Zealand waters	Gomon *et al*. 1994
Movement	Differential habitat use by the sexes during spawning with males accumulating on the beds, as opposed to more frequent small-scale	Pecl *et al.* 2006
	movement on and off the beds by females. Sex-ratio is more even both before and after the closure, however, during the closure spawning activity in aggregations males out-numbered females 10:1. Therefore, although the fishery removes a representative sample of what squid are on the spawning beds at any point in time (squid jigs do not appear to be sex-selective), the fishery is effectively selective for males and will therefore impact both the apparent size of individuals and sex-ratio of the population.	Hibberd 2005
Natural mortality	High	Pecl *et al.* 2004
Maximum age	The species is short-lived, probably living for less than one year: Maximum recorded ages: males: 275 days, females: 263 days.	Pecl *et al.* 2004
Growth	Rapid rate of growth at 7-8% body weight per day (BW day^{-1}) in individuals less than 100 days old, decreasing to 4-5% BW day^{-1} in squid older than 200 days. Extremely variable growth: At 200 days of age individual males may vary in size by as much as 1.5 kg and females by as much as 0.9 kg. Some of this variability in growth may be explained by temperature or food availability at hatching, with those individuals hatched in warmer seasons or years generally growing faster. Males attain greater size and weight than females: - Maximum recorded length: males 550 mm, females: 480mm dorsal mantle length (ML). - Maximum recorded weight: males 3.6 kg, females: 2.3 kg.	Pecl *et al.* 2004
Maturity	On the east coast of Tasmania, over 90% of females caught in summer are mature, whereas in winter over 50% of the females are either immature or in early stages of maturity.	Pecl 2001
	Minimum recorded age and size at maturity for females is approximately 117 days, 0.12 kg and 147 mm ML. Immature females were found to be as old as 196 days and up 0.62 kg and 237 mm ML. Males mature as young as 92 days and as small as 0.06 kg and 104 mm ML.	Pecl 2001
Spawning	Major spawning period in spring/summer in Tasmania, with low levels of spawning occurring all year round. The majority of summer caught squid are hatched in winter and vice versa.	Moltschaniwskyj *et al.* 2003
	Multiple spawners with individual spawning activity occurring over several months (acoustically-tagged mature females moved on and off the spawning grounds for up to 3½ months). Frequency of batch deposition is unknown.	Pecl *et al* 2006

Spawning (cont.)	Summer spawners can lay larger batches of eggs than winter spawners	Pecl 2001
	Younger females may lay more eggs than older females.	van Camp *et al.* 2005
	Spawning aggregations are male-biased. Female calamari have multiple mates with up to 85% of individual egg capsules from the one female sired by multiple fathers. Mating occurs either in temporary pairs with a large dominant male that guards the female, or in extra-pair copulations with a 'sneaker male'. Genetic studies demonstrated that both small and large males sire similar proportions of offspring.	Jantzen and Havenhand 2002 van Camp *et al.* 2004
	Several females deposit eggs together in collective egg masses, attaching the finger-like capsules to the substrate by small stalks. Eggs appear to be most commonly attached to *Amphibolis* seagrass, although they are also found attached to other seagrasses and macro-algae, or embedded directly into sand. Individual egg strands contain 4-7 eggs, with 50 to several hundred egg strands joined together to form larger egg mops. Development takes 4-8 weeks, depending on water temperature, bringing the total life span close to annual.	Moltschaniwskyj *et al.* 2003 Steer *et al.* 2002
Early life history	Newly hatched calamari are 2.4-7 mm ML and immediately swim to the surface following hatching. Hatchlings can be found near the spawning grounds for 20-30 days. The habitat and ecology of individuals between about 20-80 days of age is unknown, however at 80-150 days, juveniles have been found in deeper water adjacent to the spawning grounds. Individuals become available to the fishery at approximately 90-120 days of age.	Steer *et al.* 2002 Pecl 2000 Pecl 2004
Recruitment	Highly variable	This report

4.2 The fishery

The fishery for southern calamari in Tasmania expanded rapidly 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 at high levels. The expansion of the fishery was accompanied by a massive increase in effort, particularly 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.

4.3 Management background

In August 1999, the dramatic rise in southern calamari catches prompted a ministerial warning that management arrangements were under review and restrictions on catch, effort and numbers of operators accessing the resource may be introduced in the future. In addition, Great Oyster Bay was closed to fishing for southern calamari for two weeks twice between October and December 1999 as a precautionary measure to protect egg production. Similar short-term closures were implemented again in 2000 and 2001, while in 2002 closures were extended to include adjacent fishing grounds in Mercury Passage. In each year from 2003 to 2006, the commercial fishery in Great Oyster Bay and Mercury Passage was closed for a three-month period to reduce catches from the spawning population.

In 2003 and 2004, the area was closed from September to November inclusive. Recreational fishers were permitted to fish for calamari during this period but with a reduced daily bag limit of five calamari, and there was some limited research fishing by commercial fishers, operating under permit. The movements of acoustically-tagged calamari suggested that they were unlikely to have left the protection of the Great Oyster Bay closed area based on the boundaries that were in place during 2003. However, tracking data did indicate that some leakage out of the protected area probably occurred during the 2004 closed season, where the closed area was reduced in size (Pecl *et al.* 2006).

In 2005, the closed area was expanded to include all waters between Wineglass Bay and the northern end of Marion Bay and the closure period lasted from mid-September to mid-December. The closure also included recreational fishers, thereby providing effective protection to the spawning stock during the peak of the spawning season. A similar closure was implemented in 2006, and shortened by two weeks in 2007 and 2008 (start of October to mid-December).

Growing markets for the species coupled with increasing use of squid jigs, a method available to all holders of scalefish and rock lobster licences to target the species, have contributed to the recent expansion of the fishery. In an effort to limit this expansion, a combined possession limit of 30 calamari and arrow squid was introduced in November 2001 for all holders of scalefish C licences (but excluding those also holding beach seine or purse seine licences). In addition, a daily bag limit of 20 'squid' (southern calamari and/or Gould's squid) and a possession limit of 30 squid were introduced for recreational fishers. Recreational bag limits for squid were replaced with a possession limit of 15 calamari and 15 Gould's squid in 2004.

The fishery was divided into a "developed" region in the east and south-east and an "undeveloped" region for the rest of Tasmania in October 2008. For the developed region, a specific calamari licence was introduced, with 17 operators qualifying for this licence. In response to the restricted number of operators licensed to fish in the east and south-east region, the seasonal closure was partially relaxed in 2009 and reduced to one month, between mid October and mid November. The closed area (between Lemon Rock and northern end of Marion Bay) was, however, retained.

4.4 Management objectives and strategies

The generic management objectives for the Tasmanian scalefish fisheries apply (with reference period 1995/96 to 1997/98).

The species is currently managed by a combination of a specific calamari licence for the developed region of the fishery in the east and southeast (between Lemon Rock and Whale Head), a spawning season closure for commercial and recreational fishers in all waters between Lemon Rock and the northern end of Marion Bay, currently from mid-October to mid-December, a combined possession limit of 30 calamari and Gould's squid for all holders of scalefish C licences (excluding those also holding beach seine or purse seine licences), and a possession limit of 15 squid for recreational fishers.

4.5 Relative vulnerability to fishing

Vulnerability of calamari to fishing pressure is unclear but probably high because spawning aggregations can be 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 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.

4.6 Previous assessments

Previous assessments have involved analyses of catch, effort and catch rate trends. Rising effort and declining catch rates in the main fishing regions were noted and flagged as potential indicators that the fishery had impacted on the calamari stocks. Preliminary analysis of catch and effort data using surplus production modelling for the major fishing areas of Great Oyster Bay and Mercury Passage was investigated for the 2003 and 2004 assessments. Analyses suggested that the unfished, mid-season exploitable biomass was between about 200-275 tonnes but had been reduced to below 50% of this level, implying that harvest rates were very high and not sustainable. Three month closures were implemented as a direct management response to reduce the harvest rates as well as protect the stocks whilst spawning. These closures, however, resulted in a substantial change in the temporal distribution of catch and effort, thereby violating a key model assumption that the distribution of catch and effort is consistent over time. This meant that the surplus production modelling was no longer valid or useful.

4.7 Current assessment

Extended fishery closures have had large impacts on monthly catches in Great Oyster Bay and Mercury Passage each year since 2003 (Fig. 4.1). Fishing activity has effectively shifted from an August - December focus (1998/99 - 2002/03) to being more heavily concentrated into the single month of December (2003/04 - present).

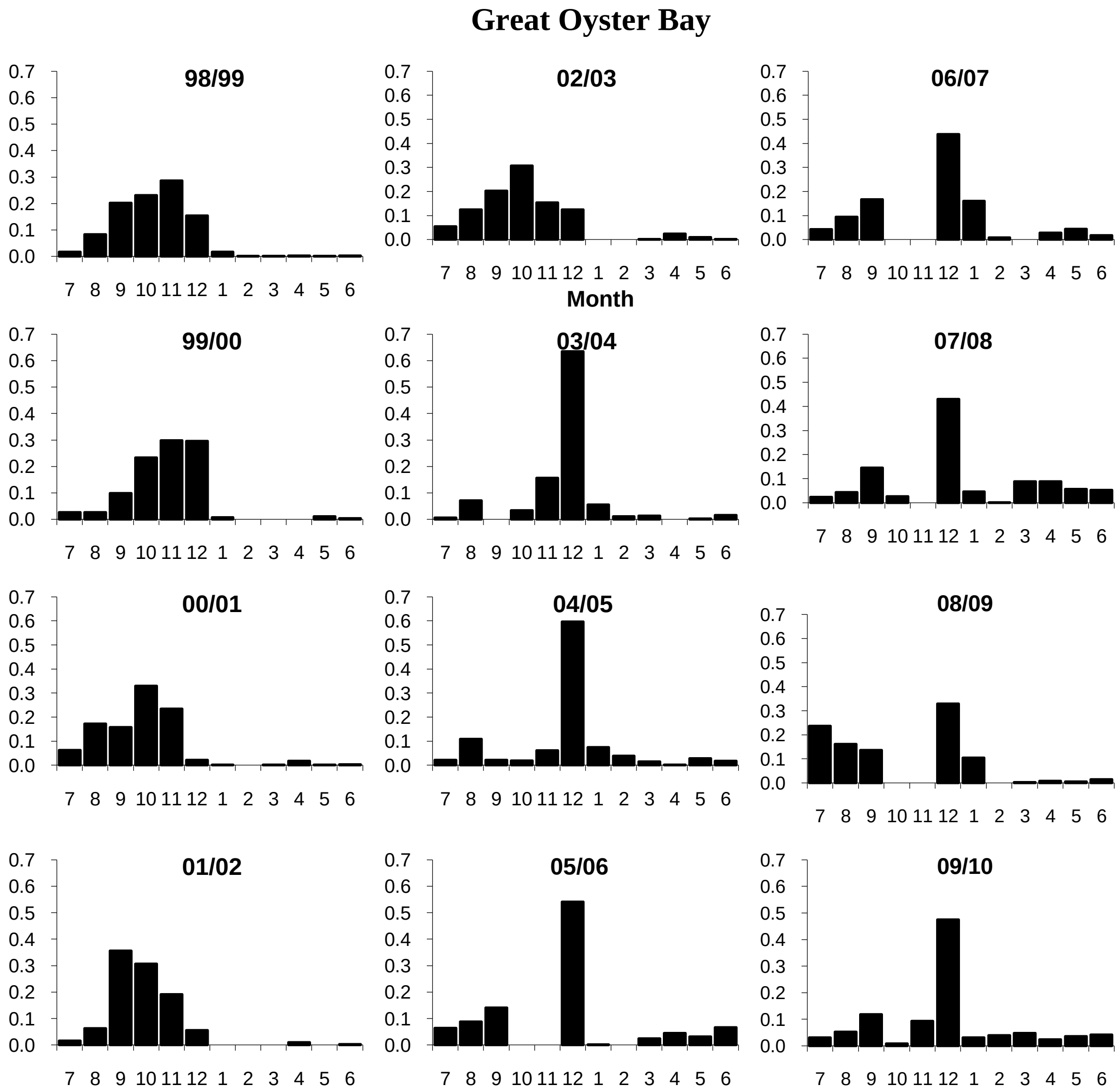

Fig. 4.1. Monthly catch distribution (as proportion of the total catch within the fishing year) for Great Oyster Bay (ES13 and ES14) and Mercury Passage (next page; ES16).

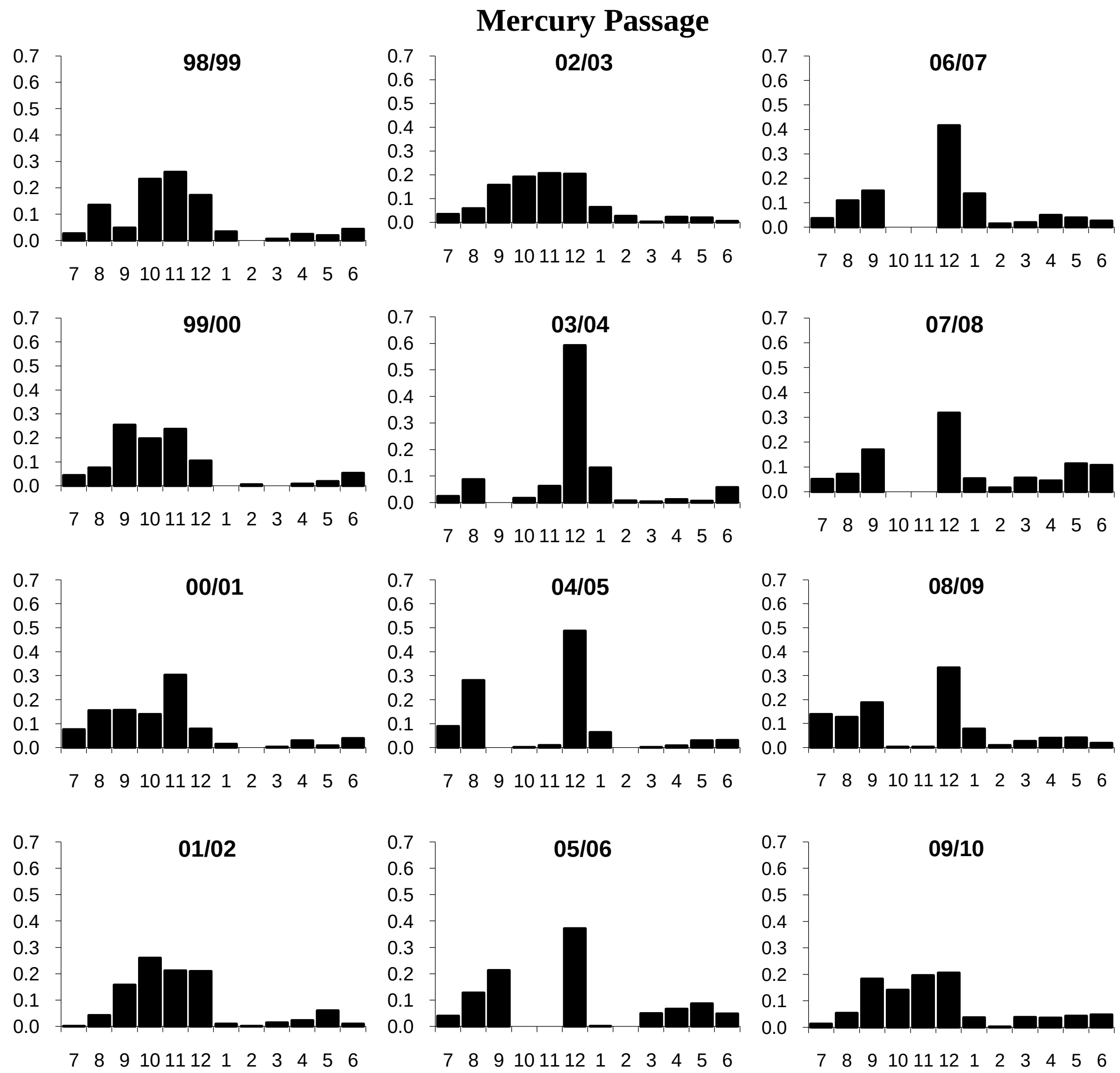

Fig. 4.1 continued. Monthly catch distribution (as proportion of the total catch within the fishing year) for Great Oyster Bay (previous page; ES13 and ES14) and Mercury Passage (ES16).

4.7.1 Catch, effort and catch rates

Since 1998/99, a significant fishery for southern calamari has developed in Tasmania, with annual catches expanding rapidly from less than about 30 tonnes prior to 1998/99 to over 100 tonnes (Fig. 4.2A). The expansion of the fishery was almost exclusively due to increased squid jig catches. Catches have fluctuated at high levels since, with the 2009/10 catch of 51 tonnes being 28 tonnes lower than the previous year and 38 tonnes lower than 2007/08. Catch declines were evident in all areas apart from Mercury Passage, where there was little change compared with 2008/09. The two estimates of the recreational calamari catches (18 tonnes in 2000/01 and 45 tonnes in 2007/08) indicate that this sector also contributes significantly to the overall fishing pressure on the species.

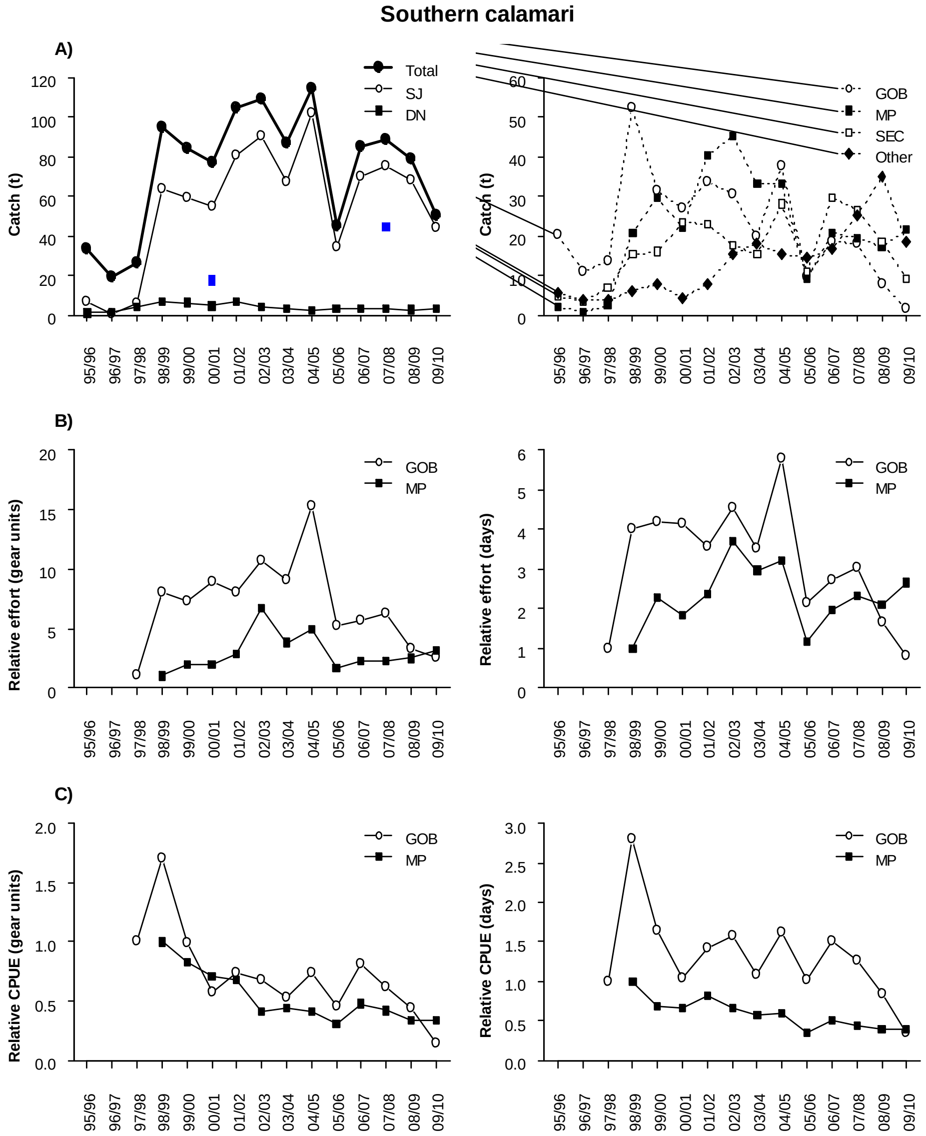

Fig. 4.2. A) Annual commercial catch (tonnes) of calamari by method (left) and by region (right) since 1995/96 reported in Tasmanian logbooks, and best estimates of recreational catches (single squares); B) commercial squid jig effort based on gear units (left) and days fished (right) relative to 1998/99 for MP and 1997/98 for GOB; and C) commercial squid jig catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day (right) relative to 1998/99 for MP, 1997/98 for GOB and 1995/96 for Tasmania (Total). SJ is squid jig, DN is dipnet; SEC is south-east coast, MP is Mercury Passage, GOB is Great Oyster Bay, and Other is all remaining areas. Only years with >5 operators are shown.

The fishery developed initially in the mid-1990s in Great Oyster Bay and then expanded to the south to include Mercury Passage, Maria Island and Tasman Peninsula (Fig. 4.2B). While the main fishery is concentrated off the central east and south-east coasts, catches are now reported from all areas apart from the west coast (Fig. 4.3). The spawning season closure, introduced in 2004/05 for Great Oyster Bay and Mercury Passage and subsequently extended over a larger area, appears to have been successful in reducing pressure on these main spawning grounds and in encouraging industry to spread the effort into the wider south-east region and the central east coast. Over recent years, moderate catches of calamari have also been taken from Flinders Island, around the Tamar, and increasingly around Stanley (Fig. 4.3).

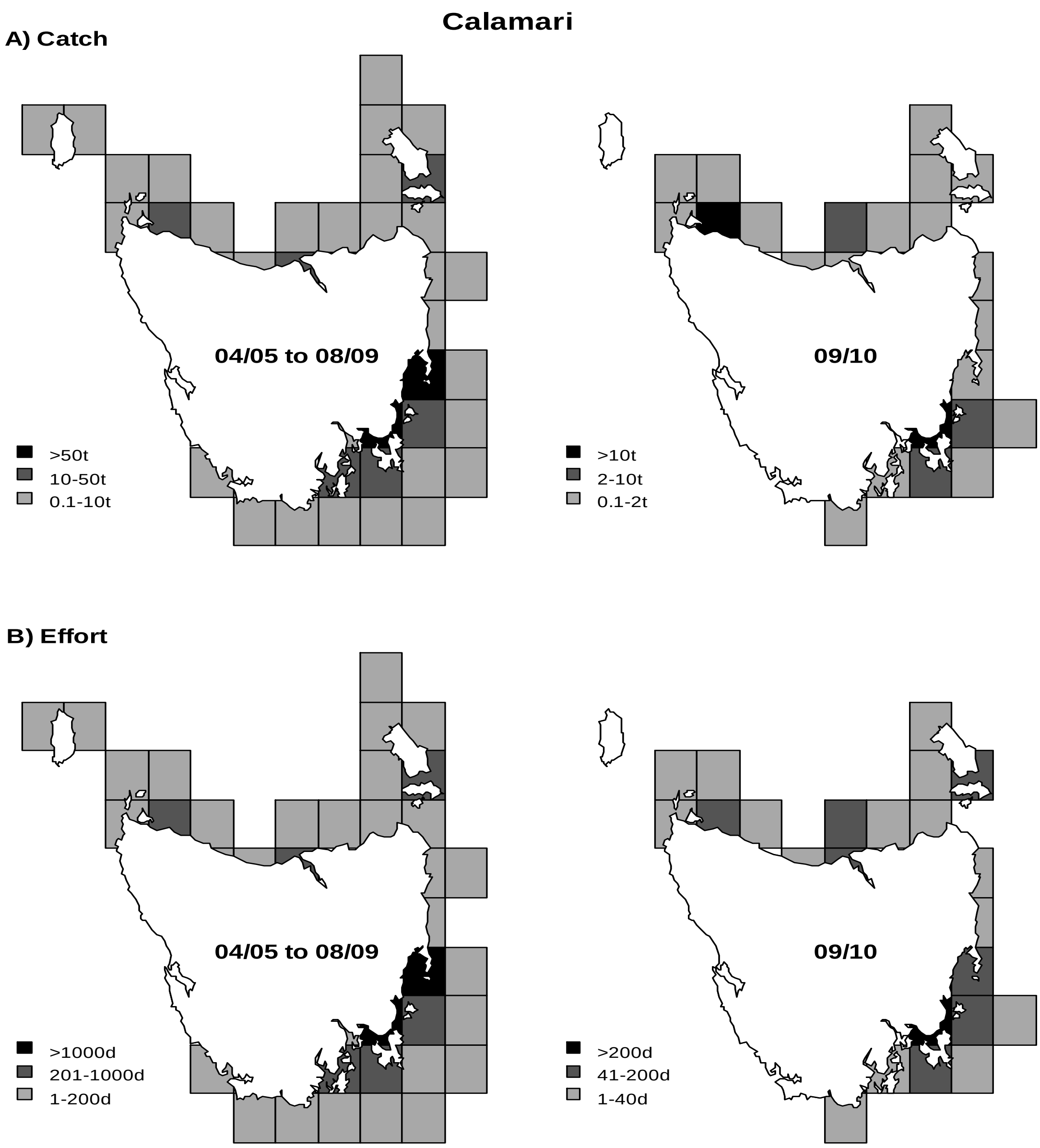

Fig. 4.3. (A) Calamari catches (tonnes) and (B) effort (days) by fishing block pooled from 2004/05 to 2008/09 (left) and during 2009/10 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

The regional distribution of effort is generally consistent with the pattern observed for catches (Fig. 4.3). Typically effort has been focussed in Great Oyster Bay, Mercury Passage, the south-east, and Tamar and Stanley in the north. During 2009/10 the focus of jig effort off the east coast shifted away from Great Oyster Bay (Fig. 4.2B), presumably linked to a marked fall in catch rates in that area, which was set against general stability for Mercury Passage (Fig. 4.2C). Industry reports confirmed low availability of calamari in Great Oyster Bay during 2009/10, with better catches from Mercury Passage.

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 during the 2009/10 spawning season, and evidence for a general decline in egg production since 2004 (Fig. 4.4). Assuming egg production is related to the abundance of adults on the spawning ground, then the general decline in catch rates in Great Oyster Bay (Fig. 4.2C) are likely to have been influenced by reduced spawning stock size and not solely the impacts of closures during peak fishing period.

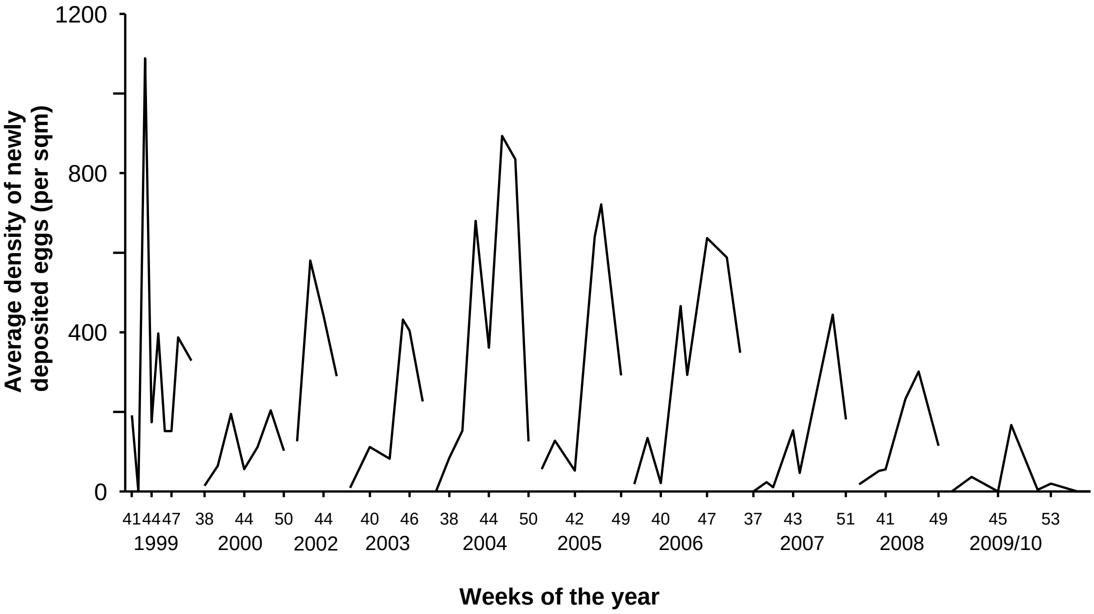

Fig. 4.4. Calamari egg production estimated from dive surveys of the main inshore spawning beds in Great Oyster Bay by week of year.

4.8 Reference points

Existing reference points	Exceeded?	Alternative RP	Exceeded?
State-wide or regional catches outside the 1990/91 to 1997/98 range (6t-33t)	Yes: Statewide ↑ (50.7t)	Commercial catch in: GOB & MP > 50t Remainder SE > 30t Outside GOB, MP & SE > 25t	 No No No
Catch increase or decline by over 30% from previous year	Yes: Statewide (-35%)	Declining catch trend over 3 consecutive years by a total of > 40% in south-east Tasmanian waters	Yes (-40.5% since 2006/07)
State-wide or regional effort over 10% of the highest for the period 1995/96 to 1997/98	Yes	-	
State-wide or regional catch rates less than 80% of the lowest annual value for the period 1995/96 to 1997/98	Yes	-	
Others: - Significant change in size/age composition of catch - Change in catches of non-commercial fish relative to 1990/91 to 1997/98 or high incidental / undersized mortality - Significant catch of unhealthy fish - Any other indicator of stock stress	Not assessed	Any indicator of stock stress	Not assessed

4.9 Management implications

The alternative reference points for calamari should finally overcome the shortfalls of the existing reference ranges for catch and effort which are based on a period prior to the development of the fishery. As a result, catch and effort indicators have been continuously triggered in the past. In contrast, the alternative reference limits relate to a more recent status of the fishery and while overall catch levels were not triggered, the strong general decline in catches in the developed region over the past two years and in particular the decline in catch rates and egg production in Great Oyster Bay suggest the need to carefully monitor developments in the fishery over the coming years.

Species-specific fishing licences for south-eastern waters were introduced in October 2008 in response to continued high interest in calamari in recent years and substantial capacity within the Tasmanian scalefish industry to further increase effort levels. These licences provide 17 fishers access to the region and are expected to limit effort concentration particularly in the major spawning grounds of Great Oyster Bay and Mercury Passage.

Previously, effort on these spawning grounds was controlled exclusively by spawning season closures that were first introduced in 1999 and subsequently extended to three months. These protracted closures represent a rather crude approach to limiting catches and have significantly impacted on the economic viability of the fishery.

Nevertheless, the closures appeared to have been effective in protecting the main known spawning event and ensuring relatively high egg production. Based on cumulative egg production (Ziegler et al. 2007b), closures that encompass the September to November (or early December) period are likely to provide effective protection to the bulk of the spring spawning event in most years. Moreover, since calamari have a life span of generally less than one year, intense fishing pressure immediately after the fishery is opened will often have a limited impact on subsequent recruitment, since most calamari caught would have already spawned and would die naturally within in a short period of time.

As the spawning dynamics and egg production are better understood, future egg surveys could be used in a real-time monitoring to determine appropriate starting times and duration of spawning closures. However, the link between egg production and subsequent recruitment to the fishery is poorly understood. Since growth, reproductive characteristics and survival of individual calamari appear to differ substantially depending upon the timing of hatching and subsequent environmental conditions, environmental factors may ultimately prove as important as egg production and fishing mortality in driving the population structure and dynamics.

Stable isotope analyses of calamari statoliths indicated that most adult calamari caught on the east and south-east coasts are probably spawned in Great Oyster Bay (Ziegler et al. 2007b). These findings highlight the significance of Great Oyster Bay as a source for calamari recruits throughout eastern and south-eastern Tasmania, and reinforce the value and effectiveness of management arrangements that involve the closure of this region during the main spawning period.

Areas in south-eastern waters such as the D'Entrecasteaux Channel, Norfolk and Frederick Henry Bay and Great Oyster Bay are also recognised recreational hotspots. Interest in the species from this sector has remained high and fishing effort directed at the species has increased over the past decade.

In contrast to south-eastern waters, commercial catches outside in the 'undeveloped' regions triggered the alternative reference points. Moderate catches have been taken from around the Tamar and Flinders Island for some years, but catches increased sharply in a relatively small area around Stanley. Further developments in this area should be therefore monitored closely.

4.10 Research needs

The Scalefish Fishery Research Advisory Group has recognised stock assessment, evaluation of critical habitat requirements, impact of management arrangements and gear interactions on calamari populations as high priority research areas.

Further information on the stock structure and level of fishing pressure that can be sustained on southern calamari is required. Integral to this is the need to quantify the relationships between reproductive output, spawning stock size and subsequent recruitment. The identification of source and sink populations supporting the Tasmanian calamari fishery is critical to ensure sustainable use of this resource. While recent research has progressed in this area, it is important to note that calamari is a highly variable species and the observed patterns may not be valid in all years. Our understanding of the variability and plasticity in the life cycle, and the subsequent application of population modelling techniques, would also benefit from more detailed research into determining links between environmental factors and growth, reproductive, and survival characteristics. Given the vulnerability to recruitment failure, the impact of fishing activities on the spawning behaviour of the aggregations needs to be addressed.

5 Striped trumpeter (*Latris lineata*)

5.1 Life-history and stock structure

Parameter	Estimates	Source
Habitat	Mainly on the continental shelf over rocky bottom to depths of about 300 m, with juveniles associated with shallow inshore reefs.	
Distribution	Distributed throughout southern Australia, from Sydney around to Kangaroo Island in South Australia and including Tasmania. The species is also found in New Zealand, the St. Paul and Amsterdam Islands in the southern Indian Ocean, and the Tristan da Cunha Group and Gough Island in the southern Atlantic Ocean.	Gomon *et al*. 1994
Movement and Stock structure	Uniform stock structure in Tasmanian waters (no significant genetic separation of populations). Tagging studies suggest that juveniles tend to remain around shallow reefs for several years, with only limited movement, before moving into deeper offshore reefs. This pattern is supported by data from the commercial fishery that shows fish do not recruit to the offshore hook fishery until about 45 cm fork length (FL). In 2001, a striped trumpeter tagged off the Tasman Peninsula in 1996 was recaptured off St. Paul Island in the Indian Ocean indicating a capacity to undergo wide-scale movements.	Tracey et al 2007b Lyle and Jordan 1999 Tracey and Lyle 2005 Lyle and Murphy 2001
Natural mortality	Estimated as $M = 0.1$	Tracey and Lyle 2005
Maximum age	Maximum age is estimated to be 43 years (while this has yet to be fully validated, the incremental structure in sectioned otoliths is clear and unambiguous)	Tracey and Lyle 2005
Growth	Growth up to 1.2 m in length and 25 kg in weight Rapid growth of juveniles, reaching a mean length of around 28 cm FL after two years and 42 cm FL after four years, with most growth occurring during summer and autumn. Older fish grow significantly more slowly, with a large range in size-at-age for fish over about 50 cm FL.	Gomon *et al*. 1994 Murphy and Lyle 1999 Tracey and Lyle 2005
Maturity	Size at 50% maturity in females is around 54 cm FL (62 cm TL; 6.8 years), with males attaining 50% maturity at 53 cm FL (61 cm TL; 6.2 years).	Tracey *et al*. 2007a TAFI unpubl data
Spawning	Spawning occurs from July to early October, depending on geographical location, with earlier start and finish at lower latitudes. Multiple spawners, highly fecund (100,000 to 400,000 eggs for females weighing 3.2 and 5.2 kg, respectively) and produce small pelagic eggs (1.3 mm diameter) with a single oil droplet.	Ruwald et al. 1991 Ruwald 1992 Hutchinson 1993
Early life history	Larval rearing trials indicate a complex and extended larval phase, with a post-larval 'paperfish' stage of up to nine months prior to settlement. The distribution of larvae and recruitment processes have not been studied. While no information is available on the size and timing of settlement, juveniles of around 18 cm FL (23 cm TL) have been caught on shallow reefs off the south-east coast in January.	Ruwald et al. 1991 Ruwald 1992 Murphy and Lyle 1999
Recruitment	Recruitment is highly variable, with evidence of a particularly strong year class spawned in 1993 and indications of good recruitment from the 1994 and 1996 cohorts. Recruitment in intervening years has apparently been poor (based on anecdotal reports of low numbers or absence of juvenile fish observed associated with inshore reefs). Otolith microchemistry supports the hypothesis that inshore reefs represent an important juvenile habitat, with the bulk of the offshore adult population derived that individuals that spent their juvenile phase inshore.	Murphy and Lyle 1999 Tracey and Lyle 2005 Tracey, unpubl. data

5.2 The fishery

Striped trumpeter has had 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 methods, 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. Limited catches are taken off the west coast.

5.3 Management background

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 to 100 kg for South East Non-Trawl (SENT) permit holders and 20 kg for all other permit holders.

When the Tasmanian scalefish fishery management plan was implemented in 1998, gear restrictions were introduced for all commercial scalefish fishers operating in State waters. However, after the introduction of the management plan, those fishers who held a Tasmanian licence and a Commonwealth permit to fish in the southern shark or SENT fisheries were effectively allowed to target unrestricted quantities of striped trumpeter in offshore waters using their Commonwealth gear allocations (this was a significant change to their original 20 kg or 100 kg restrictions). In addition, Tasmanian rock lobster fishers were also allowed to take unrestricted quantities of striped trumpeter in offshore waters using their State scalefish gear allocations.

In August 2000, the State Government introduced a combined 250 kg trip limit for striped trumpeter, yellowtail kingfish and red snapper for all fishers (Commonwealth and State) in inshore and offshore waters relevant to Tasmania. This measure was introduced to limit the potential for expansion of efforts directed at these species. A daily bag limit of five and possession limit of eight striped trumpeter was also introduced for recreational fishers.

The legal minimum size limit for striped trumpeter was raised from 35 to 45 cm total length (TL) in November 2004 in recognition that the smaller size limit was substantially below the size at maturity (62 cm TL for females and 61 cm TL for males). The recreational bag limit was also dropped and effectively replaced by the possession limit of eight fish.

Taking effect in November 2009, the minimum size limit was increased to 50 cm TL and a recreational 'on water' bag limit of 4 striped trumpeter were introduced. Furthermore, a two month spawning closure (September-October) was implemented for the first time in 2009.

5.4 Management objectives and strategies

The generic management objectives for the Tasmanian scalefish fisheries apply (with reference period 1995/96 to 1997/98).

The species is currently managed by a trip limit (250 kg)for commercial operators, on water bag (4 fish) and possession limits (8 fish) for recreational fishers, a minimum size (50 cm total length) and season spawning closure (September-October).

5.5 Relative vulnerability to fishing

The spawning potential of striped trumpeter is severely impacted by the current legal size limits that are still well below the size of maturity. Juveniles are also particularly vulnerable to inshore gillnetting and, although the recent size limit increase will offer increased protection of juvenile fish, it is possible that incidental capture of sub-legal striped trumpeter in gillnets may result in post release mortality.

Marked recruitment variability appears to be a feature of striped trumpeter, and although the species is long-lived, prolonged periods of poor recruitment combined with the impacts of fishing and natural mortality have the capacity to severely deplete the size of the mature adult stock.

5.6 Previous assessments

Previous assessments have been largely limited to the examination of catch, effort and catch rate trends, and reporting against performance indicators. Yield-per-recruit analyses have been conducted and refined since the 2003 assessment. Size and age composition data and a spawner biomass-per-recruit analysis in 2005 indicated that striped trumpeter recruitment had been generally poor over the past decade and a further increase in the minimum size limit was required to reduce the risk of recruitment and growth overfishing.

5.7 Current assessment

The current assessment examines trends in catch, effort and catch rate for the primary fishing methods, namely dropline, handline and graball net and includes data from the Commonwealth. Opportunistic catch sampling has been undertaken since the late 1990s to provide age composition information while during the latter half of 2010 research fishing was conducted to refine the timing of the spawning season and validate size at maturity. This research provided an opportunity to collect additional samples for ageing and biological study.

Data presented in this assessment have been evaluated against the reference levels of performance indicators specified in the scalefish management plan (see Section 1.3).

5.7.1 Catch, effort and catch rates

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 5.1. In the early 1990s catches by Victorian vessels were significant, peaking at around 37 tonnes. Since the mid 1990s, 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 1990s, Victorian vessels accounting for 17-39% of the total, but then fluctuated between 70-80 tonnes through the mid 1990s before increasing again to over 100 tonnes by the late 1990s (Table 5.1). 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. 5.1A). The reported catch of 12.8

tonnes for 2009/10 is a slight decline from 13.3 tonnes in 2008/09 and represents the lowest catch reported since the mid 1980s.

However, Commonwealth catches are believed to be substantially underreported and the lack of precise estimates of recreational catches represent a major source of uncertainty in estimating the total mortality. Striped trumpeter have been heavily targeted by the recreational fishery in the past, with a 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). These estimates do not fully represent catches by charter boats.

Table 5.1. Annual commercial catches of striped trumpeter (tonnes) south of latitude 39° 12'S. Based on Tasmanian (General Fishing Return), 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

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. 5.1A and 5.2). The expansion of the fishery during the late 1990s was the result of increased catches from all these areas. Catches strongly declined by 2000/01 and appear to have contracted to the south-east coast over recent years. This area has now also seen a decline to levels observed in other regions.

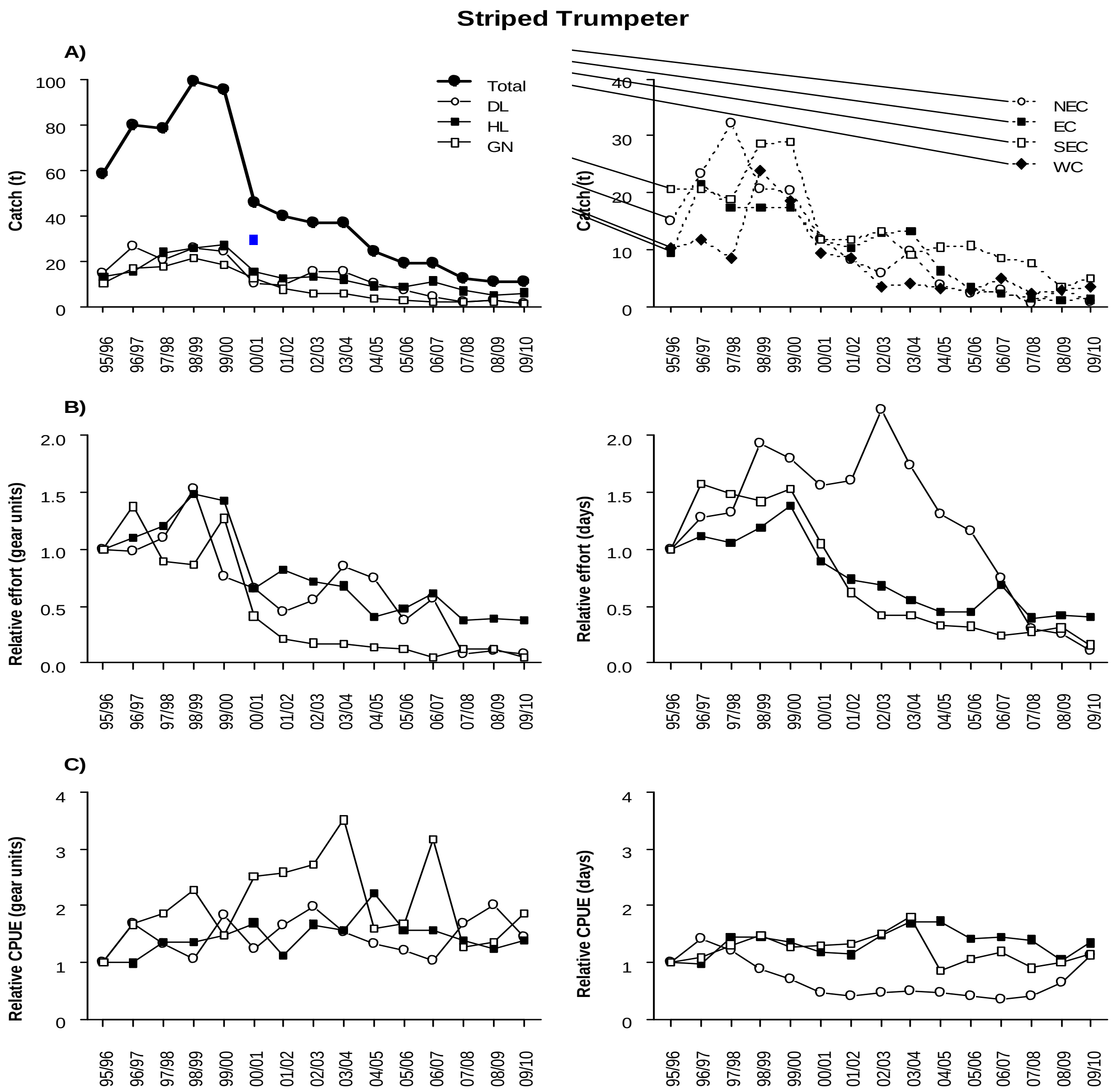

Fig. 5.1. A) Annual commercial catch (tonnes) of striped trumpeter by method (left) and region (right) since 1995/96 reported in Tasmanian logbooks, and best estimates of recreational catches (single square); B) commercial effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and C) commercial catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. DL is dropline, HL is handline and GN is graball; SEC is south-east coast, EC is east coast, NEC is north-east coast, and WC is west coast.

The observed catch trends reflect the influence of especially strong year classes (1993 and 1994) that entered the fishery between 1995/96 and 1997/98 (see also Section 5.7.2). Larger 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, was also 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 since 2000/01.

Fishing effort increased during the latter part of the 1990s, presumably linked to the increased availability of striped trumpeter (Fig. 5.1B). Subsequently, effort for all methods has declined. Fishing activity has been focussed mainly on the south-east coast and to a lesser extent off the north-east, south and south-west during the past few years (Fig. 5.2B).

Recent gear-specific trends of catch rates (including 2009/10) are based on small catches and are thus unlikely to be informative about availability (Fig. 5.1C). 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.

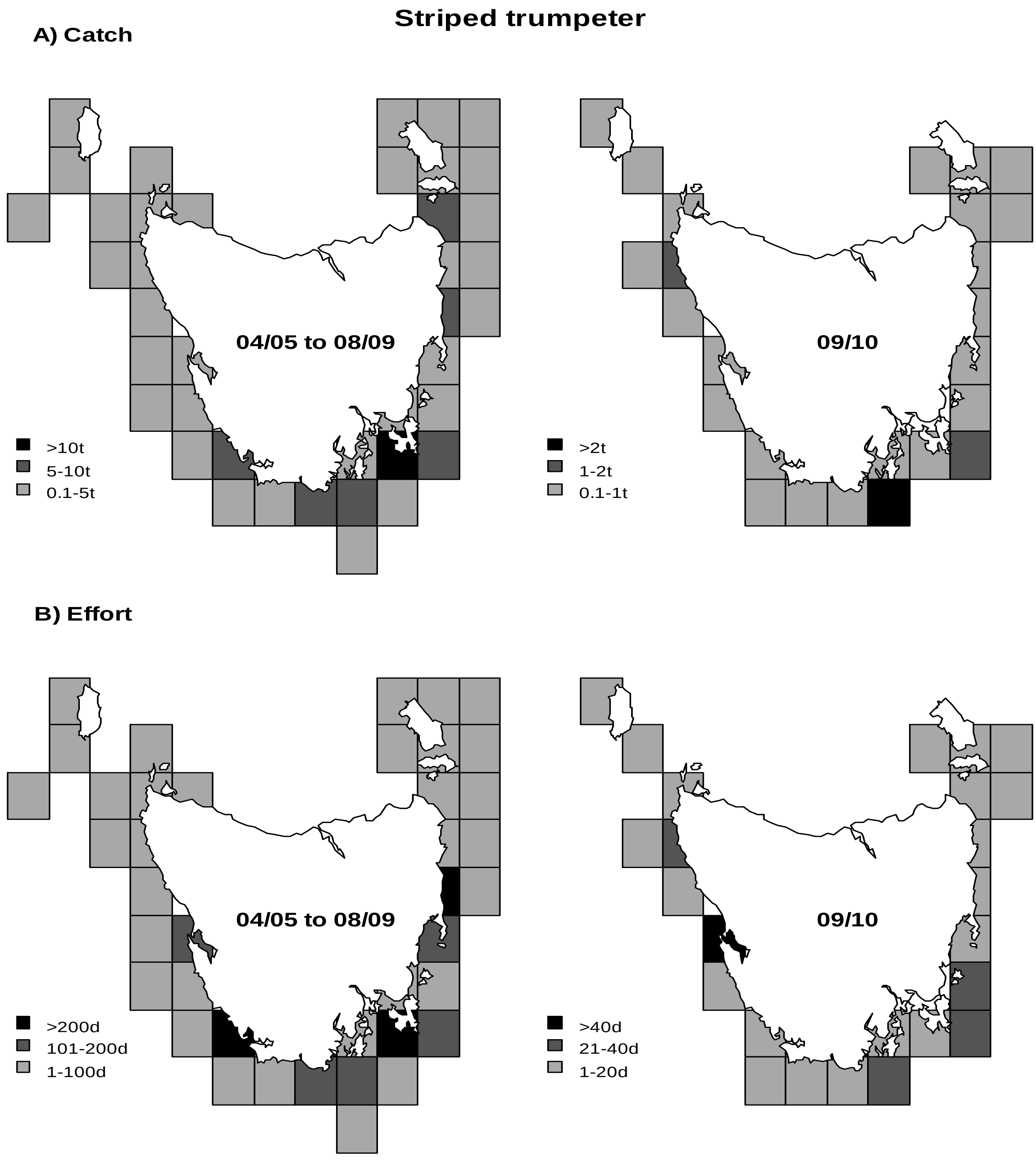

Fig. 5.2. (A) Striped trumpeter catches (tonnes) and (B) effort (days) by fishing block pooled from 2004/05 to 2008/09 (left) and during 2009/10 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

5.7.2. 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 about 2007 (Fig. 5.3). However, since many of the sample sizes were low and sampling was opportunistic, the age compositions 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 1990s.

A larger sample for ageing was available in 2010 and was dominated by 5-6 year olds (the age at which the species tends to recruit to the hook fishery), providing evidence of recent recruitment success. While the relative strength of these cohorts is unknown, they do 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).

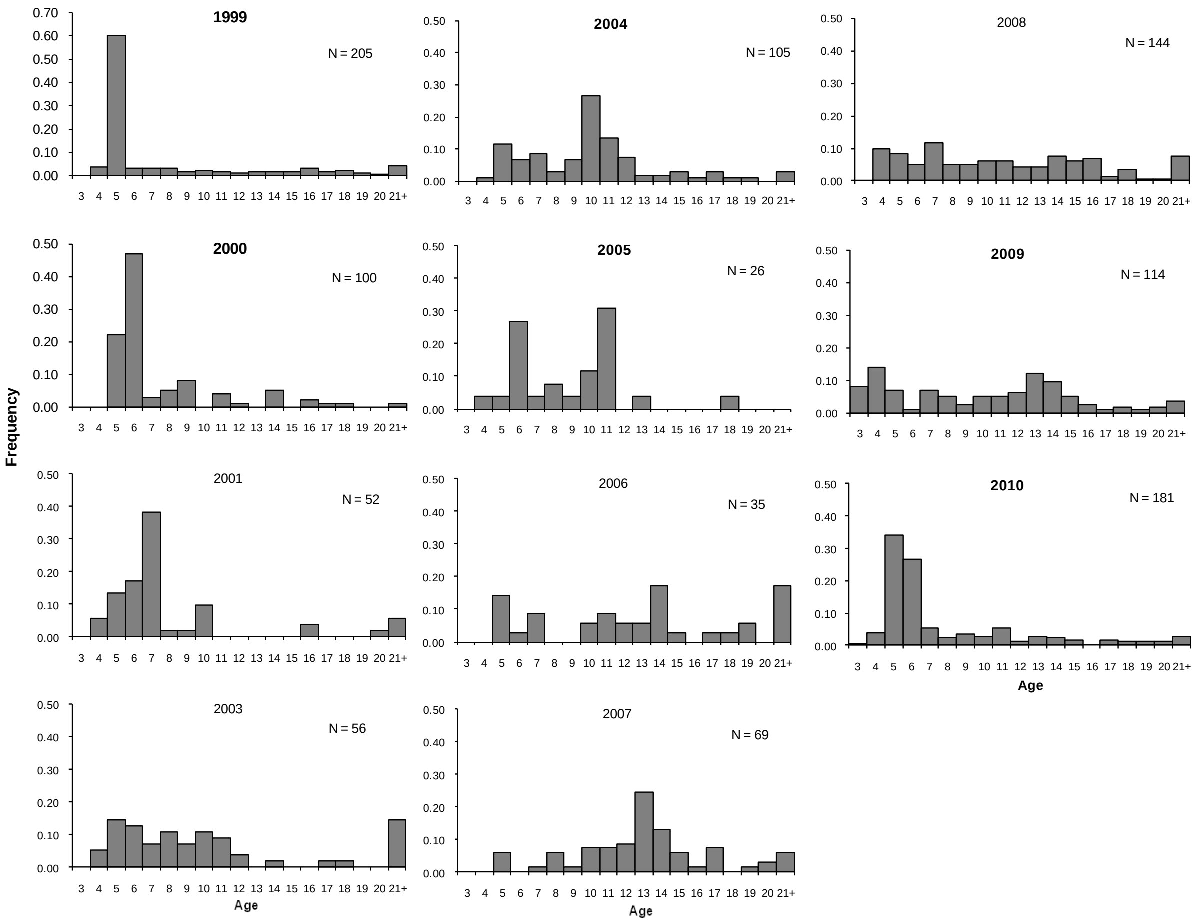

Fig. 5.3. Age composition of striped trumpeter samples by year. N is sample size.

5.8 Reference points

Existing reference points	Exceeded?	Alternative RP	Exceeded?
State-wide or regional catches outside the 1990/91 to 1997/98 range (52t- 81t)	Yes: Statewide ↓ (12.8t)	Commercial catch is > 50t	No
Catch increase or decline by over 30% from previous year	No	-	
State-wide or regional effort over 10% of the highest for the period 1995/96 to 1997/98	No	-	
State-wide or regional catch rates less than 80% of the lowest annual value for the period 1995/96 to 1997/98	No	-	
		Catch curve estimated every 3 years as an index of fishing mortality from all sectors: Target range: Fishing mortality $F \leq$ Natural mortality M Limit RP: $F = 1.5*M$	Not assessed
Others: - Significant change in size/age composition of catch - Change in catches of non-commercial fish relative to 1990/91 to 1997/98 or high incidental / undersized mortality - Significant catch of unhealthy fish - Any other indicator of stock stress	Variable - protracted period of poor recruitment, thus adult stock likely to be depleted; evidence of recent recruits entering fishery	Any indicator of stock stress	Variable - protracted period of poor recruitment, thus adult stock likely to be depleted; evidence of recent recruits entering fishery

5.9 Implications for management

The sharp decline in commercial catches since 2000/01 gives 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. For the first time in over a decade the 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. 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.

Although a more rigorous assessment is required to assess the sustainability of the fishery, the recent influx of 5-6 year olds provides the first positive signs of population recovery after a prolonged period of low recruitment. The relative strength of these year classes is unknown and will need to be monitored over time to determine how much they contribute to population rebuilding. Further management action is required to align the size limit with size at maturity, allowing fish to spawn before they become vulnerable to capture.

5.10 Research needs

The Scalefish Fishery Research Advisory Group has identified the need for research into stock assessment, recruitment variability and gear interactions as areas of high research priority for striped trumpeter. There is a need to better estimate the recreational catch and reduce uncertainty in the magnitude of the catch by Commonwealth operators. In addition, there is an urgent need to characterize the commercial and recreational fisheries for this species in terms of size composition and age-structure. Finally, there is a need to further examine the impacts of present and alternative harvest strategies.

6 Sea garfish (*Hyporhamphus melanochir*)

6.1 Life history and stock structure

Parameter	Estimates	Source
Habitat	Southern garfish are found in sheltered bays, clear coastal waters and estuaries to depths of about 20 m. Fish school near the surface at night, and close to the bottom, often over seagrass beds during the day. They are predominantly herbivores with around 75% of their diet being comprised of seagrass and algal filaments (). Other diet items include diatoms, insect larvae, worms and small crustaceans, particularly amphipods	 Klumpp and Nichols 1983; St Hill 1996
Distribution	Endemic to Australian waters and is distributed from Eden in NSW to Kalbarri in Western Australia, including Bass Strait and Tasmanian waters.	Gomon *et al.* 1994
Movement and Stock structure	There appear to be four genetically separate populations of southern garfish in Australia, distributed in Western Australia, western South Australia, eastern South Australia/Victoria and Tasmania. Stock structure within Tasmanian waters not known.	Jones *et al.* 2002
Natural mortality	No estimates available	
Maximum age	Maximum age is estimated to be 9 years in Tasmanian waters when fish may be 40 cm FL long and weigh around 0.35 kg.	Jordan et al. 1998
Growth	Growth in eastern Tasmania is relatively rapid for the first 3 years, achieving a length of around 20 cm FL by 2 years of age and 25 to 30 cm FL by 3 years. Growth then slows appreciably, reaching a maximum age of around 9 years. After 3-4 years there is an increasing variation in size-at-age, with fish at a length of 30 cm FL ranging from 3 to 8 years old.	Jordan et al. 1998
Maturity	Size at 50% maturity information have not been reported for Tasmania.	
Spawning	Southern garfish in eastern Tasmania spawn over an extended period of at least five months from October to February, with peak activity occurring between October and December. The extended spawning period is related to the fact that the species is a multiple batch spawner, with asynchronous oocyte development occurring simultaneously in reproductively active ovaries. Eggs are around 2.93 mm in diameter and are negatively buoyant, sinking immediately to the bottom after fertilization and become attached to filamentous drift algae. In eastern Tasmania spawning occurs in shallow areas (<5 m deep) over beds of drift algae, which is the dominant shallow water soft-sediment habitat. There is no evidence that eggs are attached in clusters on seagrass blades as has been suggested in the literature. However, seagrass beds may be of greater significance around areas such as Flinders Island where the majority of shallow water habitat consists of seagrass beds (principally *Posidonia australis* and *Amphibolis antarctica*).	Jordan et al. 1998 St Hill 1996, Jones et al. 2002 Jordan et al. 1998
Early life history	Southern garfish have a long egg duration of around 28-30 days and are unusual in that they hatch out as large (7.8-8.5 mm) post-flexion larvae. Small juveniles (0+ cohort) have been caught in shallow sheltered waters of eastern Tasmania. The early life-history of southern garfish has been described from South Australia . In Western Australia, southern garfish may spend the first year of life in estuarine areas and the first 2 years in inshore waters.	Jordan et al. 1998 Noell 2003 Lenanton 1982
Recruitment	Unknown	

6.2 The fishery

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.

6.3 Management background

Under the scalefish management plan all scalefish and rock lobster licence holders are entitled to use dipnets (scalefish C licence holders are only permitted a single dipnet). The use of beach seine and purse seine nets is, however, restricted to those fishers who hold a fishing licence (beach seine A or B or purse seine licences). No trip limit or other licensing restrictions apply to garfish. However, concern about garfish stocks following recent and sharp falls in commercial landings prompted the introduction of a one month spawning closure in 2009. This was implemented as a state-wide closure between mid-November and mid-December and applied to the commercial sector only. For 2010/11 the closure was split; mid-November to mid-December in southern waters and mid-January to mid-February in northern waters, recognising differences in the timing of peak spawning with latitude. 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.

A legal minimum size limit of 25 cm TL applies for sea garfish and a possession limit of 30 fish for recreational fishers.

6.4 Management objectives and strategies

The generic management objectives for the Tasmanian scalefish fisheries apply (with reference period 1995/96 to 1997/98).

No catch limits apply to commercial fishers although the use of seine nets is restricted to those who hold either a beach seine or purse seine net licence. Recreational fishers are limited to a possession limit of 30 fish. Seasonal spawning closures and a minimum size limit also apply.

6.5 Relative vulnerability to fishing

Vulnerability of southern garfish to fishing pressure is unclear but 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 the population being dominated by relatively few age classes, any recruitment variability is likely to have a marked impact on population size.

6.6 Current assessment

6.6.1 Biological characteristics

The sharp and unexpected decline in catches prompted the need to better understand stock status and resulted in the introduction of a one month closed season, introduced in 2009 between mid-November and mid-December and timed to protect the species during the spawning season. The primary objectives of the present study were to (i) to refine information on the spawning activity of southern garfish in Tasmania and (ii) compare current population characteristics with those determined during the mid-1990s to provide some insight into current stock status.

Size composition and biological information was collected from commercial catches taken between 1994 and 1997 (Jordan *et al*. 1998) and again between 2008 and 2010. In addition, southern garfish were collected by research fishing between 1995 and 1997 using a variety of gear types, including small mesh beach seine, research beam trawl and gillnets, as part of a project examining the importance of inshore habitats for a range of commercial fish species (Jordan *et al.* 1998).

For analysis purposes, samples were assigned to either the east coast (including Norfolk & Frederick Henry Bay, Great Oyster Bay) or north coast region (including Flinders Island, Tamar estuary).

Size composition

Since the mid-1990s there has been a reduction of 2-3 cm in the average size of southern garfish in eastern Tasmania and up to 5-6 cm in northern Tasmania (Fig. 6.1). Annual length frequency distributions tend to be unimodal, with peaks between 28-33 cm in the 1990s and 26-28 cm during the late 2000s. These reductions in size have been associated with a sharp decline in commercial catches and may be indicative of a more general change in population structure.

During the mid-1990s individuals between 35 and 40 cm were relatively common in north coast catches but in subsequent years fish larger than about 35 cm have been uncommon (Fig. 6.1).

Size composition by fishing method

Size composition of commercial catches based on fishing method for the east and north coasts are presented in Figs 6.2 & 6.3, respectively. Pair-wise comparisons of length frequency compositions were undertaken between methods within each region for each time period and between time periods for each method using two sample Kolmogorov-Smirnov tests. Length frequencies were significantly different ($P< 0.001$) in each of the comparisons apart from the east coast dip net - purse seine comparison based on 2000s data ($Z = 1.266$, $P = 0.081$). While there were statistical differences between most method-based comparisons, they were not consistent enough be indicative of obvious gear selectivity effects. In order to examine gear effects, noting concerns from some industry members that the different methods may select for different parts of the population and also disrupt schooling behaviour, a more structured approach to this question is required, including experimental fishing using alternative methods.

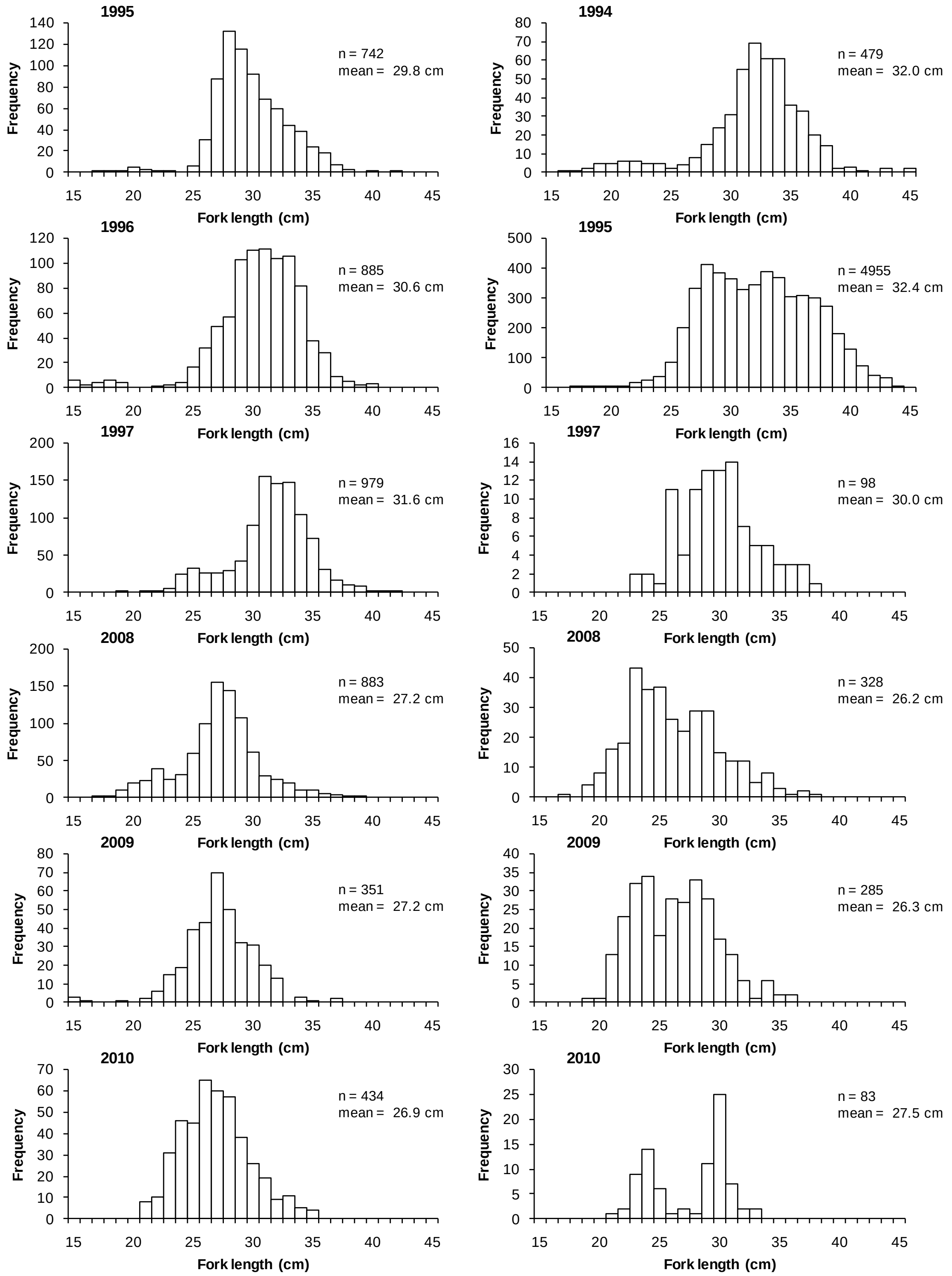

Fig. 6.1 Size composition of southern garfish by year for east coast (left) and north coast (right) commercial catches. n is sample size.

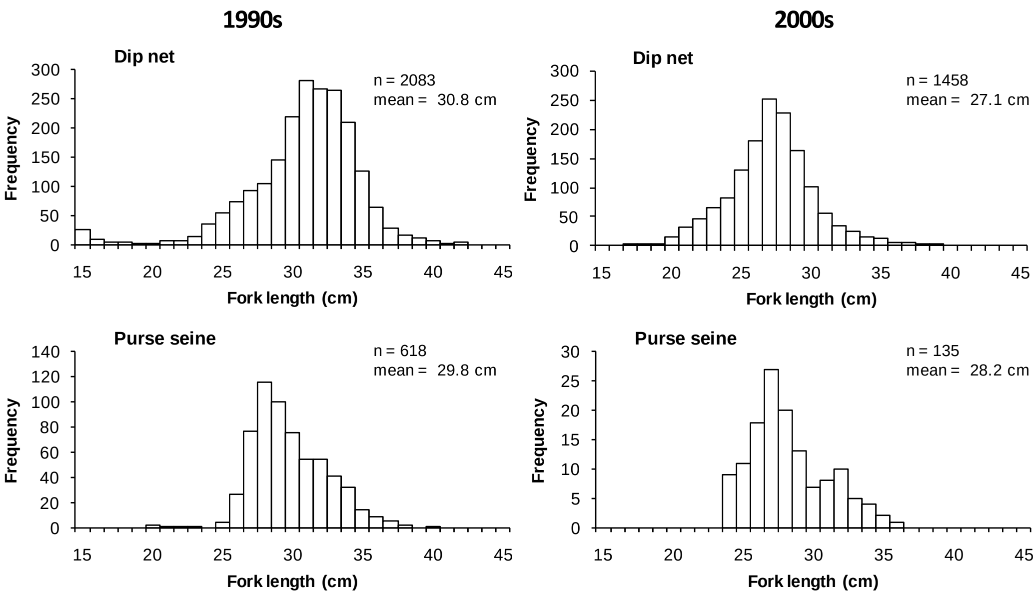

Fig 6.2. Southern garfish size composition by fishing method and decade for commercial catches sampled from the east coast.

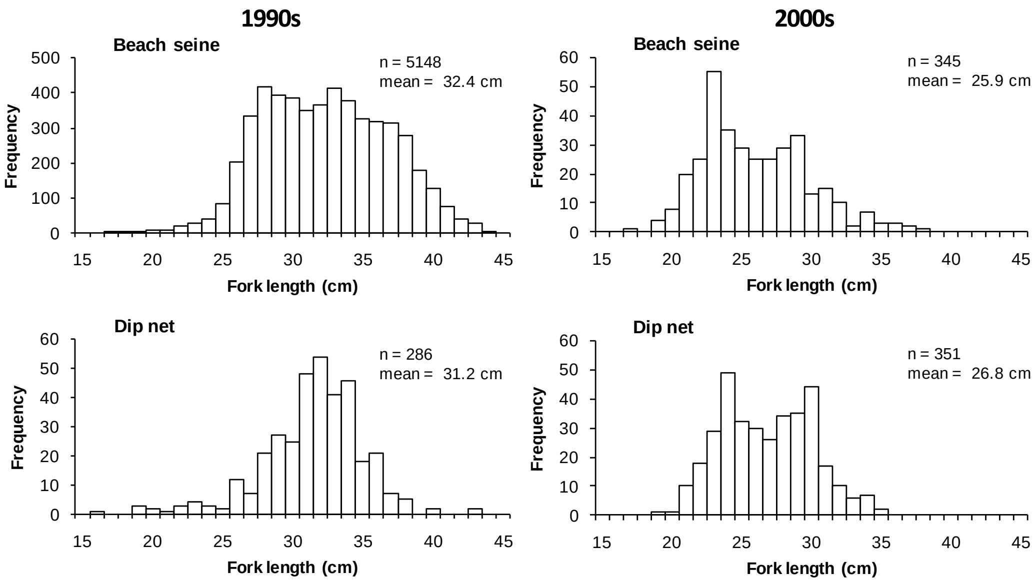

Fig 6.3. Southern garfish size composition by fishing method and decade for commercial catches sampled from the north coast.

Sex ratios

Previous studies have found that females tend to dominate catches (Jordan *et al*. 1998; Jones *et al.* 2002; McGarvey *et al.* 2009), implying some degree of spatial segregation of the sexes between schools. Sampling of Tasmanian commercial catches confirmed that there was a significant bias toward females in both regions during the 'summer' period that encompassed the spawning season (Table 6.1). Off the east coast, sex ratios were either not significantly different or even biased towards males during the cooler months, suggesting some schooling behaviour differences outside of the spawning season. By contrast, the predominance of females in north coast catches persisted throughout the year, although sample sizes were relatively small. McGarvey *et al.* (2009) also noted that in the Spencer Gulf fishery of South

Australia the bias towards females in commercial catches was less pronounced outside of the spawning season.

Table 6.1 Proportion of females in commercial catches based on year, region and season ('summer' September – February; 'winter' – March-October).
Difference from 50% sex ratio; ns p>0.05; ** p<0.01; *** p<0.001

	East coast				North coast			
	Summer		Winter		Summer		Winter	
Year	Sample size	% Female	Sample size	% Females	Sample size	% Females	Sample size	% Females
1996	136	62.5**	-		-		-	
1997	80	97.5***	158	67.1***	-		56	73.2***
2008	662	80.8***	190	54.7 ns	254	68.9***	74	71.6***
2009	223	84.3***	83	31.3***	202	69.3***	83	79.5***
2010	330	70.3***	103	40.8 ns	83	85.5***	-	

Size at maturity

Length maturity ogives based on fish collected between October and February are presented in Fig 6.4. Sizes at 50% maturity were 17.1 cm and 19.9 cm fork length for males and females respectively; logistic function parameters were *a*= -24.74 and *b*= 1.24 for females, and *a*= -147.65 and *b* = 8.64 for males.

These data indicate that the current minimum legal length of 25 cm total length is above the size at maturity for both sexes.

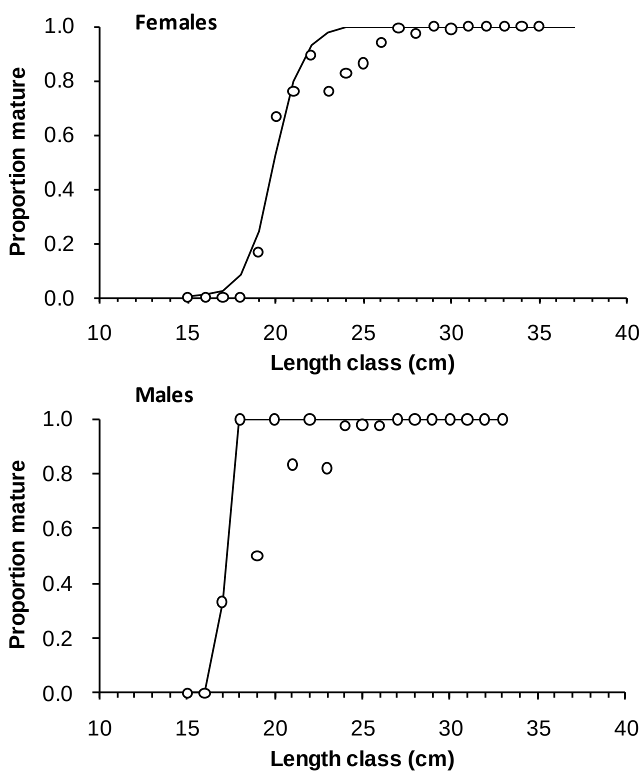

Fig. 6.4 Size at maturity data presented as the proportion of mature female and male southern garfish in 1cm fork length size classes with logistic maturation curves fitted.

Reproductive cycle

Gonad development in southern garfish exhibited a distinct seasonal pattern with GSIs peaking between October and January off the east coast and November and January[4] off the north coast for both sexes (Fig. 6.5). Gonad staging information revealed that females in spawning condition (Stages V and VI) were present in east coast catches between November and February, with spent fish (stage VII) present in February and March (Fig. 6.6). Males exhibited a similar pattern (Fig. 6.7), indicating that off the east coast spawning occurs over a 3-4 month period commencing in late spring. Data for the north coast was more limited, with some evidence of spawning activity as early as November and a peak during January (Fig. 6.6 & 6.7). The apparent low level of spawning off the north coast between November and December implies that either the peak in activity may occur slightly later than off the east coast or that the season is shorter. In relation to the former possibility, the lack of samples during February meant that it was not possible to determine the full extent of the spawning period.

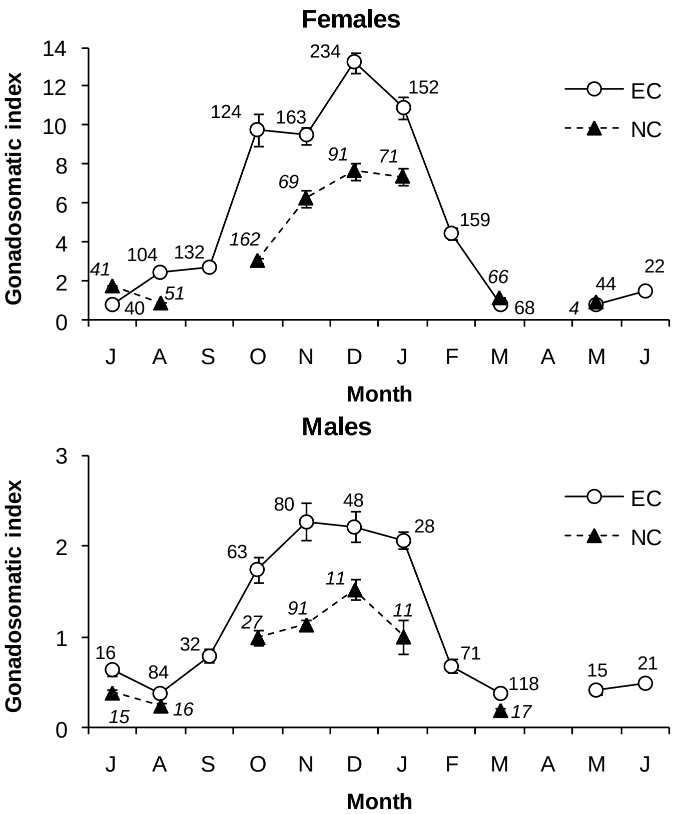

Fig. 6.5. Mean gonadosomatic index (± standard error) by month and region for southern garfish ≥ 20 cm (based on all available data). EC east coast, NC north coast. Numbers represent sample size (NC values are in italics).

4 There were no north coast samples available for February.

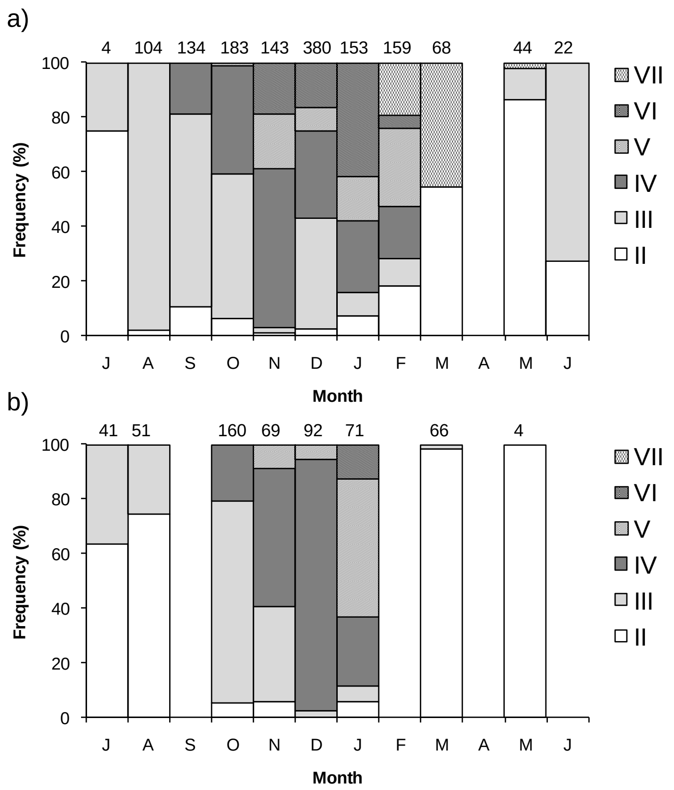

Fig. 6.6. Monthly female gonad stages for a) east coast and b) north coast southern garfish ≥ 20 cm (based on all available data). Numbers represent sample size.

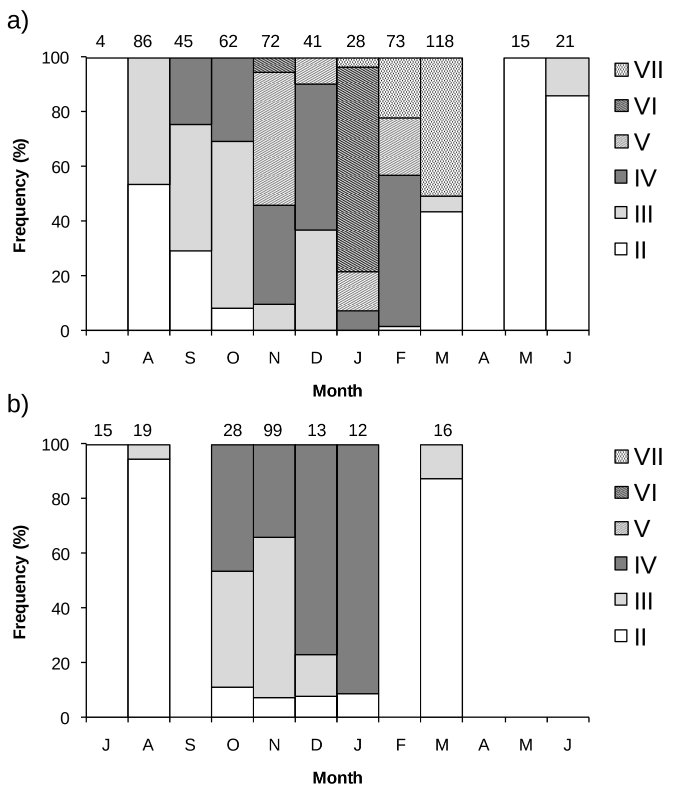

Fig. 6.7. Monthly male gonad stages for a) east coast and b) north coast fish (≥ 20 cm). Numbers represent sample size.

Female gonad condition for southern garfish collected during the 2008/09 and 2009/10 spawning seasons are presented in Fig. 6.8 and suggest that there may be some inter-annual variability in the timing of spawning. However, the fact that no running ripe fish were encountered during 2008 may be an artefact of sampling and gonad classification since fish retained for histology during December 2008 included ripe individuals (stages V and VI). Based on 2009/10 spawning season data it was evident that about 20% of females were actively spawning during November, increasing to over 50% in December and January off the east coast. By contrast, only a small proportion (~ 10%) of the fish examined from the north coast were spawning in November and December whereas spawning appear to peaked during January (> 50%), implying some spatial variability in the timing of spawning within the same season.

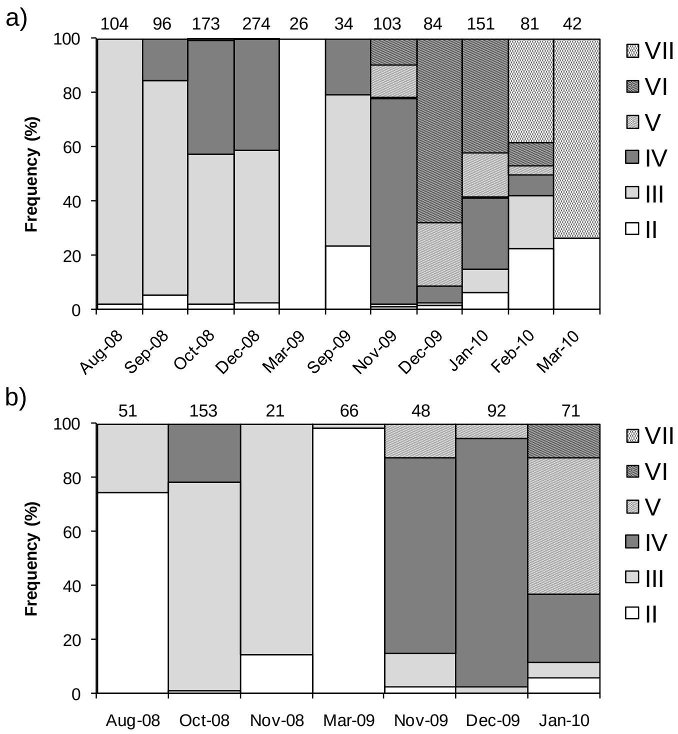

Fig. 6.8. Female gonad stages by month of collection for a) east coast and b) north coast fish (≥ 20 cm), based on samples collected between 2008-10. Numbers represent sample size.

Age composition

Ages for a total of 1482 garfish were determined (894 in 2008, 343 in 2009 and 245 in 2010) and used to generate age length keys by region. The age structure of east and north coast catches taken between 2008 and 2010 differed markedly in that the former was dominated by 2-3 year old fish and the latter by 3-4 year olds; in both instances these dominant age classes accounted for over 70% of the catch numbers in each of the years (Fig. 6.9). Fish aged up to 7 years were represented in catches from both regions, although individuals 5 years or older were rare (< 5% numbers). These regional differences suggest differences in population structure that are only partially accounted for by differences in size composition (refer Fig. 6.1).

By contrast, the age structure of east coast catches 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 total sample (Jordan *et al*. 1998, Fig. 6.10). 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 experienced since the mid-2000s may, therefore, reflect fundamental changes in population structure and may have resulted from heavy fishing pressure and/or poor recruitment during the early 2000s. Of relevance to recent developments in the Tasmanian fishery is the experience of the larger South Australia fishery (300-500 tonnes per annum, McGarvey *et al.,* 2009), where 1-2 year old fish now dominate catches whereas during the 1950s catches were dominated by 3-4 year old fish. The present truncated age structure is taken to indicate that exploitation rates are very high, an observation supported by a stock assessment model, and that the fishery is now highly depended on recruitment success, with minimal biomass ‘stored’ in older age classes (McGarvey *et al*., 2009).

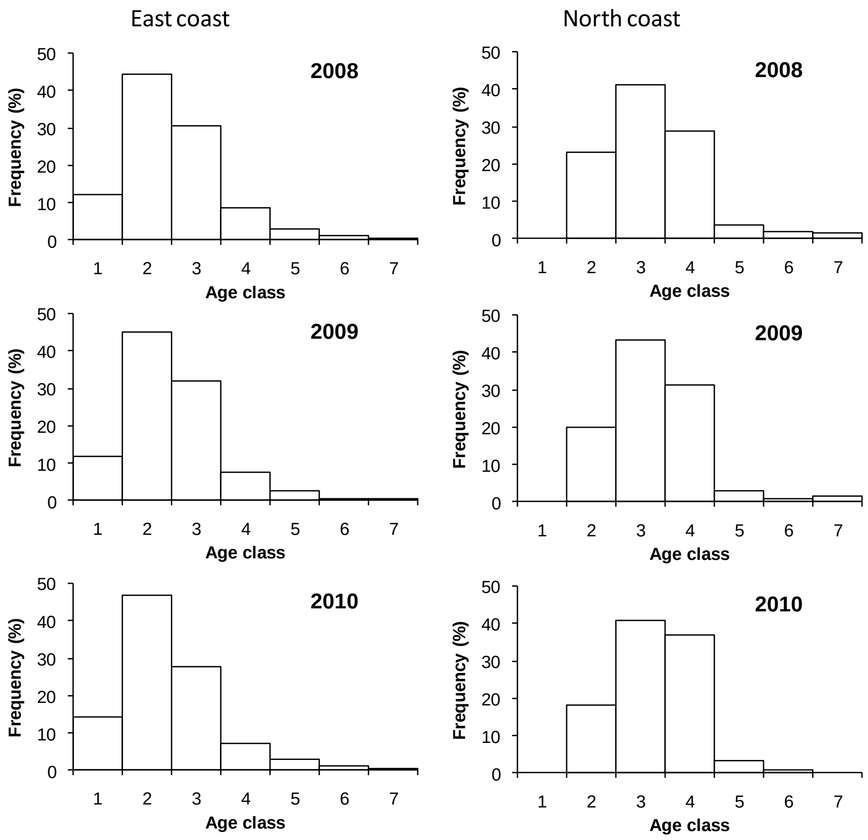

Fig 6.9. Annual age structure of southern garfish catches taken between 2008-2010 from the east and north coast regions of Tasmania.

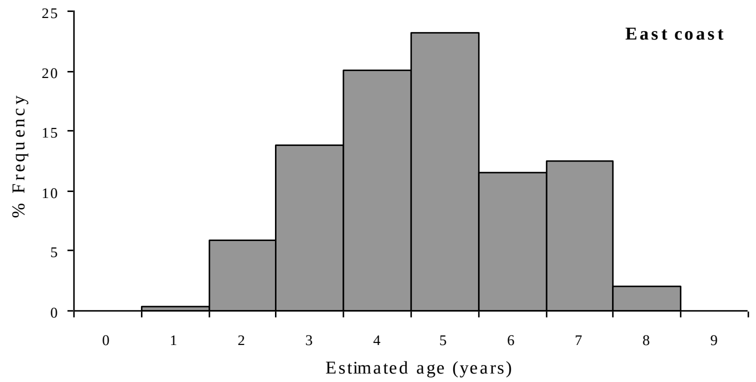

Fig. 6.10 Age structure of southern garfish catches taken between 1995-1997 from the east coast region of Tasmania (from Jordan *et a*l. 1998)

6.6.2 Catch, effort and catch rates

The southern sea garfish is caught in Tasmania almost exclusively taken by beach seine on the north-east coast, but mainly by dipnets off the south-east and east coasts. In these regions, dipnetting accounts for around 85% and 70%, respectively to the total catches.

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 2009/10 catch of 44.5 tonnes represented a fall of almost 30% compared with 2008/09 (Fig. 6.11A). Decreases have been experienced by the two main fishing methods, beach seine and dipnets, and in all major fishing regions. While catches from the south-east and east coast remained steady at historic low levels, the increase in northeast coast production during 2008/09 (mainly Flinders Island) was reversed in current year.

Recreational garfish catches for 2000/01 and 2007/08 were estimated to be in the order of 2 tonnes in both years (Lyle et al. 2009).

Effort has continued increasing slowly from the low levels in 2007/08, but still only five or fewer fishers operate in most fishing blocks (Fig. 6.12). Dipnet effort increased initially to a peak during 1998/99 but has subsequently decreased to a lower level (Fig. 6.11B, days fished), while beach seine effort experienced a more recent decline.

Catch rates for beach seine fluctuated much more strongly over time than those for dipnet. Beach seine catch rates generally rose during the late 1990s and early 2000s and have fluctuated at a high level since that time (Fig. 6.11C). 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.

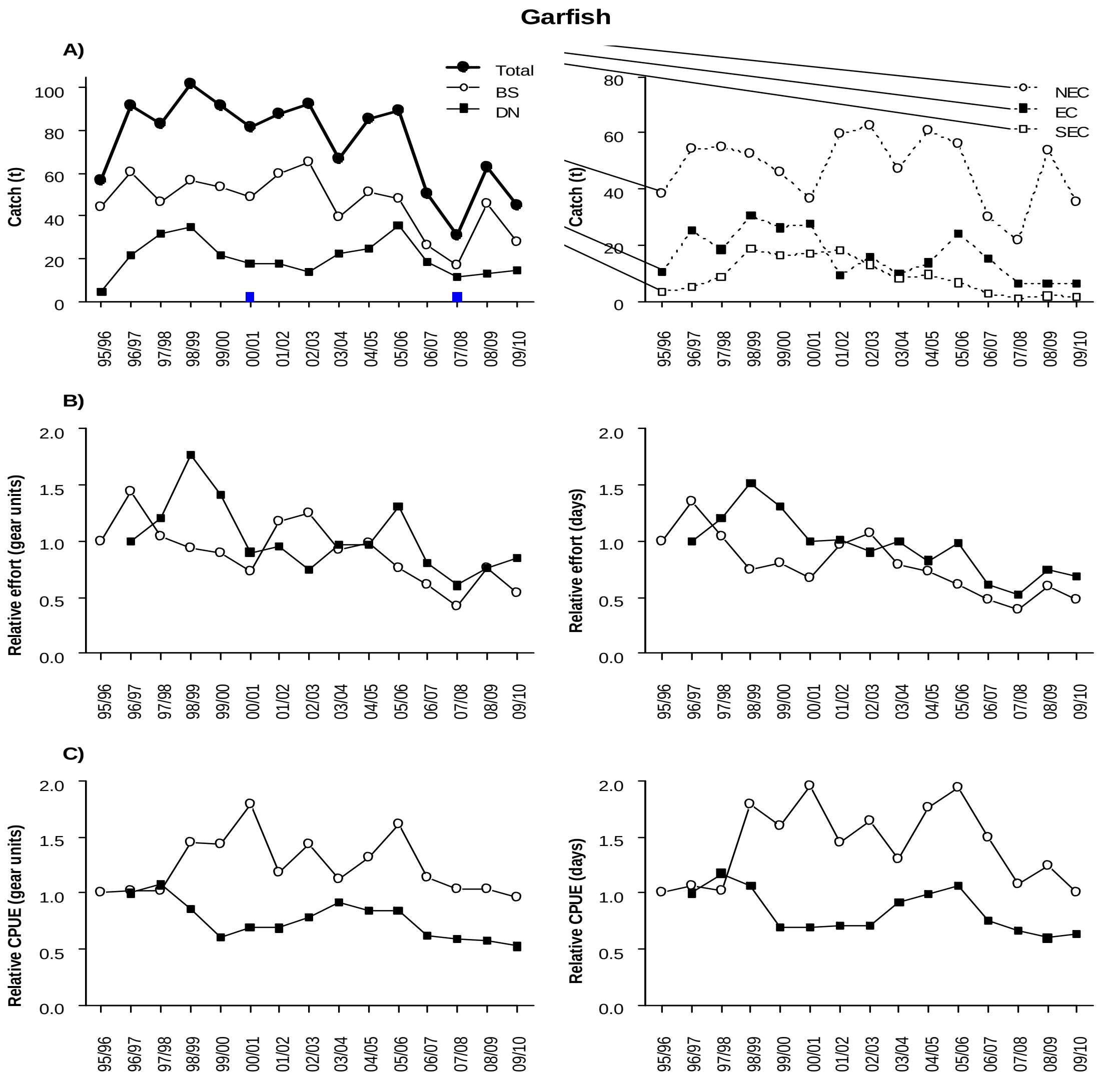

Fig. 6.11. A) Annual commercial catch (tonnes) of garfish by method (left) and region (right) since 1995/96 reported in Tasmanian logbooks, and best estimates of recreational catches (single squares);
B) commercial effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and 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) and 1996/97 (DN). BS is beach seine and DN is dip net; SEC is south-east coast, EC is east coast, and NEC is north-east coast.

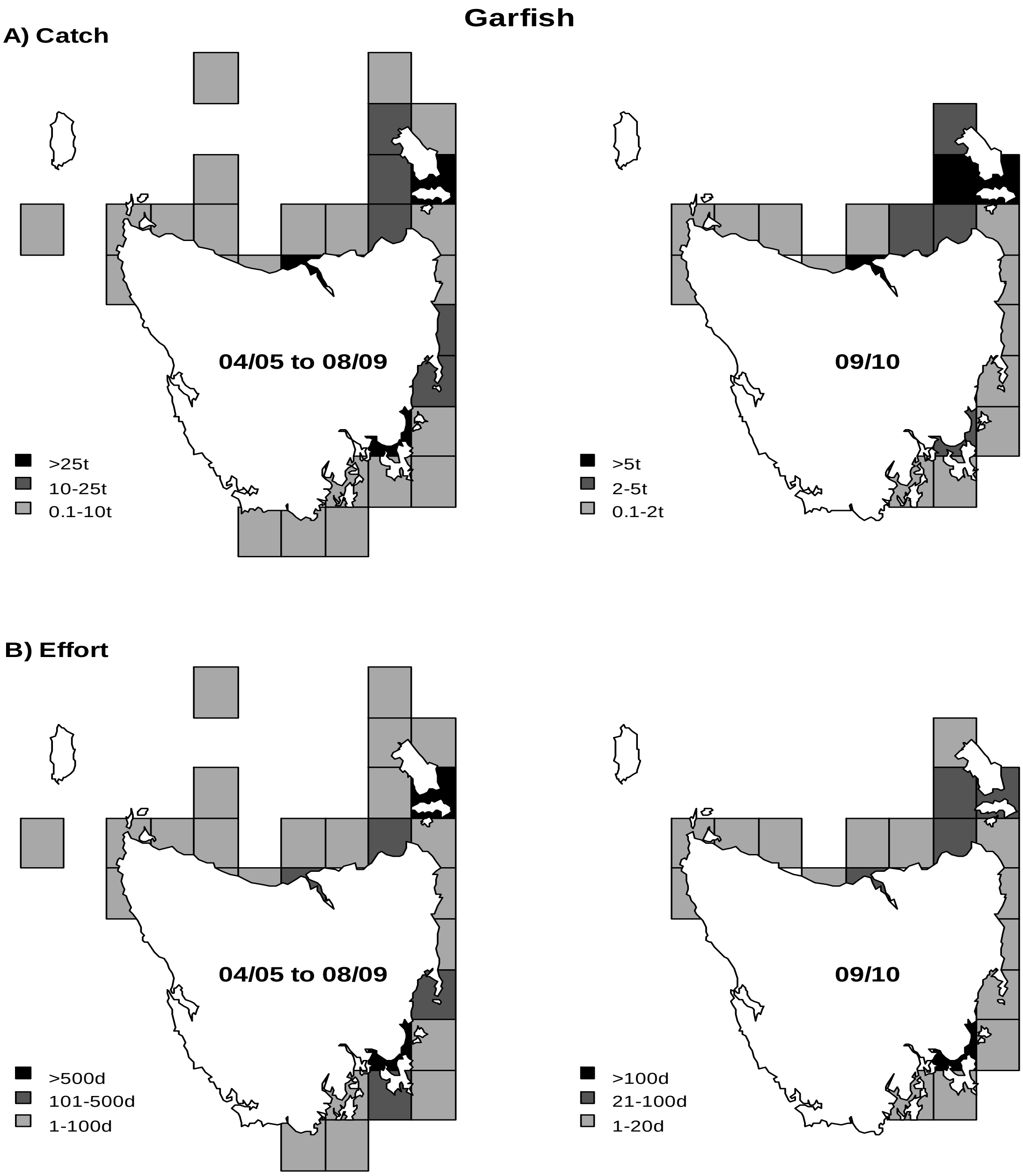

Fig. 6.12. (A) Garfish catches (tonnes) and (B) effort (days) by fishing block pooled from 2004/05 to 2008/09 (left) and during 2009/10 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

6.7 Reference points

Existing reference points	Exceeded?	Alternative RP	Exceeded?
State-wide or regional catches outside the 1990/91 to 1997/98 range (56t-92t)	Yes (44.5t)	State-wide catch outside reference range from 1998/99 to 2006/07 (66-102t)	Yes: (44.5t)
Catch increase or decline by over 30% from previous year	No: Statewide (-29%)	-	
State-wide or regional effort over 10% of the highest for the period 1995/96 to 1997/98	No	-	
State-wide or regional catch rates less than 80% of the lowest annual value for the period 1995/96 to 1997/98	Yes: DN (gear units)	-	
Others: - Significant change in size/age composition of catch - Change in catches of non-commercial fish relative to 1990/91 to 1997/98 or high incidental / undersized mortality - Significant catch of unhealthy fish - Any other indicator of stock stress	Recent catches indicate reduction in average size and truncation of age structure	Any indicator of stock stress	Recent catches indicate reduction in average size and truncation of age structure

6.8 Implications for management

Industry members indicated that the recent catch declines in all major fishing regions were due to a general lack of resource availability, despite apparently high abundances of undersized fish in some areas. Abundances appeared to have increased slightly in the north-east (based on catch levels) recent, but have remained particularly depressed in eastern and south-eastern waters.

Commercial catch sampling since 2008 has demonstrated a reduction in average fish size and truncation of the age structure that may be indicative of a more general change in population structure. The South Australian fishery recently experienced a marked fall in catches after many years of apparent stability and is now based largely on two age groups (1-2 year olds), providing evidence that exploitation rates have been tended to be very high. The similar pattern of events observed in Tasmania may also be indicative that exploitation rates have been relatively high and that the fishery has now impacted on stocks. Although catches may be sustainable at relatively high exploitation rates (as evidenced by the SA fishery), management measures should be considered that restrict the potential for further fishery expansion. The implementation of a spawning closure for commercial operators should add some protection.

Some industry members have expressed concern about the effects of dipnets on the schooling behaviour of garfish. Specifically, it has been suggested that intensive dipnet activity tends to cause schools to break up and hence reduces opportunities to use beach seines to target the species and possibly affects 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.

6.9 Research needs

In the absence of a formal quantitative assessment, catch trends and size and age structure of catches need to be monitored as indicators of potential stock stress.

7 Bastard trumpeter (*Latridopsis forsteri*)

7.1 Catch, effort and catch rates

Bastard trumpeter catches declined steadily from the mid 1990s and appeared stable during the early 2000s. Since 2005/2006 catches have been declining with a catch of 10 tonnes in 2009/10 (Fig. 7.1A). Bastard trumpeter are taken almost exclusively by graball from inshore waters off the east, south and west coasts (Fig. 7.2). The species also has significance to recreational fishers. The estimated 43 tonnes taken in 2000/01 was almost double the size of the commercial catch for the corresponding period (Lyle 2005). Estimates of recreational catches in 2007/08 were uncertain but likely to be lower, with an estimated 19 tonnes for combined catches of striped and bastard trumpeter (Lyle et al. 2009).

Graball effort for bastard trumpeter has followed a similar downward trend to catches since the mid-1990s (Figs. 7.1B and 7.2). Daily catch rates have remained relatively stable over time with a slight decrease in the early 1990s and since 2006/2007 (Fig. 7.1C). This lack of an obvious trend, despite the sharp decrease in catches, presumably reflects the fact that bastard trumpeter are taken primarily as by-product, rather than as a target species.

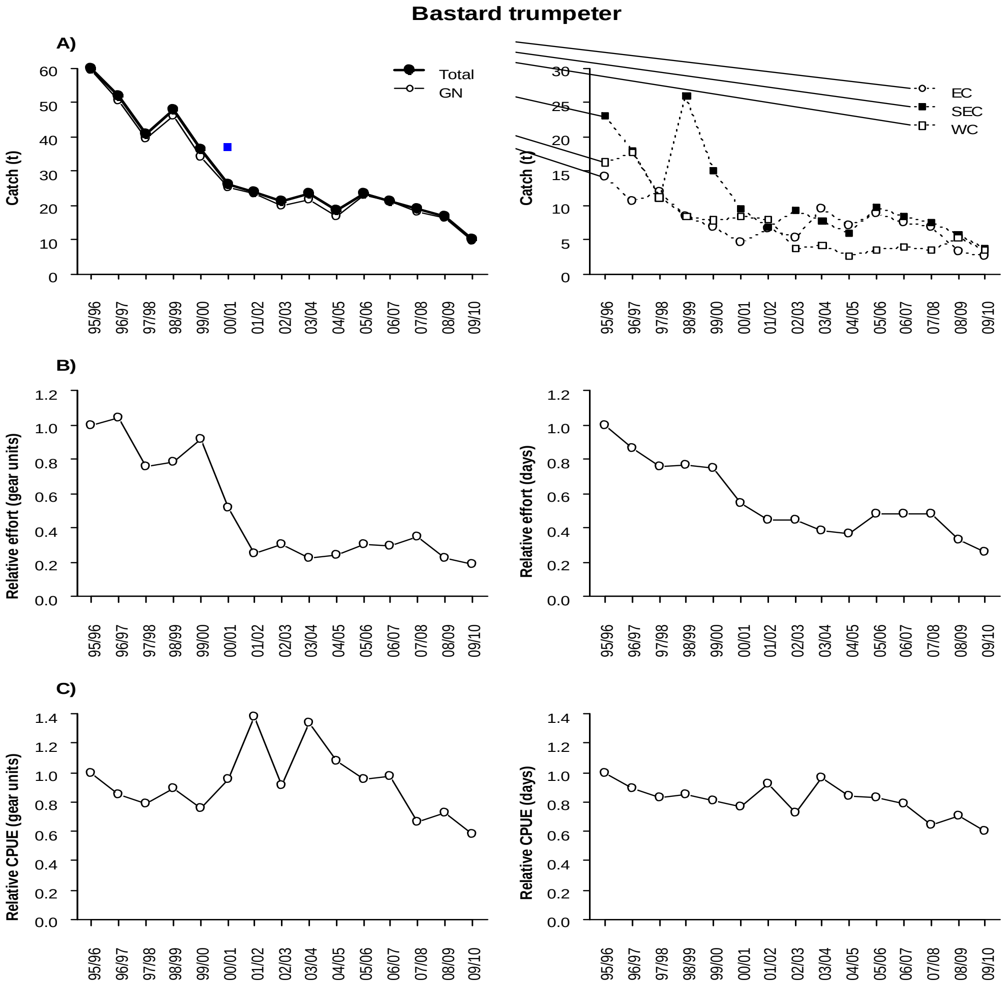

Fig. 7.1. A) Annual commercial catch (tonnes) of bastard trumpeter by method (left) and region (right) since 1995/96 reported in Tasmanian logbooks, and best estimates of recreational catches (single squares); B) commercial effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and 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 is graball; SEC is south-east coast, EC is east coast and WC is west coast.

7.2 Reference points

Existing reference points	Exceeded?	Alternative RP	Exceeded?
State-wide or regional catches outside the 1990/91 to 1997/98 range (34t-63t)	Yes: Statewide (10t)	Pending	
Catch increase or decline by over 30% from previous year	Yes (-39%)		
State-wide or regional effort over 10% of the highest for the period 1995/96 to 1997/98	No		
State-wide or regional catch rates less than 80% of the lowest annual value for the period 1995/96 to 1997/98	Yes (gear units and days fished)		
Others: - Significant change in size/age composition of catch - Change in catches of non-commercial fish relative to 1990/91 to 1997/98 or high incidental / undersized mortality - Significant catch of unhealthy fish - Any other indicator of stock stress	Not assessed		

7.3 Implications for management

Total catch rather than catch rates may be a better indicator of abundance/availability for bastard trumpeter and 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.

Two aspects of bastard trumpeter life history have direct relevance when assessing the status of the fishery. Firstly, the fishery is based almost entirely on juveniles. As the fish grow they appear to move offshore and are rarely caught. Secondly, the species exhibits strong recruitment variability that can result in short-term variability in catches and such variability has been a feature of the fishery over the past century (Harries and Croome 1989). Anecdotal reports and low inshore catches suggest that recruitment levels have been low in recent years, although higher numbers have been reported from the Tasman Peninsula since 2007.

Whilst juvenile biomass may vary widely due to recruitment variability and fishing pressure, no information regarding the adult segment of the population is available. However, it is clear that low levels of fishing pressure are exerted on those adults that evade the inshore fishery. Since commercial and recreational fisheries are based on juveniles, recruitment as well as growth overfishing could be occurring.

In November 2009, the size limit was increased from 35 cm to 38 cm TL, a commercial trip limit of 200 kg was introduced and the recreational possession limit was reduced from 15 to 10 fish. While the commercial trip limit and the reduction of the recreational possession limits are expected to reduce fishing mortality, the minimum size limit is still well below the size at maturity, which appears to be greater than 50 cm FL. 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.

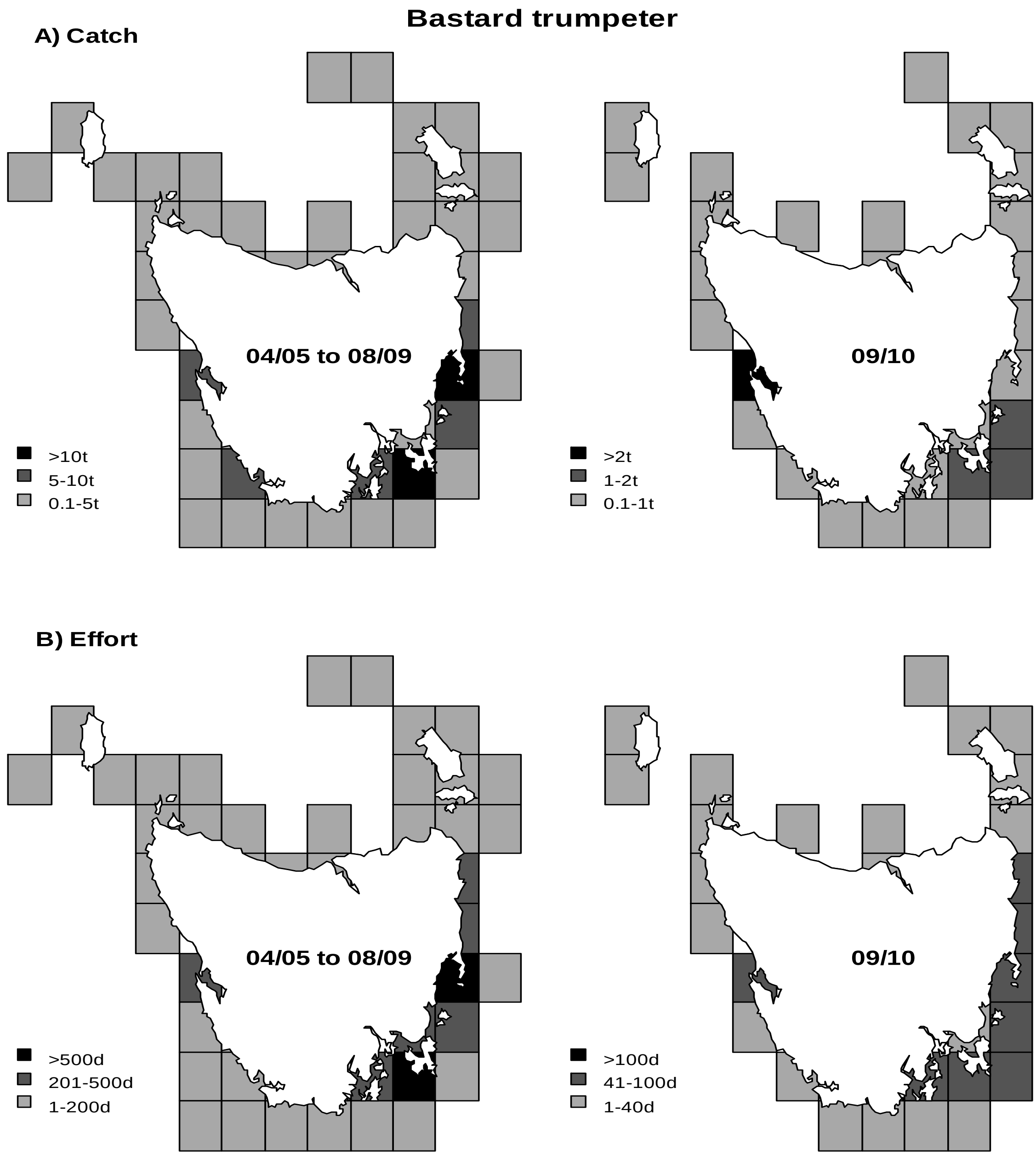

Fig. 7.2. (A) Bastard trumpeter catches (tonnes) and (B) effort (days) by fishing block pooled from 2004/05 to 2008/09 (left) and during 2009/10 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

8 Wrasse (Fam. Labridae)

8.1 Catch, effort and catch rates

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 recently distinguished in catch returns. While there is an apparent market preference for blue-throat wrasse, purple wrasse are more robust for live handling.

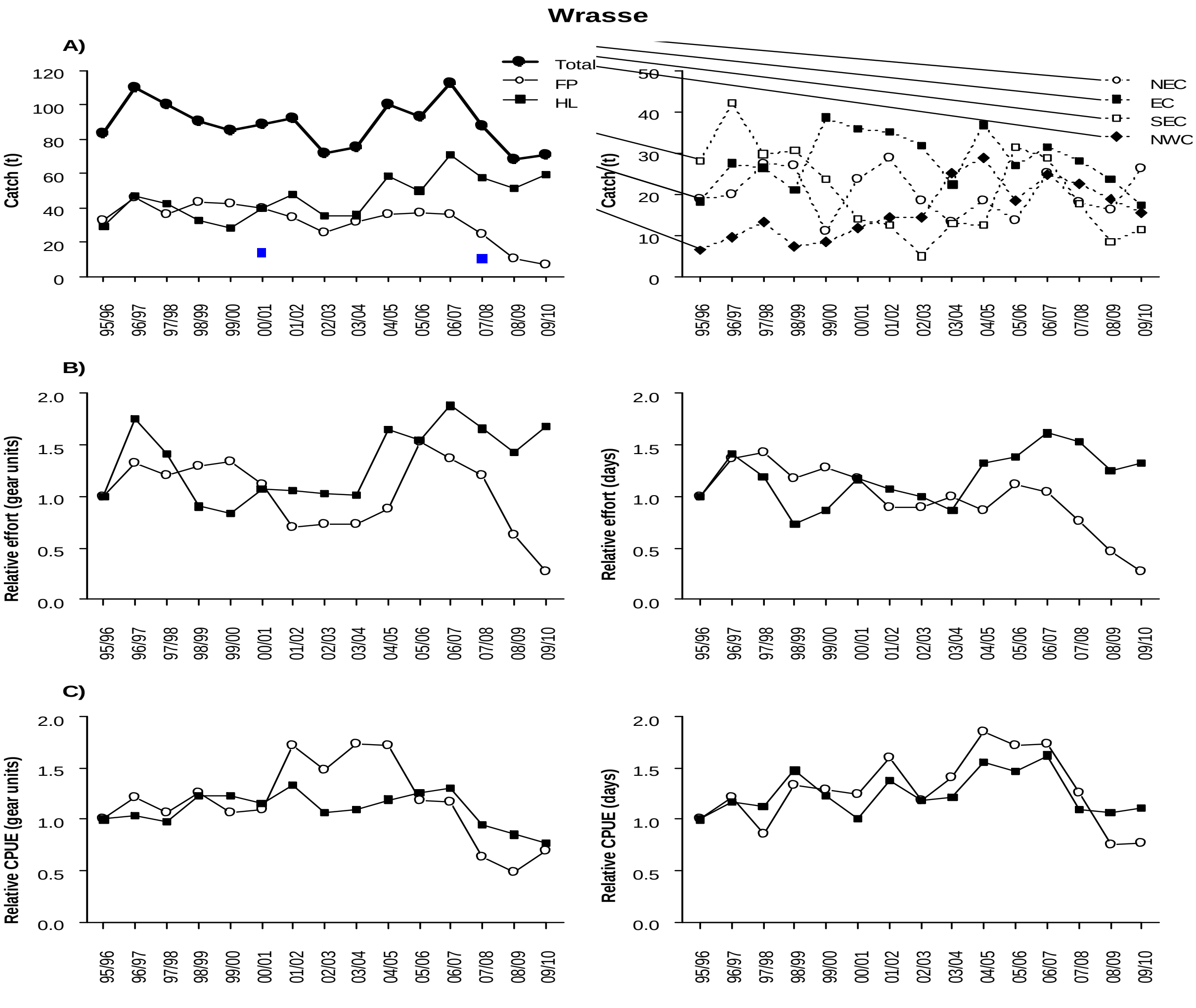

Fig. 8.1. A) Annual commercial catch (tonnes) of wrasse by method (left) and region (right) since 1995/96 reported in Tasmanian logbooks, and best estimates of recreational catches (single squares);
B) commercial effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and 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 is fish trap and HL is hand line; SEC is south-east coast, EC is east coast, NEC is north-east coast, and NWC is north-west coast.

Wrasse catches fluctuated between about 75-110 tonnes between 1995/96 and 2007/08, peaking at 113 tonnes in 2006/07(Fig. 8.1A). Reported catches fell in 2008/09 to just 69 tonnes (42 tonnes of blue-throat wrasse, 26 tonnes of purple wrasse) and remained at a similar level of 72 tonnes (46t blue-throat, 26t purple) in 2009/10. 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 virus 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. 8.1 and 8.2) 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 together 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.

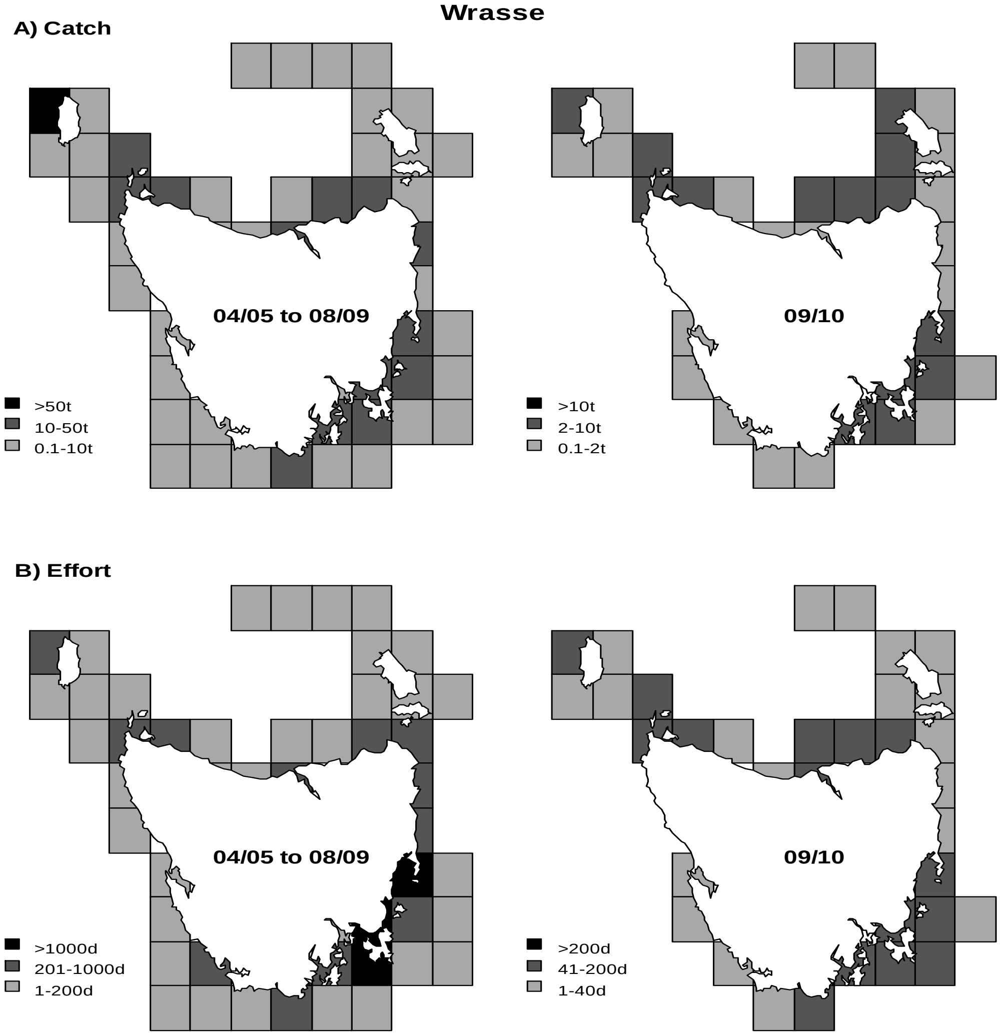

Fig. 8.2. (A) Wrasse catches (tonnes) and (B) effort (days) by fishing block pooled from 2004/05 to 2008/09 (left) and during 2009/10 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

Catch rate trends imply that wrasse stocks have not been impacted significantly by the fishery until recent years. Since the mid-1990s 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. 8.1C). Similarly, catch rates for handline had remained relatively stable since the mid 1990s 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.

8.2 Reference points

Existing reference points	**Exceeded?**	**Alternative RP**	**Exceeded?**
State-wide or regional catches outside the 1995/96 to 1997/98 range (83t-110t)	Yes: Statewide (79t)	State-wide catch outside reference range from 1998/99 to 2006/07 (72-99t)	No: (79t)
Catch increase or decline by over 30% from previous year	No	-	
State-wide or regional effort over 10% of the highest for the period 1995/96 to 1997/98	No	-	
State-wide or regional catch rates less than 80% of the lowest annual value for the period 1995/96 to 1997/98	Yes: Fish traps (gear units)	-	
Others: - Significant change in size/age composition of catch - Change in catches of non-commercial fish relative to 1990/91 to 1997/98 or high incidental / undersized mortality - Significant catch of unhealthy fish - Any other indicator of stock stress	Not assessed	Any indicator of stock stress	Not assessed

8.3 Implications for management

While input controls (limited entry) have capped participation in the live wrasse fishery, there is still a substantial level of latent effort. Increasing catches in previous years reflected strong interest in the species, but the recent declines in catch rates could indicate that those catch 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 is already 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 populations of 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 (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.

9 Key scalefish fisheries shared with Commonwealth / other States

9.1 Blue warehou (*Seriolella brama*)

9.1.1 Catch, effort and catch rates

Blue warehou occur seasonally in Tasmanian inshore waters, the region representing the southern-most extent of the species' distribution. Traditionally, the availability of blue warehou in coastal waters has been assumed to be influenced by prevailing oceanographic conditions and availability of prey species. These factors produce marked inter-annual variability in abundance and hence catches taken from State waters as demonstrated in Fig. 9.1A. Due to low availability since the early 2000s, the species has been rarely targeted. The current catch of 37.3 tonnes is a 39% increase from the previous year, but remains low compared to the catches reported during the 1990s.

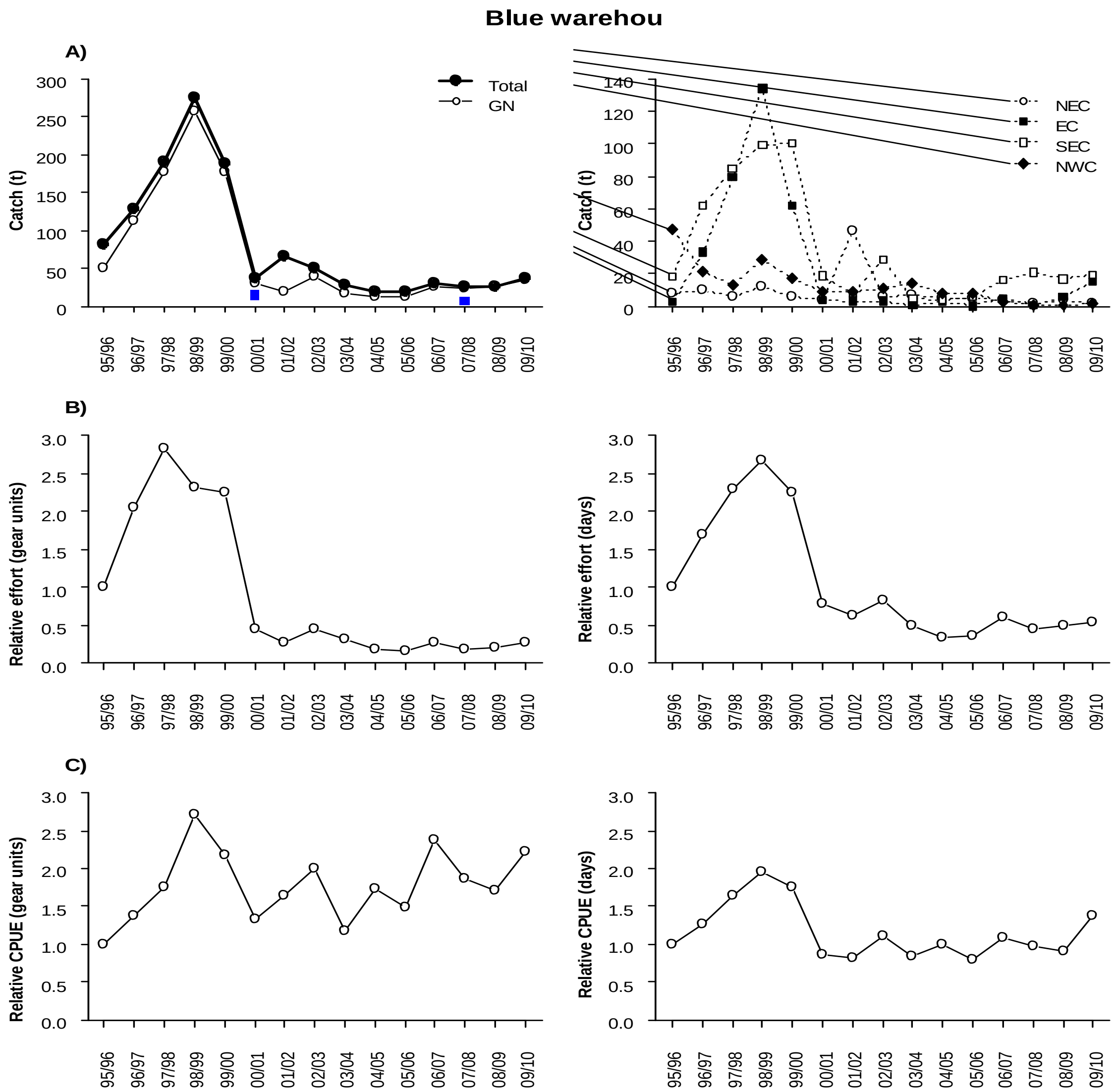

Fig. 9.1. A) Annual commercial catch (tonnes) of blue warehou by method (left) and region (right) since 1995/96 reported in Tasmanian logbooks, and best estimates of recreational catches (single squares); B) commercial effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and 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 is graball; SEC is south-east coast, EC is east coast, NEC is north-east coast, and NWC is north-west coast.

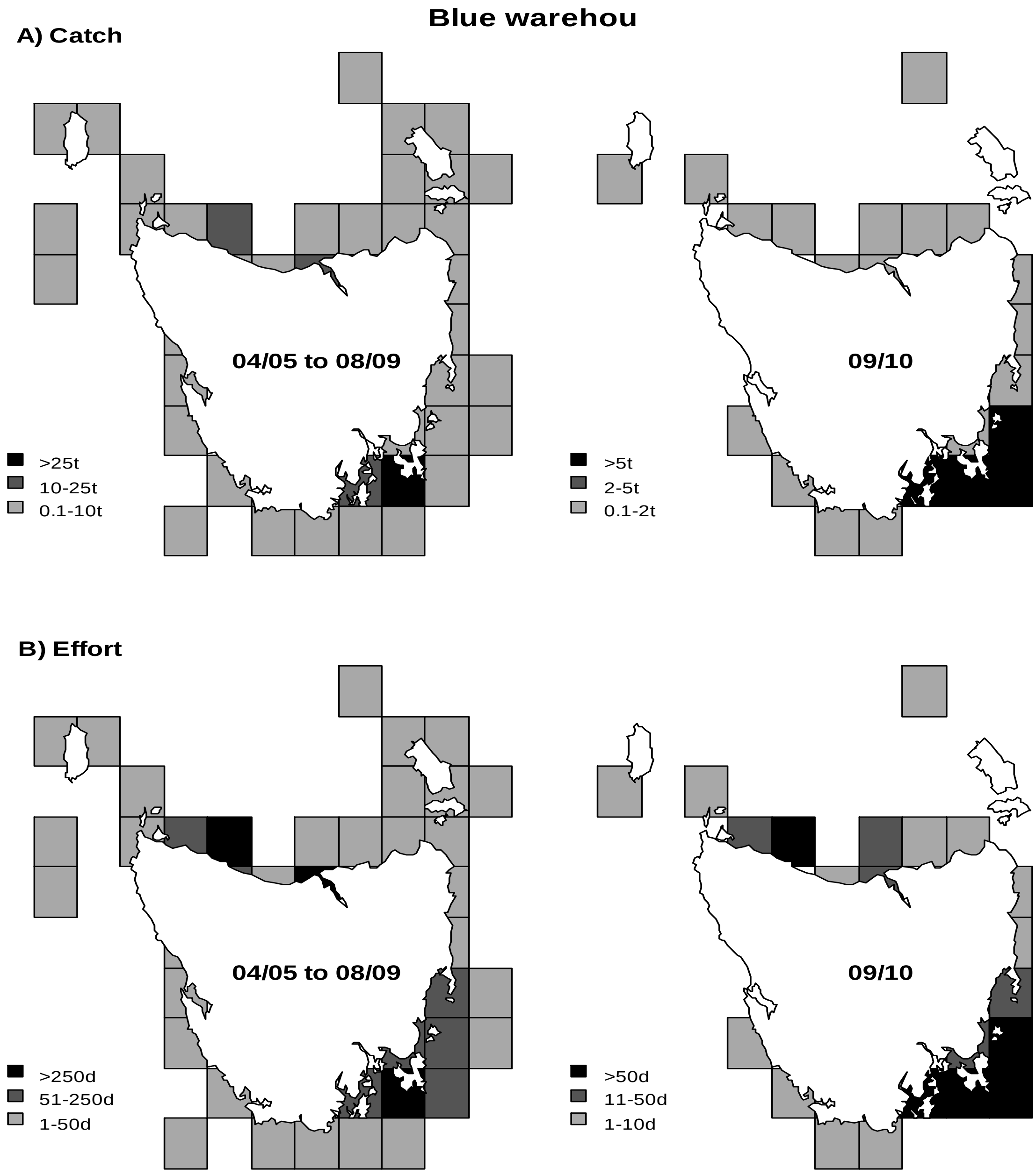

Fig. 9.2. (A) Blue warehou catches (tonnes) and (B) effort (days) by fishing block pooled from 2004/05 to 2008/09 (left) and during 2009/10 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

Two stocks of blue warehou occur in southern Australian waters, east and west of Bass Strait (Bruce *et al.* 2001). The fishery for blue warehou in Tasmanian waters is mainly centred off the south-east and east coast and thus probably targets the eastern stock (Figs. 9.1A and 9.2). Catches are also taken off the north-east and north-west coasts, the latter potentially involving the western stock.

The species is taken primarily in graball nets (Fig. 9.1A), with a range of other capture methods used including other gillnet categories (small mesh and shark net) and seine nets. In 2001/02 about half the catch was taken by beach seine off the north-east coast and in many respects this was unusual, with fishers reporting the presence of large schools of fish off some beaches at that time.

Recreational fishers also target the species using gillnets and to a lesser extent line fishing. The estimated recreational harvest in 2000/01 was just 15 tonnes (Lyle 2005), substantially lower than recreational catches taken in 1997 and 1998 (Lyle 2000) but consistent with the depressed state of commercial catches. The recreational catch further declined in 2007/08 to around 7 tonnes (Lyle et al. 2009)

Following an increase in commercial graball effort between 1995/96 and 1998/99 that resulted in increased catches, effort has since fallen to a substantially lower level (Fig. 9.1B). Low effort is largely in response to the reduced availability of the target species.

Graball catch rates increased markedly between 1995/96 and 1998/99 reflecting increased availability and targeting of warehou around Tasmania at the time (Fig. 9.1C). Since then catch rates have declined fluctuated around levels similar to those of the mid-1990s.

9.1.2 Reference points

Existing reference points	**Exceeded?**	**Alternative RP**	**Exceeded?**
State-wide or regional catches outside the 1990/91 to 1997/98 range (82t-318t)	Yes: State-wide (37t)	Commercial catch limit of 318 tonnes as per Memorandum Of Understanding (MOU)	No (37t)
Catch increase or decline by over 30% from previous year	Yes (39%)	-	
State-wide or regional effort over 10% of the highest for the period 1995/96 to 1997/98	No	-	
State-wide or regional catch rates less than 80% of the lowest annual value for the period 1995/96 to 1997/98	No	-	
Others: - Significant change in size/age composition of catch - Change in catches of non-commercial fish relative to 1990/91 to 1997/98 or high incidental / undersized mortality - Significant catch of unhealthy fish - Any other indicator of stock stress	Not assessed	Any indicator of stock stress	Not assessed

9.1.3 Implications for management

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 historic levels.

The availability of blue warehou in Tasmanian inshore waters is influenced by a range of environmental factors as well as stock size. Recent depressed catches are almost certainly linked to reduced biomass, the result of overfishing by Commonwealth and State fisheries during the 1990s. In 2003, the total allowable catch (TAC) for the Commonwealth fishery was reduced to 300 tonnes per year, down from over 2,000 tonnes in late 1990s, because catches of blue warehou were expected to be poor for the foreseeable future due to overfishing in combination with a lack of good recruitment. The TAC has remained low since and was reduced from 365 tonnes to 183 tonnes for 2009/2010 and 2010/2011 since both western and eastern stocks were considered to be overfished and unlikely to recover under current management arrangements (Wilson et al. 2010, AFMA 2009).

9.2 Australian salmon (*Arripis trutta and A. truttaceus*)

9.2.1 Catch, effort and catch rates

The commercial catch of Australian salmon increased by 33 tonnes in 2009/10 to 372 tonnes – the highest catch since 2002/03 (Fig. 9.3A). The vast majority of the catch was caught by beach seine, predominantly from the north-east and north-west coasts (Figs. 9.3A and 9.4). Despite this, beach seine effort fell to a record low level (Figs. 9.3B and 9.4).

Australian salmon also represent the second most commonly caught species in the recreational scalefish fishery, with an estimated harvest of 111 tonnes in 2000/01 (Lyle 2005) and 48 tonnes in 2007/08 (Lyle et al 2009).

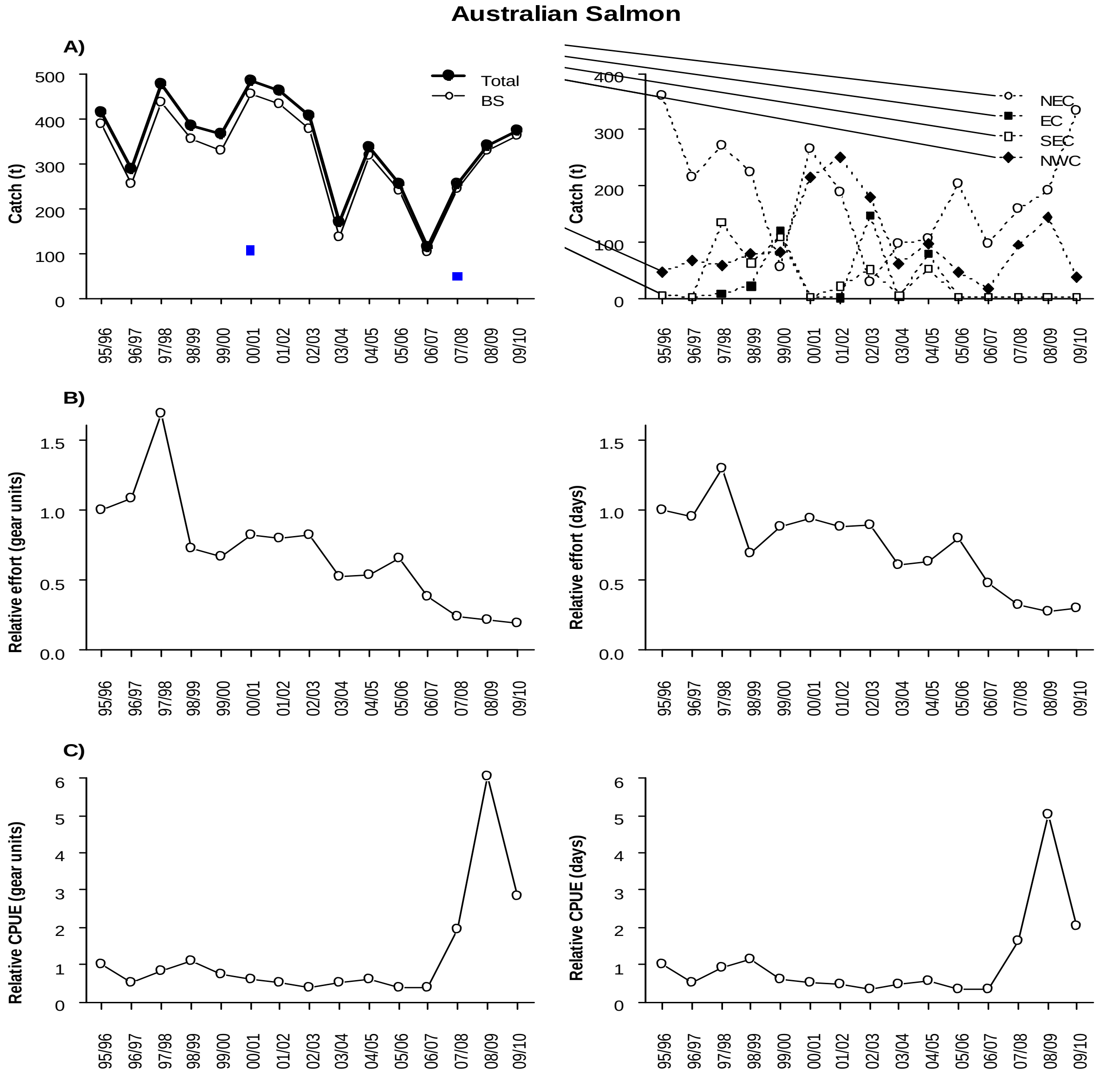

Fig. 9.3. A) Annual commercial catch (tonnes) of Australian salmon by method (left) and region (right) since 1995/96 reported in Tasmanian logbooks, and best estimates of recreational catches (single squares); B) commercial effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and 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 is beach seine; SEC is south-east coast, EC is east coast, NEC is north-east coast, and NWC is north-west coast.

Beach seine catch rates by gear units and days fished increased substantially in recent years (Fig. 9.3C). It should be noted however, that catch rate estimation is influenced by the extremely 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 this respect, even the geometric mean approach to calculating catch rates may provide biased estimates. Notwithstanding this, for schooling species such as Australian salmon, catch rates will not be a particularly sensitive indicator of stock condition especially if search time is not taken into account.

9.2.2 Reference points

Existing reference points	Exceeded?	Alternative RP	Exceeded?
State-wide or regional catches outside the 1990/91 to 1997/98 range (287t-879t)	No (372t)	Commercial catch trigger of 435 tonnes for Australian salmon A licences (120% of 10-year average for the period 1996/97 to 2006/07) as per Ministerial decision	No (372t)
Catch increase or decline by over 30% from previous year	No (+10%)	-	
State-wide or regional effort over 10% of the highest for the period 1995/96 to 1997/98	No	-	
State-wide or regional catch rates less than 80% of the lowest annual value for the period 1995/96 to 1997/98	No	-	
Others: - Significant change in size/age composition of catch - Change in catches of non-commercial fish relative to 1990/91 to 1997/98 or high incidental / undersized mortality - Significant catch of unhealthy fish - Any other indicator of stock stress	Not assessed	-	

9.2.3 Implications for management

Although Australian salmon stocks appear to fluctuate throughout the year in relation to environmental conditions, annual production is strongly linked to market demand, specifically the bait market, and thus not a good indicator of stock status. There is capacity for industry to expand production to the commercial catch limit should the market expand or new markets be found. Demand is expected to be influenced in the coming years due to declines in allowable catches in Australian rock lobster fisheries.

While stock status is unknown, the species has sustained substantially higher catches in the past and current commercial and recreational catches would appear sustainable.

Australian salmon also have commercial and recreational significance across several other southern states and thus a coordinated approach to management of stocks across jurisdictions would have the advantage to minimising potential conflicts, especially if there is a change in the market situation.

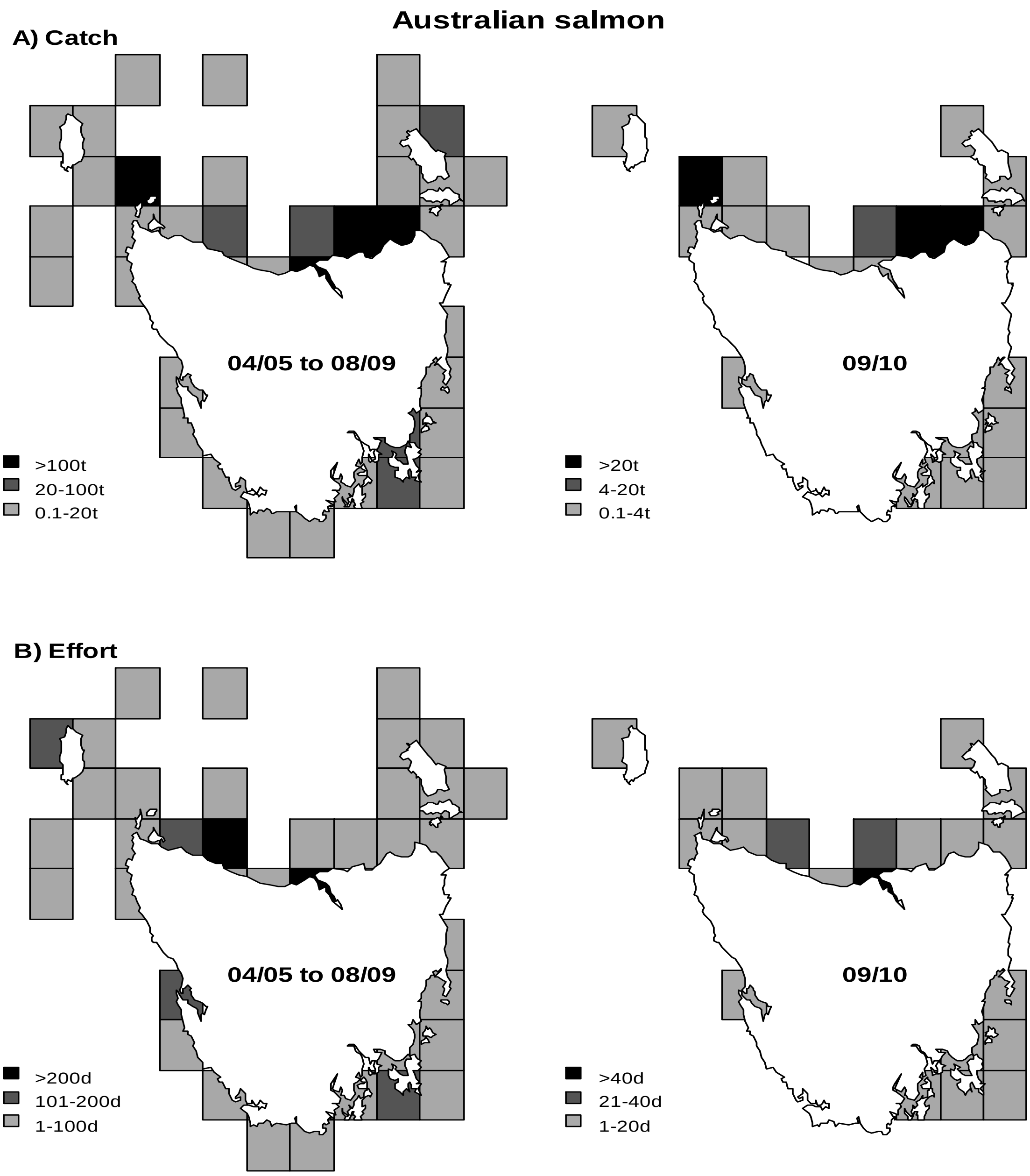

Fig. 9.4. (A) Australian salmon catches (tonnes) and (B) effort (days) by fishing block pooled from 2004/05 to 2008/09 (left) and during 2009/10 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

9.3 Flathead (Fam. Platycephalidae)

9.3.1 Catch, effort and catch rates

Several species of flathead occur in Tasmanian waters, but commercial catches are dominated by tiger flathead (*Neoplatycephalus richardsoni*) taken by Danish seine. Sand flathead (*Platycephalus bassensis*) are caught to a lesser extent by handline. However, the two species have not been routinely distinguished in catch returns until recently and catches by species are inferred by the gear taking the catch.

Flathead catches declined steadily between 2000/01 and 2003/04 but more than doubled in 2005/06 (Fig. 9.5 and Fig. 9.6). Since then they have fluctuated between 50 and 75t, these fluctuations are mainly caused by variability in tiger flathead catches taken by Danish seiners. By contrast, handline catches, mainly targeting sand flathead, have remained stable since the mid 1990s.

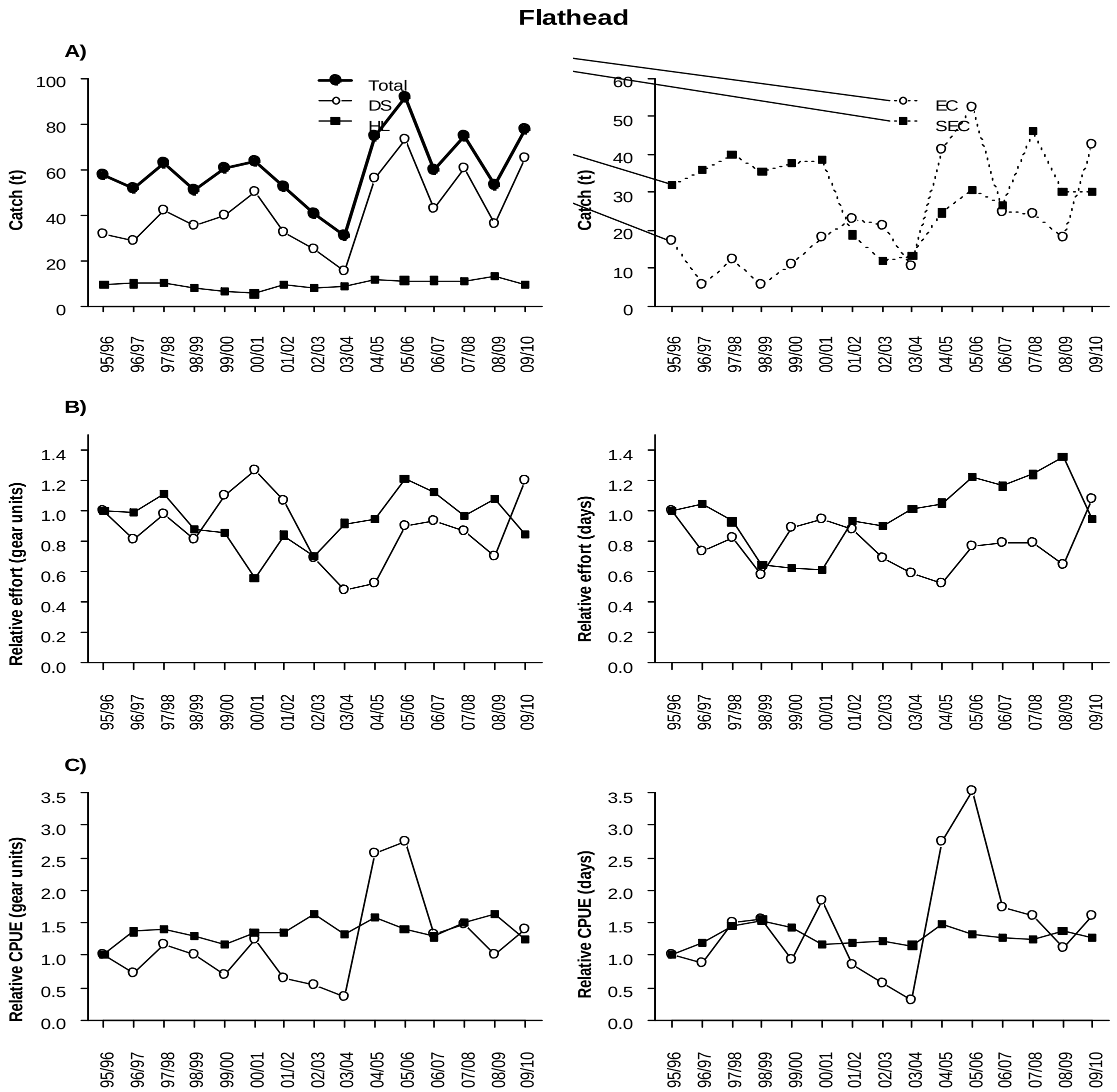

Fig. 9.5. A) Annual commercial catch (tonnes) of flathead by method (left) and region (right) since 1995/96 reported in Tasmanian logbooks. Best estimates of recreational catches (321t in 2000/01 and 293t in 2008/09 not shown); B) commercial effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and 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 is hand line; SEC is south-east coast and EC is east coast.

Catches were derived mainly from the south-east and east coasts, with smaller quantities also taken from the north-east (including around Flinders Island) and north-west coasts (Figs. 9.5A and 9.6). The increased production of the past years has been mainly focussed in the south-east of the state.

Recreational catches are dominated by sand flathead and estimated to have been 361 tonnes in 2000/01 (Lyle 2005) and 292 tonnes in 2007/08 (Lyle et al. 2009). Tiger flathead comprised only a minor component of the harvest.

Effort for both gear types has fluctuated without obvious trend and overall has remained relatively stable since the mid 1990s except for a gradual increase in days fished with handline (9.5B). The regional distribution of effort has changed little from previous years, with commercial effort particularly concentrated off the south-east, east and north-east coasts (Fig. 9.6).

Hand line catch rates have remained stable over time, whereas Danish seine catch rates have fluctuated strongly in recent years, presumably reflecting the level of targeting for the species (Fig. 9.5C).

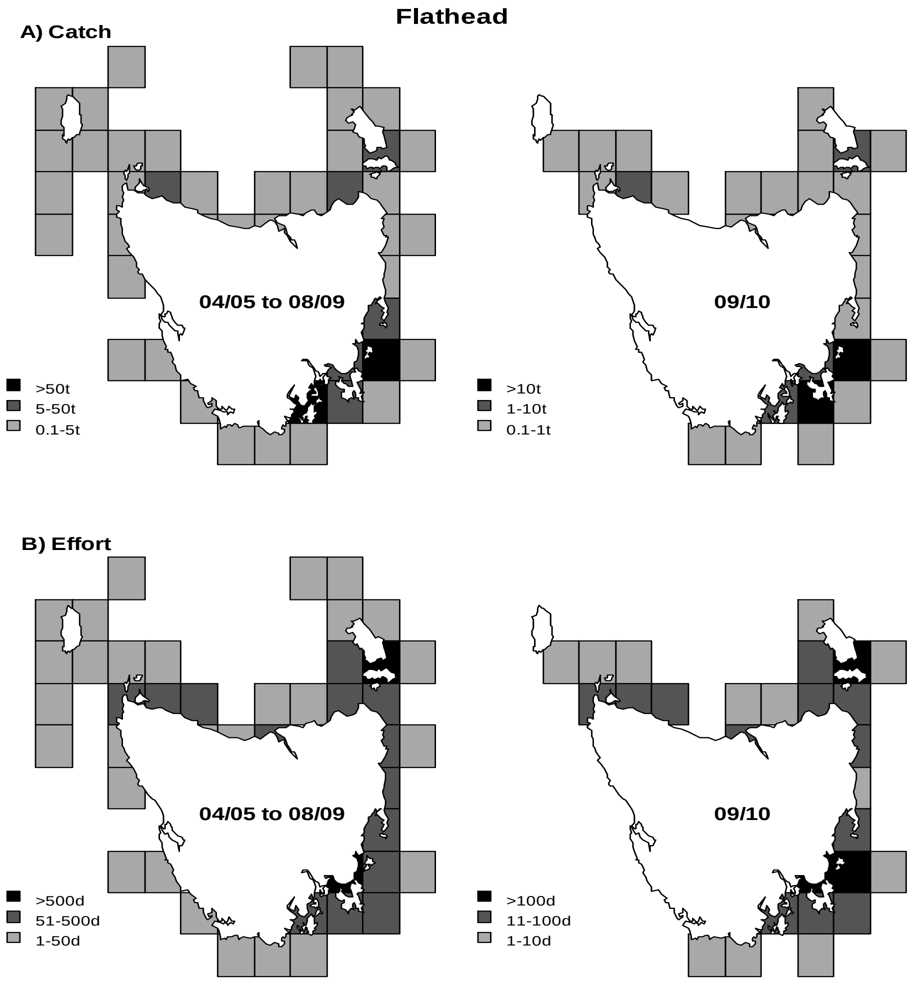

Fig. 9.6. (A) Flathead catches (tonnes) and (B) effort (days) by fishing block pooled from 2004/05 to 2008/09 (left) and during 2009109 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

9.3.2 Reference points

Existing reference points	Exceeded?	Alternative RP	Exceeded?
State-wide or regional catches outside the 1990/91 to 1997/98 range (52t-165t)	No (77.3t)	Catch by Danish Seine above 1.3* the maximum catch from the reference period 1998/99 to 2006/07: South-east coast: 45t East coast: 63t	 No (30t) No (42t; 24t increase)
Catch increase or decline by over 30% from previous year	Yes (47% Increase)	-	
State-wide or regional effort over 10% of the highest for the period 1995/96 to 1997/98	Yes: Danish seine (gear units)	-	
State-wide or regional catch rates less than 80% of the lowest annual value for the period 1995/96 to 1997/98	No	-	
Others: - Significant change in size/age composition of catch - Change in catches of non-commercial fish relative to 1990/91 to 1997/98 or high incidental / undersized mortality - Significant catch of unhealthy fish - Any other indicator of stock stress	Not assessed	Any indicator of stock stress	Not assessed

9.3.3 Implications for management

Danish seine catches are highly variable and tend to be inversely related with catches of whiting (refer Table 2.3 and Fig. 2.2). While stock status of both key flathead species in state waters is unknown, commercial catches of tiger flathead have been maintained at higher levels in past. There are however, additional and significant trawl catches of flathead (almost exclusively tiger flathead) that are taken from Commonwealth waters as part of the South East Fishery, with the tiger flathead stocks classified as not overfished (Wilson et al. 2009). 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. Clearly the main impact on sand flathead stocks is from the recreational sector.

Increased interest from commercial operators is likely, as evidenced in the recent Danish seine catches, 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 recreational fishers. 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.

Acknowledgements

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Appendices

Appendix 1. Common and scientific names for species reported in catch returns.

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

Appendix 2. Data restrictions 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[5].

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.

Commonwealth logbook data:

[5] 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 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.

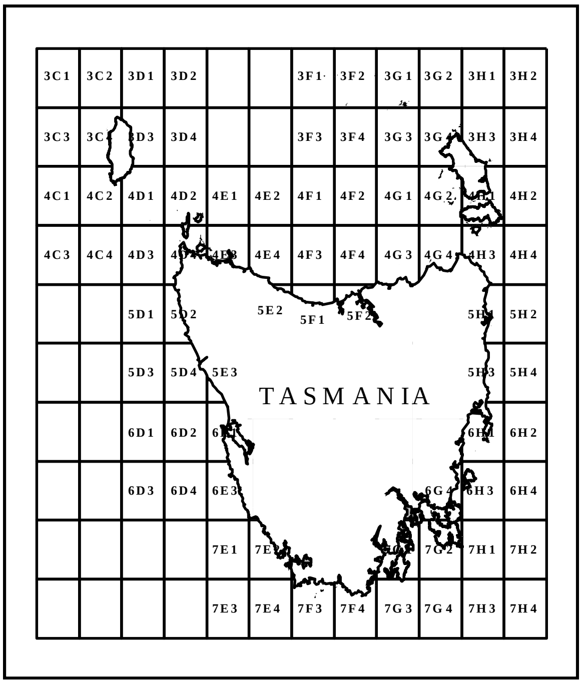

Fig. A1. Numbers for fishing blocks used in calculation of catch figures.

(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.

The Institute for Marine and Antarctic Studies (IMAS), established in 2010, comprises the University of Tasmania's internationally recognised expertise across the full spectrum of temperate marine, Southern Ocean, and Antarctic research and education.

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