FISHERY ASSESSMENT REPORT

TASMANIAN SCALEFISH FISHERY - 2006

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This assessment of the scalefish fishery is produced by the Tasmanian Aquaculture and Fisheries Institute (TAFI) and uses input from the Scalefish Fishery Assessment Working Group (SFAWG).

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Tasmanian Scalefish Fishery - 2006

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, introduced in 1998, reviewed in 2001 and again 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, catches and effort. The commercial catch history for the period 1990/91 to 2005/06 is presented, with more detailed analyses of catch and effort by method for the period 1995/96 to 2005/06. 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 and bastard trumpeter) have been incorporated in the analyses.

Following the introduction of the management plan, dipnet, dropline and squid jig effort expanded to historically high levels whereas effort for other methods tended to remain relatively stable or declined. By 2005/06, effort levels for all methods, apart from squid jigs, had fallen to within or below reference levels (Table 1). The dramatic increase in squid jig effort occurred primarily in response to the expansion of the southern calamary fishery.

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.

Table 1. Effort performance indicator assessment by major fishing methods for 2005/06
Y triggered, N not triggered.

	Effort >10% peak 1995/96 - 1997/98 levels	
Method	Gear units	Days fished
Beach seine	N	N
Purse seine	N	N
Graball net	N	N
Small mesh	N	N
Dropline	N	N
Handline	N	N
Troll	N	N
Fish trap	N	N
Spear	N	N
Dip net	N	N
Squid jig	Y	Y

Species assessments

Detailed assessments were performed for banded morwong, southern calamary and striped trumpeter, while other key species - sea garfish, wrasse, blue warehou, bastard trumpeter, Australian salmon, flounder and flathead - were considered more briefly.

Species assessments evaluate fishery-dependent information against agreed upon reference or trigger points for the performance indicators, as detailed in the Scalefish Management Plan. Specifically, these reference points relate to defined levels of catch, effort and catch rates. The management plan also provides for biological characteristics to be used as performance indicators for which reference points can be defined against which stock status can be evaluated and, where such data are available, they have been updated in this assessment.

Banded morwong

Performance indicators

- State-wide, as well as in the Maria and Bicheno fishing regions, catch levels were below the 1994/95 to 1997/98 range and therefore exceeded the reference point.
- Gillnet effort for banded morwong was within reference levels at either regional or state-wide scales.
- State-wide standardised catch rates were within reference levels, however standardised catch rates for St Helens remained low and exceeded the reference point for the fourth year running.

Resource status

- A regional stock assessment model suggested that exploitation rates in some regions may not be sustainable.
- Current catch levels are likely to continue to reduce spawning biomass, though stocks now exhibit higher productivity (faster growth of individuals, earlier maturity of females) than at the commencement of the fishery.

Management advice

- Management action is required to ensure that east coast catches do not exceed recent levels.
- Given the limited mobility of this species, management should explicitly include reference to the spatial distribution of effort.

The fishery for banded morwong expanded in the early 1990s with the development of live fish markets for this species. Annual production declined steadily between 1994/95 and 1999/00, but has since stabilised, the 2005/06 catch of 48 tonnes being close to the average for the past six years. State-wide effort has also stabilised and remained low compared with the reference period. Increasing effort was evident in the St. Helens region though the level was still below reference values.

Catch rates for the Maria and Tasman regions have generally risen in recent years, whereas they have trended downward for St Helens and Bicheno since the late 1990s. In 2005/06, there was an improvement in catch rates in the Bicheno region to just above the reference levels. Catch rates in the St. Helens region remained below reference levels. State-wide, however, catch rates were above reference levels.

Results from last year's assessment using a regional age-structured stock assessment model (not updated this year) indicated high harvest rates over an extended period of the fishery. Only in recent years have harvest rates reduced towards sustainable levels. The model predicted relatively low estimates of mature biomass in at least some regions, although predicted mature biomass levels in 2004/05 were higher than 30% or 40% of the initial mature biomass. The model reflected the uncertainty in the underlying data and uncertainty over the dynamics and spatial structuring of the stock. Because of the spatial mis-match between catch rate data (by 30nm blocks) and stock processes (at reef level), model predictions were considered overly-optimistic due to possible masking of serial depletion of stocks. In addition, uncertainty about the regional biomass distribution coupled with generally poor model fits to the biological data did not allow the optimum spatial model structure to be identified.

A harvest strategy evaluation indicated that maximum future catch levels from the east coast should on average be less than 36 tonnes if the management objective is to maintain or rebuild catch rates and mature biomass. However, model results were based on substantial changes in some life-history characteristics of banded morwong (faster growth of individuals, earlier maturity of females). In effect, predicted stability in the fish biomass and the fishery has been founded mainly on young fish becoming more productive rather than sustainable use of old fish.

Therefore, despite uncertainty in the commercial and biological data, the assessment suggested that management action is required to ensure that fishing mortality in this fishery does not exceed current levels or is even reduced in the long term. Given the limited mobility of this species, management should also explicitly include reference to the spatial distribution of effort.

Southern calamary

Performance indicators

- Catch and effort were higher than the reference levels and therefore exceeded reference points for the eighth consecutive year. The State-wide catch of 40 tonnes represented a 65% reduction compared with the previous year and therefore exceeded the rate of change reference point.
- Catch rates were within reference levels.

Resource status

- There is a high degree of uncertainty about stock status.

Management advice

- Extended closure of the major spawning grounds appears to be effective in protecting the main (known) spawning event. Recent studies have confirmed that Great Oyster Bay represents a significance population source of calamary for south-eastern Tasmania and thereby the importance of ensuring high levels of egg production from this region.

The fishery for southern calamary expanded markedly in 1998/99 and, reflecting the development of this as a target fishery, subsequent catches have exceeded those for the reference period. After years of generally increasing catches, the 2005/06 catch of 40 tonnes represented a 65% decline compared with 2004/05. Declines in production were reported in all areas, not just those areas subject to the 3-month closure, *i.e.* Great Oyster Bay and Mercury Passage. The extension of closure to include a larger area of the east coast and changed timing will have contributed to the decline in production in 2005/06, but is unlikely to have been the sole contributing factor. Trends in effort were consistent with the pattern observed for catches. State-wide catch rates also decreased slightly, but were within reference levels during 2005/06.

Since the development of the calamary fishery occurred after the introduction of the management plan the application of the generic catch and effort reference points with their specific reference years have little relevance. The fact that catches remain above reference levels is of far less concern than if catches were to fall to within historic levels (suggesting the collapse of the fishery).

Egg production showed some potential as an indicator of relative spawning biomass, but may be less useful as a pre-recruit index. However, with the limited time series of data available these observations remain preliminary.

Although a high degree of uncertainty is associated with the present assessment, the extended spatial and temporal closure of the major spawning grounds appears to be effective in protecting the main (known) spawning event and ensuring relatively high egg production. Any major shift in the fishery to increase effort prior to the closure could adversely impact on the spawning stock prior to the main spawning season. Recent studies indicate that the most adult calamary caught on the east and south-east coasts are probably spawned in Great Oyster Bay; this area exhibits a high degree of self-recruitment as well as supplying other parts of the south-east coast with the bulk of recruits. These findings reinforce the efficacy of management arrangements that involve the closure of this region during the main spawning period.

Striped trumpeter

Performance indicators

- Striped trumpeter catches were at the lowest level since the mid-1980s and therefore exceeded the catch reference point.
- Effort was within reference levels.
- Catch rates for dropline (days fished) remained below reference levels and therefore exceeded the reference point.

Resource status

- Resource status is uncertain though potentially depleted due the combined effects of fishing and apparent poor recruitment in recent years. Major uncertainties surround the lack of information on the recreational catch and the magnitude of the catch taken by Commonwealth operators.

Management Advice

- Although a more rigorous assessment is required to assess the sustainability of the fishery, the expectation is that the stocks are declining and will continue to do so without management action and/or a period of sustained good recruitment. It would be prudent to reduce fishing mortality in both commercial and recreational sectors and to review the minimum size limit, which is below the size at maturity.

Commercial catches of striped trumpeter continued to decline during 2005/06 to be just 23 tonnes, the lowest catch recorded since the mid 1980s. However, Commonwealth catches are likely to have been substantially under-reported and recreational catches have most likely increased in recent years. The commercial fishery also appears to have spatially contracted and catches are now concentrated off the south east coast. Handline and graball effort were well below levels experienced during the latter half of the 1990s. Despite a further fall in dropline effort, it remained relatively high and within the reference period range. Catch rates for the hook methods fell very slightly, with dropline (days fished) well below reference levels. There was little change in graball catch rates following the sharp fall experienced during 2004/05, presumably reflecting the impact of the size limit increase.

The continued decline in catches since 1999/00 gives rise to concerns about the current status of striped trumpeter stocks. Falling graball net catches (primarily juvenile fish) and reductions in offshore hook catches (mainly adult fish) suggest that the biomass of new recruits and adults have declined significantly. Striped trumpeter exhibit strong recruitment variability resulting in inter-annual variability in fishable biomass. Recent size and age composition data imply that there has been no substantial recruitment recently and that strong cohorts from 1993 and 1994 are still well represented in the population. The average size of hook-caught fish is thus expected to continue to increase as the present cohorts grow but spawner biomass will continue to decline.

The introduction of a 250 kg trip limit may have also contributed to the downturn in commercial catches. There was evidence that the quantities of gear fished each day had declined (presumably to limit catches) and there are reports that some operators have simply decided not to bother targeting the species because of the trip limit.

Based on yield and spawning biomass-per-recruit analyses and size at maturity it would appear that the recent increased minimum size limit, while a positive step, was sub-optimal and the risk of growth overfishing and possibly recruitment overfishing remains. Although a more rigorous assessment is required to assess the sustainability of the fishery, stocks are expected to decline further without management action and/or a period of sustained good recruitment. It would be prudent to act to reduce fishing mortality, both commercial and recreational, and to review the minimum size limit.

Sea garfish

Performance indicators

- State-wide catch and effort were within reference levels.
- Dipnet catch rates were below reference levels and therefore exceeded the catch rate reference point.

Resource status

- Fishery dependent performance indicators provided no basis for concern over resource status, noting that catch rates may not be good indicators of abundance for schooling species such as garfish.

Management advice

- While it is not known whether present catch levels are sustainable, the potential for increased targeted effort is great. It would be prudent to consider management options that limit further expansion in this fishery.

Garfish catches have remained relatively stable since the early 1990s, with 75 tonnes caught in 2005/06. Beach seine effort was slightly lower while dipnet rose slightly in 2005/06 but overall effort for both methods remained relatively low compared to the reference period. While beach seine catch rates have increased over time, dipnet catch rates fell slightly and are now just below the reference limit. Since sea garfish is a schooling species, catch rate trends are unlikely to be sensitive indicators of abundance.

There is little evidence for concern over the status of the garfish stocks based on the fishery dependent performance indicators, but there is potential for targeted effort to expand, especially in the dipnet sector. While it is not known whether present catch levels are sustainable, it would be prudent to consider management options that limit further expansion in this fishery.

Wrasse

Performance indicators

- No reference points were exceeded.

Resource status

- Resource status is unknown though the two species targeted are vulnerable to localised depletion of legal-size biomass. Minimum size limits provide considerable protection to purple wrasse and female blue-throat wrasse spawner biomass. The size limit does not, however, offer the same level of protection to male blue-throat wrasse which derive from mature females after a sex change, typically at sizes after they have entered the fishery.

Management advice

- The *status quo* appears to be acceptable in terms of sustainability. Improvements in the collection of spatial information and species based reporting are required in order to reduce the risk of failing to detect serial depletion.

The development of live fish markets for wrasse in the early 1990s resulted in increased catches. Two species are involved, purple wrasse and blue-throat wrasse, though catches of these species are still not generally distinguished in catch returns. Despite some fluctuations, wrasse catch has remained relatively stable since the mid 1990s, and the catch of 85 tonnes in 2005/06 is well within reference limits. Industry reports suggest recent high levels of interest in the fishery.

Catch rates for both handline and fish traps have increased. However, broad-scale analyses may be relatively insensitive to changes in abundance at the level of individual reefs, the scale at which the fishery impacts the fished populations. Marked regional shifts that have occurred in the fishery may also mask localised depletions, with fishers moving to new or lightly fished areas to maintain catches. Because fishery performance indicators ignore the spatial structure of the fishery, caution needs to be exercised when making inferences about the status of the wrasse stocks.

There are concerns that blue-throat males may not be adequately protected by the current minimum size limit. This is because blue-throat wrasse change sex, with males derived from mature females generally after they have entered the fishery. When combined with the fact that males are strongly site attached and have higher catchability than females, because they are more aggressive, this suggests that they are potentially vulnerable to over-fishing. In extreme situations 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) females present. Presently there is no evidence of this occurring in Tasmania or in Victoria where the blue wrasse is more intensely fished than that in Tasmania.

Blue warehou

Performance indicators

- State-wide catches of blue warehou were below reference levels and therefore exceeded the reference points.
- Effort and catch rates were within reference levels.

Resource status

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

Management advice

- Management action for stock rebuilding has been implemented in the Commonwealth fishery.

Blue warehou catches in Tasmanian waters have been low for some years and the current catch of 19 tonnes was the lowest catch reported since the mid-1980s. Graball effort remained low and catch rates were above reference levels.

A range of environmental factors, as well as stock size, influences the availability of blue warehou in Tasmanian waters. Recent depressed catches are almost certainly linked to reduced biomass, the result of overfishing by Commonwealth and State fisheries during the 1990s. In the absence of significant rebuilding, catches are likely to remain low, although there are some signs of stock recovery in the Commonwealth fishery.

Bastard trumpeter

Performance indicators

- State-wide catches of bastard trumpeter were below reference levels and therefore exceeded the catch reference points for the sixth consecutive year.
- Effort and catch rates were within reference levels.

Resource status

- Resource status is uncertain though potentially depleted, due to the effects of fishing coupled with variable recruitment.

Management advice

- Management options to reduce the total fishing mortality on this species should be explored.

Bastard trumpeter catches have declined steadily since the mid 1990s. They have remained stable at around 20 tonnes for the past five years with a catch of 22 tonnes in 2005/06. Graball effort and catch rates have also remained stable over the same period.

Catch rates are probably a poor indicator of stock status for bastard trumpeter since the species is now largely taken as by-product and thus total catch may be a better indicator of abundance and/or availability. As such, trends in commercial production suggest that current inshore populations are at low levels. Strong recruitment variability is a feature of this species, with limited evidence of good recruitment in recent years.

The commercial and recreational fishery is almost entirely based on juveniles, giving rise to the possibility of growth overfishing. Increasing the minimum size limit to above the size at maturity would be beneficial to the stock, but would effectively close down inshore fisheries for the species. Reducing the recreational possession limits and discouraging targeting through the introduction of a trip limit for commercial operators may be more suitable alternatives.

Australian salmon

Performance indicators

- Australian salmon catches were below the reference range and therefore exceeded the reference point.
- Effort was within reference levels.
- Beach seine catch rates were below reference levels and therefore exceeded the reference point.

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. Resource status is unknown.

Management advice

- The *status quo* appears to be acceptable though the possibility of significant expansion remains if new markets open.

The catch of Australian salmon has strongly fluctuated over the last few years and in 2005/06 dropped by 25% to 252 tonnes, the second lowest on record. Beach seine catch rates also decreased compared to recent years. It is, however, recognised 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 a very small number of extremely large catches. In this respect catch rates are not a sensitive fishery performance indicator for a schooling species such as Australian salmon.

Commercial catches of Australian salmon are to a large extent linked to market demand (specifically the bait market). While stock status is unknown, the species has sustained substantially higher catches in the past. There is capacity within industry to significantly expand production should new markets be found and under such circumstances management may need to be proactive moderating such expansion.

Flounder

Performance indicators

- State-wide catches were below the reference range and therefore exceeded the reference points for the eighth consecutive year.
- Effort was within reference levels.
- Spear catch rates were below reference levels and therefore exceeded the reference point.

Resource status

- Resource status is unknown.

Management advice

- *Status quo* appears to be acceptable until more evidence, industry reports, or recreational reports become available.

Flounder catches declined steadily from over 40 tonnes p.a. during the early 1990s to around 12 tonnes in 2000/01 and have remained low since then. The current catch of 10 tonnes was the lowest on record and well below reference catches. Fishing effort for graball has remained stable at low levels over the past 4-5 years, while spear effort dropped sharply during 2005/06 to the lowest level on record. Catch rate trends were variable between methods. Catch rates for spears have exhibited a downward trend over time and are now below reference levels. Graball catch rates by gear units (kg per 100-m net hour) have increased, while daily graball catch rates have declined since the mid 1990s. These apparently contradictory trends imply some changes in fishery dynamics for flounder, with less graball net effort expended on each day fished and more time fished per day on average with spears.

The degree of interest by the commercial sector in flounder appears to be quite low at present. It is unclear whether this is market or resource driven, and therefore the current status of flounder stocks is unknown.

Flathead

Performance indicators

- No reference points were exceeded.

Resource status

- Resource status is unknown.

Management advice

- *Status quo* appears to be acceptable until more evidence, industry reports, or recreational reports become available. As further expansion in the commercial fishery is likely it would be prudent to consider spatial management options that avoid the regional concentration of effort. In addition, it would be helpful to distinguish between the tiger and sand flathead, as the commercial and recreational fisheries target different species, but information on the real degree of overlap is not available.

Two main species are involved, tiger and sand flathead, with tiger flathead dominating the commercial catch taken by Danish seine. By contrast, sand flathead account for the vast majority of the hand line and recreational take. Flathead catches have expanded over the past two years reaching 95 tonnes in 2005/06, representing the highest catch reported since the mid 1990s. Increased catch appear to be mainly due to a switch in targeted Danish seine fishing from whiting to flathead.

Hand line effort and catch rates remained relatively stable. There is some evidence for increased commercial fishing with lines (presumably targeting sand flathead) but compared with the recreational take, these catches are very minor.

The status of both key flathead species in state waters is unknown, although commercial catches of tiger flathead have been maintained at higher levels in past. In adjacent Commonwealth waters significant quantities of tiger flathead are taken by trawling, but the impact of this fishery on inshore stocks is unknown.

Activation of dormant Danish seine licences is likely in the near future and, as a result, flathead catches are expected to rise further. It would be prudent to consider spatial management options that avoid the regional concentration of effort.

2005/06 performance indicator summary

Performance indicator analysis for the key species or species groups is summarised in Table 2.

Table 2 Summary performance indicator assessment for key species with assessment of risk 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;
Y triggered, N not triggered, arrows indicate direction of change, na not assessed;
H high risk, M medium risk, L low risk, U uncertain; # applies only to particular methods or regions; ## main fishery managed by Commonwealth. Changes since last 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 ↓#	**N**	N	Y #	Y	H
Southern calamary	Y ↑	**Y ↓**	Y	N	N	M
Striped trumpeter	Y ↓	**N**	N	Y #	Y	**H**
Garfish	N	N	N	**Y ↓**	na	U
Wrasse**	N	N	N	N	na	L
Blue warehou	Y ↓	**N**	N	N	na	##
Bastard trumpeter	Y ↓	N	N	N	na	M
Australian salmon	**Y ↓**	**N**	N	Y	na	L
Flounder	Y ↓	N	N	Y #	na	U
Flathead	N	**N**	N	N	na	L

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1 Management Objectives and Strategies

The Scalefish Management Plan was first introduced in 1998 (DPIF 1998) and was reviewed in 2001 and again in 2004. The primary issues tackled in the latest review related to latent effort in the fishery (addressed by introducing non-transferability for class-C and inactive licences), wastage in gillnets (addressed by a prohibition on night netting for recreational fishers and the requirement for commercial operators to be in attendance whilst night netting[1]), a review of recreational possession and size limits and the closing of further selected waters to gillnetting.

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] Note: some exclusions exist in relation to the gillnet usage changes.

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. 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 of the 1990 to 1997 range; 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, increases by 10% from the highest of the 1995 to 1997 levels;
- catch rates for a key target species is less than 80% of the lowest annual value for the period 1995 to 1997;
- 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 1990 to 1997 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.

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 and 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. Caton and McLoughlin 2004).

This report represents the ninth in a series of annual assessments of the scalefish fishery and incorporates catch and effort information available up to and including June 2006. Copies of previous assessment reports are available on the TAFI web page - http://fcms.its.utas.edu.au/scieng/mrl/index.asp.

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 only provided monthly summaries of catches (landings) but were often incomplete or very limited in terms of providing effort information. Lennon (1998) discussed in some detail the limitations of these catch returns and, in summary, noted that they provided only basic information about production levels and were of little value for effort and catch rate analyses.

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 (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).

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 refer to 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 became apparent that there was some confusion amongst fishers about reporting requirements and 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. Data were 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 2006. All catch returns from within this period and available as at October 2006 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 period reflects the seasonality of the fisheries for most species better than the calendar year, with catches (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.

If not 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).

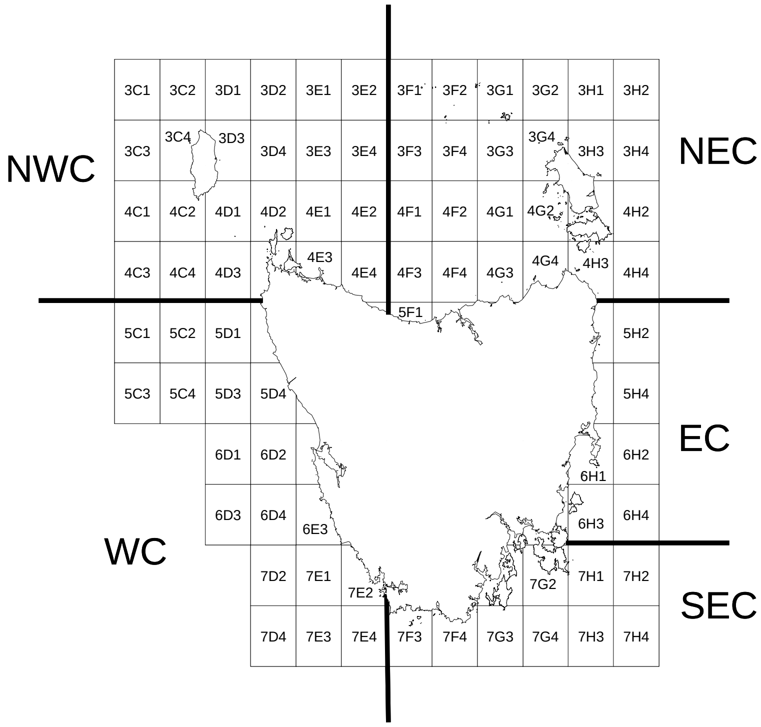

Fig. 2.1: Map of Tasmania with 30 nm fishing blocks and the assessment regions. SEC is south east coast, EC is east coast, NEC is north east coast, NWC is north west coast, and WC is west coast.

Two measures of effort have been examined: (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.

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. Less than 0.2% of all fishing records during 2005/06 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 arithmetic mean of catch rates does not accurately characterize the data. Instead, the geometric 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:

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

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

2.2.4 Recreational fishery

A detailed analysis of the Tasmanian recreational fishery, based on the 2000/01 National Survey dataset, has been recently completed (Lyle 2005). Apart from recreational net licence numbers, there are no additional data relevant to the recreational scalefish fishery in Tasmania.

2.3 Commercial catch trends

2.3.1 Overview

Annual commercial catches have been variable since 1990/91 (Table 2.2) and since the early 1990s, catch trends for the major species (except garfish) have generally been declining (Fig. 2.2). Overall, total scalefish catches declined from over 2000 tonnes in the early 1990s to around 1000 tonnes in recent years. The 2005/06 catch of 791 tonnes represented a decrease of 162 tonnes compared to 2004/05, but is similar to that in 2003/04. Compared to the last fishing year, catch declines were experienced for Australian salmon (-85 tonnes), barracouta (-38 tonnes), whiting (-29 tonnes) and wrasse (-15 tonnes), and while flathead experienced an increase (+16 tonnes) catches of most other scalefish species were within ± 10 tonnes of 2004/05 levels.

When assessing trends within the scalefish fishery it is important to recognise that some species only occur seasonally in Tasmanian waters and that availability can differ markedly between years; such variability does not necessarily reflect changes in stock condition. Species in this category include blue warehou, barracouta and arrow squid. By contrast, species such as banded morwong, garfish, wrasse, the trumpeters and calamary 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.

2.3.2 Key species

Australian salmon have consistently dominated the scalefish catch, with catches in excess of 650 tonnes p.a. prior to 1995/96 (Fig. 2.2). More recent landings of this species have remained lower, fluctuating between about 200-500 tonnes. The 2005/06 catch of 252 tonnes was down 85 tonnes compared to the previous fishing year and below the catch range for the reference period (1990/91 to 1997/98). Industry reports suggest that the generally lower landings since the mid 1990s have been largely in response to reduced bait-market demand rather than reduced stock abundance.

In the early 1990s, barracouta catches declined sharply from around 350 tonnes to around 60 tonnes by 1993/94. Up until 2001/02, landings remained at low levels reflecting, in part at least, low market demand coupled with reduced availability. The most recent catch of over 59 tonnes was lower than in the preceding year, but within the range of reference catch levels (Fig. 2.2).

Flathead catches declined from over 150 tonnes p.a. in the early 1990s to around 50 tonnes by the mid 1990s (Fig. 2.2), largely due to reductions in inshore trawl (demersal trawl and Danish seine) activity (Lyle and Jordan 1999). The 2005/06 catch of 91 tonnes continued the increasing trend from last year but remained within reference levels. Demersal trawling was banned in State Fishing Waters in 2001 and there are currently very few active Danish seine operators. The recent increase in landings is largely the result of targeted fishing by the Danish seiners, with tiger flathead the dominant species taken.

Catches of flounder typically ranged between 30-40 tonnes, but over the past six years have fallen to below 20 tonnes. The catch of just 10 tonnes reported in 2005/06 is the lowest on record (Fig. 2.2). It is unclear whether this is a reflection of reduced abundance or changed market demand, but recent catches remain well below reference catch levels.

Apart from the mid 1990s, sea garfish production has remained relatively stable at between 80-100 tonnes p.a (Fig. 2.2). Current landings of 75 tonnes represented a slight decrease over 2004/05 but was within reference catch levels.

Landings of mullet (sea and yellow-eyed mullet) were around 30 tonnes in the early 1990s, but have since declined steadily. The catch of 6 tonnes in 2005/06 was similar to that for the preceding year and close to the lowest level on record (Fig. 2.2).

The development of live fish markets for banded morwong during the early 1990s resulted in a marked increase in reported landings to 145 tonnes (1993/94), though it is generally accepted that this figure is unreliable and represents a significant overstatement of the real catch. Catches declined from almost 90 tonnes in 1995/96 to less than 35 tonnes in 1999/00 (Fig. 2.2). Over the past eight years, reported catches have averaged 45 tonnes, the current catch of 48 tonnes representing a slight increase compared with 2004/05.

Table 2.2. Annual 'Tasmanian' scalefish and cephalopod production (whole weight) between 1990/91 to 2005/06 by species

Based on General Fishing Returns and Commonwealth (GN01, GN01A and SSJF) logbook returns.

	Catch (tonnes)															
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**
Scalefish																
Australian salmon	815.9	651.9	867	878.8	682.1	413.2	287.3	476.0	384.7	363.7	485.0	462.1	407.2	167.2	336.3	251.8
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	96.9	58.5
Boarfish	7.2	9.4	7.6	10.1	9.1	7.3	10.4	9.4	7.0	7.3	8.0	5.5	3.6	4.3	3.6	4.5
Bream	5.7	3.5	1.4	7.4	7.2	2.5	9.9	1.0	0.0	0.1	0.0	0.1	0.4	0.0	0.0	0.8
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	1.5	1.9
Dory	2.8	1.3	6.0	1.1	1.0	0.4	1.0	1.3	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.1
Eel	0.2	0.5	0.9	2.2	3.1	2.1	1.4	1.7	2.0	1.2	0.6	0.4	0.4	0.2	1.0	0.6
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	74.6	90.7
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	9.7
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	75.4
Gurnard	20.5	19.0	19.3	19.3	14	13.5	10.4	9.1	7.1	9.9	7.8	5.3	9.7	6.8	6.1	5.0
Latchet	13.9	10.0	6.5	12.4	11.9	6.1	3.3	1.9	1.1	2.3	1.5	0.8	0.8	0.6	0.6	1.0
Leatherjacket	12.2	14	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	8.1
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
Mackerel, blue	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
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	2.8
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	0.4
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	47.9
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	12.9
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
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	5.6
Other	106.8	92.1	77.6	60.0	25.2	17.6	18.8	19.9	19.5	11.0	10.1	11.0	33.4	28.7	30.8	49.6
Pike, long-finned	0.1	0.0	0.1	0.3	0.2	0.3	3.1	3.9	9.5	10.0	6.6	12.2	10.7	14.0	6.7	9.0
Pike, short-finned	10.4	9.5	11.0	12.4	18.6	13.7	15.2	17.7	3.2	4.1	5.9	6.6	6.6	3.7	2.2	2.9
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
Stargazer	10.7	3.0	1.2	4.3	1.5	0.2	0.0	0.3	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Trevally, silver	15.0	12.2	2.5	5.9	15.5	5.9	4.5	7.8	8.0	3.2	1.6	4.6	5.5	3.4	3.7	4.2
Trevally, unspec.	5.6	1.4	9.5	2.4	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
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	18.4	22.4
Trumpeter, striped	74.5	58.2	52.7	56.5	72.4	58.2	79.4	78.1	98.8	95.0	45.5	39.9	36.5	36.9	23.9	17.1
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
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	18.9	19.0
Warehou, spotted	0.7	0.4	4.2	8.8	3.4	14.6	15.6	4.8	0.0	0.0	0.0	0.0	0.2	0.1	0.8	0.1
Whiting	124.2	152.3	84.3	97.9	81.4	25.4	39.3	48.1	30.4	31.4	42.5	39.9	35.9	50.9	31.6	2.3
Wrasse	57.2	71.7	97.3	142.4	178	83.4	110.1	100.0	90.7	85.4	88.4	92.3	72.0	75.1	99.3	84.6
Total scalefish	**2450**	**2154**	**2135**	**2367**	**1933**	**1190**	**1203**	**1454**	**1368**	**1166**	**1047**	**1183**	**1023**	**772**	**954**	**791**
Cephalopod																
Calamary	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	40.5
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	0.1	0.0
Octopus	32.2	35.2	47.4	58.2	55.3	76.9	40.8	43.4	85.5	61.5	62.0	63.1	67.7	71.1	81.3	98.1
Squid, arrow	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
Total cephalopod	**76**	**51**	**60**	**77**	**77**	**116**	**68**	**83**	**260**	**627**	**178**	**171**	**181**	**161**	**198**	**140**

Corresponding to the reduction in inshore trawl activity in the early 1990s, jackass morwong landings declined from over 100 tonnes p.a. to between 10-20 tonnes in more recent years (Fig. 2.2). The most recent catch was the lowest on record and thus below reference levels, though as Tasmanian catches represent a very minor component of the fishery for the species relative to the Commonwealth sector, little can be inferred from recent trends. The most recent Commonwealth assessment indicates that the stock is relatively depleted with the spawning biomass reported as being close to the limit reference point of 20% unfished spawning biomass.

Prior to the mid 1990s, bastard trumpeter catches fluctuated between 35-65 tonnes p.a., but since then annual catches have declined steadily. The catch of 22 tonnes reported in 2005/06 represents a slight increase compared to the preceding year (Fig. 2.2). By contrast, striped trumpeter production grew during the 1990s to over 100 tonnes by 1999/00 before falling sharply to half this level in the following year. Catches have continued to fall each year with just 17 tonnes of striped trumpeter reported in 2005/06, the lowest on record (Fig. 2.2). The main reason for catch declines in both trumpeter species may lie in reduced abundances, exacerbated by a prolonged period of poor recruitment, while market demand has remained high for striped trumpeter.

Annual production of blue warehou fluctuated widely, between 100-300 tonnes, up until 1999/2000 but has averaged less than 40 tonnes p.a. since (Fig. 2.2). The 2005/06 catch of just 19 tonnes was similar to that taken in 2004/05 and was, for the fifth year running, well below the range of reference catch levels. The major fishery for blue warehou occurs in Commonwealth waters (trawl) and recent assessments have indicated that the stocks are depleted through overfishing coupled with poor recruitment. However, there are indications of some recovery in the western stock while the eastern stock remains depleted.

Whiting catches experienced a marked decline during the early 1990s, largely in response to reduced inshore trawl activity (Lyle and Jordan 1999). Since the mid-1990s annual landings have stabilised between 30-55 tonnes, but they have dropped sharply to just 2 tonnes in 2005/06, well below reference levels (Fig. 2.2). Market demand and fishing practices (level of targeted fishing by Danish seine) are considered to be the main factors influencing catch levels.

The marked increase in wrasse landings that occurred in the early 1990s was due to the expansion of live fish markets. Subsequent to 1995/96 however, wrasse production generally stabilised at around 85-100 tonnes p.a. (Fig. 2.2). The 2005/06 wrasse catch of 85 tonnes was lower than in the previous year but within reference catch levels.

Cephalopod production at 140 tonnes was down 30% on 2004/05, mainly due to a large decrease in calamary catch (-74 tonnes). During the latter half of the 1990s the fishery for calamary expanded markedly, with catches rising from less than about 20 tonnes p.a. prior to 1995/96 to about 90 tonnes in 1998/99 (Fig. 2.2). Subsequent catches have averaged about 95 tonnes, with production peaking at 113 tonnes during 2004/05 (Fig. 2.2). While market demand has remained high for calamary, the recent drop in catches appears to be related both to the implementation of a three-month fishery closure off the east coast and a general reduction in availability. Total octopus catches grew steadily from around 30 to 75 tonnes p.a. by the mid 1990s, fell to around 40 tonnes in the late-1990s and have tended to rise gradually since then, to a peak of 98 tonnes in 2005/06 (Fig. 2.2). After a sharp increase in the catch of arrow squid to 480 tonnes

(1999/00), subsequent production in Tasmanian waters has fallen to about 2 tonnes p.a., a consequence of low arrow squid abundances in inshore waters (Fig. 2.2). During the same period, arrow squid catches in the western Bass Strait off Portland have remained variable, but have consistently exceeded 1000 tonnes p.a. (Caton and McLoughlin 2004).

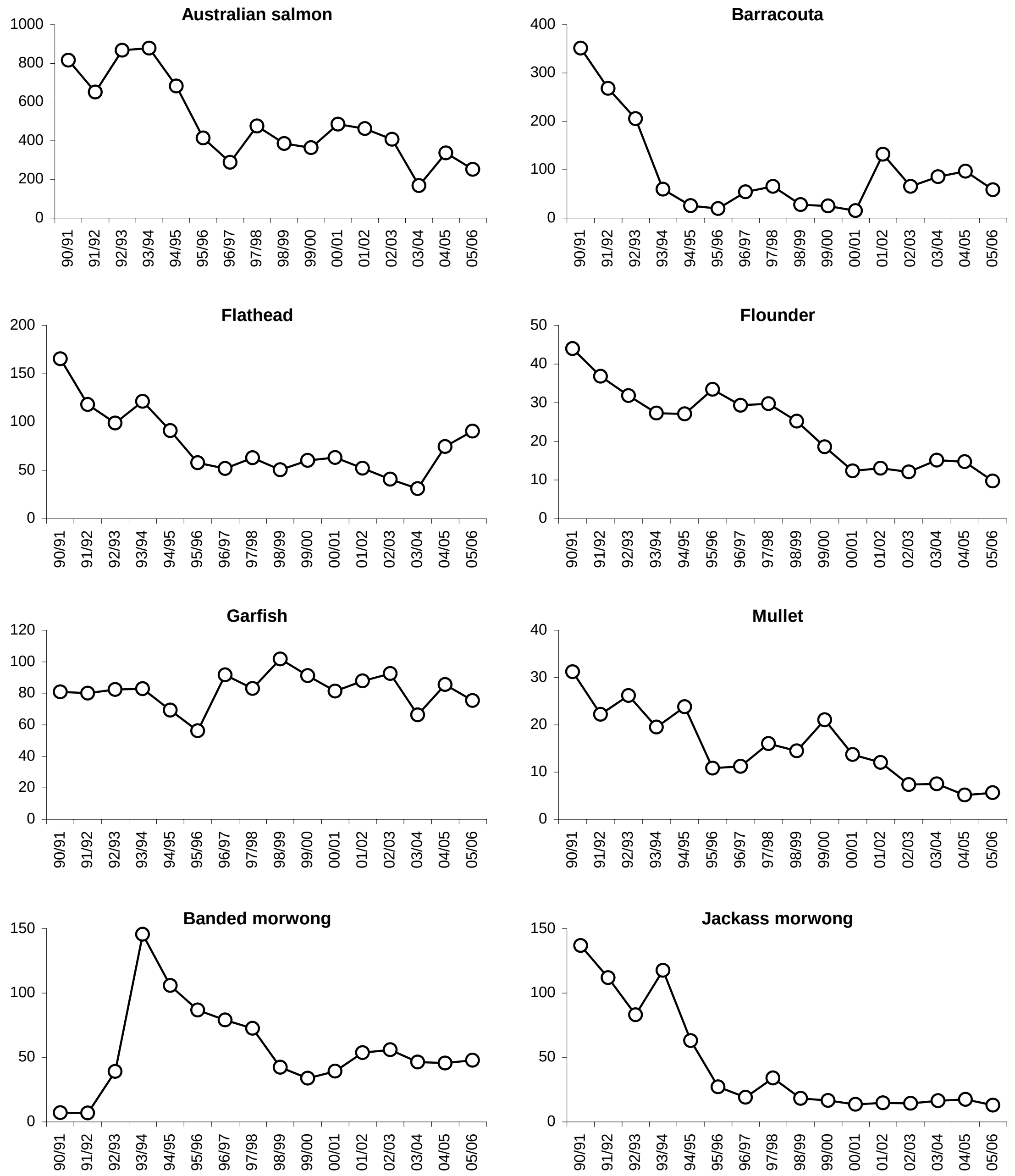

Fig. 2.2. Annual catches for key scalefish species 1990/91 to 2005/06.

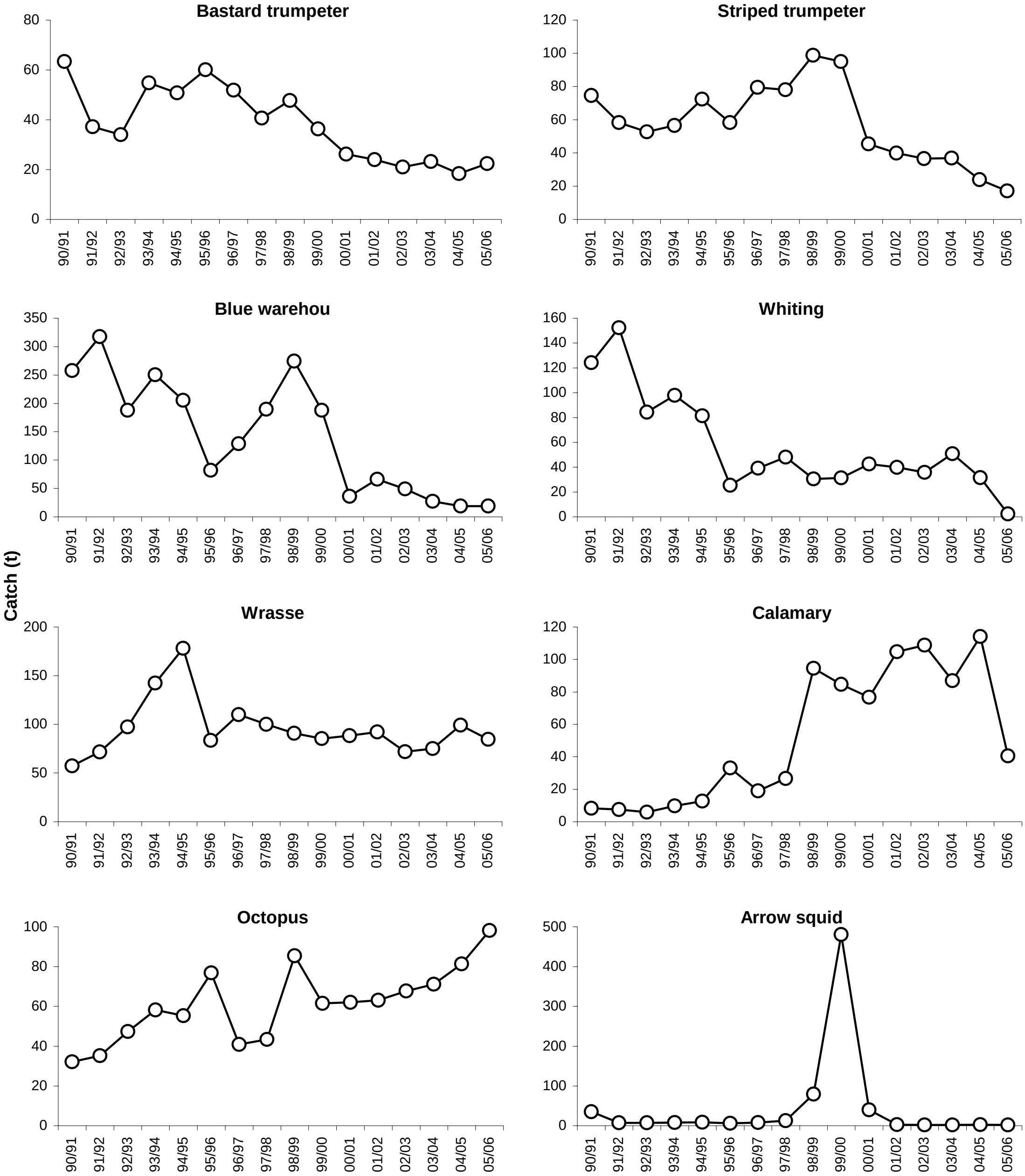

Fig. 2.2. Continued.

2.4 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 2.3. 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. 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 (purse seine and graball), increased or remained stable initially but has then undergone recent declines (beach seine, dipnet, dropline. small mesh nets and fish trap), remained relatively stable (spear and handline) or increased over time (squid jig) (Table 2.3 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 2005/06 were generally similar to or lower than that in 2004/05 for most gear types, except for dip nets and fish traps which increased. By comparison with reference levels, effort was either lower (beach seine, purse seine, graball, small mesh, dropline and spear) or within the range (fish trap, dipnet and handline) from the reference period (Table 2.3). Squid jig effort continued to be significantly higher than during the reference period despite a substantial drop compared to previous years. The sharp decline was a consequence of the three month fishery closure off the east coast during the peak fishing period and a general lack of availability in 2005/06.

Considering effort by gear type alone, however, 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, beach seines are used primarily to target Australian salmon or garfish. 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 (Fig. 2.3). The decline in purse seine effort (Table 2.3) was driven largely by falls in effort directed at calamary, whereas there has been only minor variation in purse seine effort for garfish in recent years (not shown).

Lyle (1998) noted that there are effectively three main sub-fisheries within the graball fishery, targeting blue warehou, banded morwong or flounder, with a variety of other species commonly taken as by-product of these sub-fisheries. By analysing graball effort based on the occurrence of these species in the catches it was evident that there was an initial increase in effort for blue warehou, peaking in 1997/98 (gear units) and 1998/99 (days fished), followed by a rapid decline especially between 1999/00 and 2000/01. There was a decline in effort directed at banded morwong up until the late 1990s that was followed by a slight expansion between 2000/01 and 2002/03 and then general stability at a lower level in recent years. By comparison, effort directed at flounder has decreased steadily of over time and is now at a low level (Fig. 2.3).

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

A significant expansion in jig effort (particularly evident in days fished) commenced in 1998/99 and was initially directed at calamary, but in 1999/00 there was also a dramatic increase in effort targeted at arrow squid (graph not shown). Effort for calamary continued to rise up until 2004/05, but fell sharply in 2005/06 with the 3-month part-fishery closure. In contrast, effort directed at arrow squid fell sharply after the 1999/00 peak and has remained very low especially during the last four years.

The remaining methods are used primarily to target single species and as such effort trends tend to reflect the dynamics of the fishery for the target species, *i.e.* dipnets for garfish, dropline for striped trumpeter, spears for flounder and fish traps for wrasse. Species-based effort trends are also considered in more detail in Chapters 3-6.

In terms of the effort-based performance criterion, only squid jig effort exceeded the effort trigger, reflecting the development of the calamary fishery that occurred largely after the reference period (see Table 2.3). 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 recent management plan review has attempted to address this issue through several strategies including making C-class licences non-transferable.

Table 2.3. Total annual catch, effort and number of vessels by fishing methods - 1995/96-2005/06
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
Beach seine	95/96	469.2	1083	559	54
	96/97	356.3	1352	689	50
	97/98	520.9	1203	582	44
	98/99	440.4	864	397	41
	99/00	422.7	844	428	33
	00/01	528.1	783	372	31
	01/02	570.9	1053	494	30
	02/03	490.7	1061	511	35
	03/04	238.1	1262	458	31
	04/05	397.0	974	368	27
	05/06	288.5	577	267	25
Purse seine	95/96	35.2	417	185	11
	96/97	30.4	336	153	10
	97/98	41.8	319	154	7
	98/99	76.9	246	150	9
	99/00	33.7	244	123	10
	00/01	*	224	104	4
	01/02	*	216	91	5
	02/03	*	139	76	4
	03/04	*	68	45	3
	04/05	*	130	70	5
	05/06	*	98	38	3
Graball net	95/96	348.0	222350	5440	260
	96/97	378.7	230803	5182	232
	97/98	446.3	230219	5249	216
	98/99	493.3	165759	4689	208
	99/00	359.7	150849	4169	204
	00/01	173.4	86638	3187	186
	01/02	196.0	70735	3303	180
	02/03	231.0	85317	3394	168
	03/04	189.8	68959	2904	160
	04/05	153.8	52986	2473	137
	05/06	160.0	48771	2279	122
Small mesh net	95/96	38.7	10995	286	20
	96/97	27.0	7941	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	8135	256	14
	01/02	24.7	9808	259	11
	02/03	22.9	10216	284	11
	03/04	23.0	7236	228	11
	04/05	15.2	5910	219	13
	05/06	21.3	5748	183	11
Dip net	95/96	*	320	83	5
	96/97	24.2	1518	364	11
	97/98	33.4	1707	409	22
	98/99	42.4	2690	557	29
	99/00	29.3	2262	500	35
	00/01	22.8	1422	371	27
	01/02	23.9	1491	372	26
	02/03	18.5	1238	335	19
	03/04	15.9	1036	289	18
	04/05	14.2	1010	232	13
	05/06	14.4	1343	286	16

Table 2.3. Continued

Gear	Year	Catch(t)	Effort#	Days fished	Vessels
Fish trap	95/96	41.8	8262	1401	67
	96/97	57.2	10707	1796	66
	97/98	49.9	9864	1875	71
	98/99	53.7	10624	1559	56
	99/00	56.1	10909	1637	62
	00/01	54.3	9338	1548	68
	01/02	49.0	6063	1278	62
	02/03	38.2	6158	1246	58
	03/04	48.0	6307	1414	58
	04/05	46.6	7376	1219	54
	05/06	39.7	10790	1300	53
Dropline	95/96	19.9	423	158	31
	96/97	30.0	433	203	27
	97/98	24.7	537	222	42
	98/99	31.8	663	309	38
	99/00	30.8	385	291	48
	00/01	15.8	380	248	36
	01/02	12.8	218	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	8.1	163	176	32
Handline	95/96	74.3	16801	1612	147
	96/97	94.3	21460	1893	135
	97/98	97.5	21038	1702	145
	98/99	88.3	17638	1280	129
	99/00	87.8	16602	1438	133
	00/01	75.0	13811	1552	130
	01/02	89.7	15489	1606	138
	02/03	72.4	14974	1547	124
	03/04	76.3	15413	1404	127
	04/05	101.6	20442	1808	124
	05/06	79.9	20284	1822	112
Squid jig	95/96	10.1	5386	124	22
	96/97	5.7	640	77	14
	97/98	15.2	4381	211	18
	98/99	89.8	10200	611	53
	99/00	161.5	42198	1001	64
	00/01	65.7	12852	775	47
	01/02	82.8	11759	880	63
	02/03	91.4	18978	1208	65
	03/04	69.5	15561	1209	72
	04/05	101.2	21321	1362	76
	05/06	29.2	9072	669	50
Spear	95/96	14.0	1382	366	21
	96/97	19.3	1843	463	28
	97/98	16.8	1977	483	41
	98/99	19.8	1804	452	41
	99/00	19.3	2229	475	25
	00/01	14.4	1586	355	22
	01/02	13.1	1296	279	19
	02/03	11.6	1378	247	22
	03/04	10.7	1432	288	22
	04/05	13.5	1569	353	23
	05/06	6.7	908	247	21

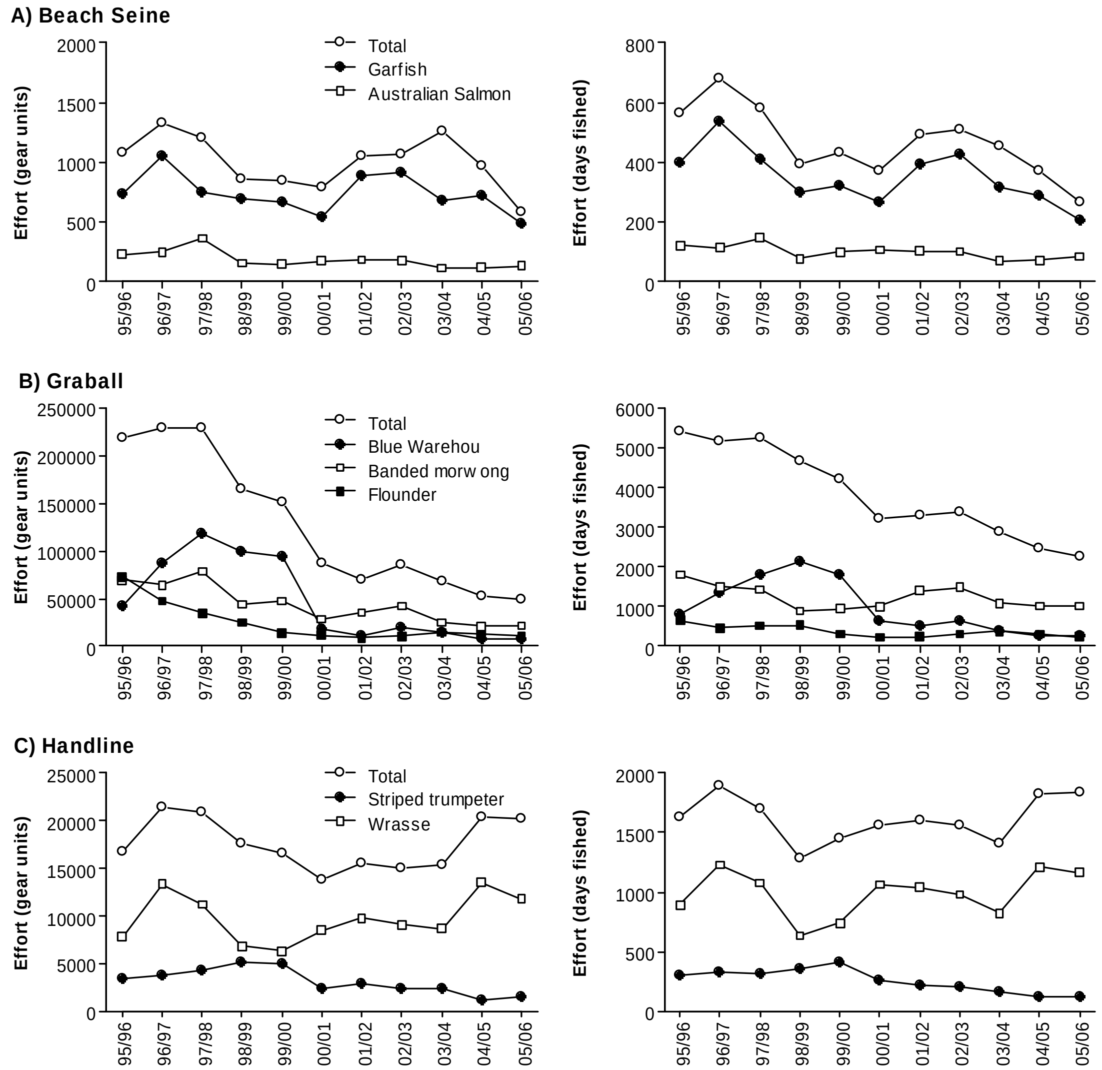

Fig 2.3. Annual effort by selected methods for key species, expressed as gear units (refer Table 2.1) and days fished.

2.5 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 3-6.

2.6 Recreational fishery

2.6.1 Catch and effort

Catch and effort information are not routinely available for the recreational fishery. A survey of the recreational fishery conducted between May 2000 and April 2001 provides the only comprehensive snapshot of the Tasmanian recreational fishery (Henry and Lyle 2003, Lyle 2005). There are plans to repeat a state-wide survey in the near future.

The 2000/01 survey demonstrated that the recreational catch represented a significant component of the total harvest for many species, either as a proportion of the total harvest or in absolute quantities taken. For instance, recreational catches exceeded commercial catches for flathead, barracouta, jackass morwong, bastard trumpeter, cod, flounder and silver trevally in 2000/01 (Lyle 2005). By contrast, the commercial sector dominated the catches of Australian salmon, southern calamary, arrow squid, wrasse, garfish, whiting and banded morwong. The striped trumpeter catch was shared more or less equally between the two sectors.

In the absence of more recent data few inferences can be made in relation to the relative impacts of recreational catches on the finfish stocks. However, there is no reason to believe that the recreational catch has reduced in importance for those species that are popular recreational targets.

2.6.2 Recreational net licences

Since 1995, the use of recreational nets in Tasmania has been subject to licensing, with fishers able to licence up to two graball nets prior to 2003/04, plus one mullet net and a beach seine. From November 2002 the number of graball nets was reduced to one per person.

Following the introduction of recreational net licences in 1995 the number of net licences issued rose rapidly from around 8900 to a peak of over 11000 in 1999/00, stabilising at around 8-9000 in recent years (Table 2.5). However, as indicated by the number of Graball Net 1 licences issued, the actual number of gillnet licence-holders varied only slightly since the late 1990s with the exception of the most recent year when licence numbers increased by almost 9% to over 8000. It is significant that night netting was banned for recreational fishers (with the exception of Macquarie Harbour) in late 2004. Night netting was a common and popular practice amongst recreational fishers (Lyle 2000) but its ban would appear to have had no discernable impact on licence numbers.

Table 2.5. Number of recreational gillnet licences issued by licensing year since 1995/96

na not applicable

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

Although not a direct index of recreational net fishing effort (not all licence holders fish each year and in any case the level of individual fishing effort is highly variable), licence numbers suggest that netting effort may have increased in the last year. With the exception of surveys conducted between 1996-98 (Lyle 2000) and the national survey in 2000/01 (Lyle 2005) there have been no recent assessments of recreational net catch or effort in Tasmania.

2.7 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, both in terms of the limited time series available and the level of detail provided. In addition, 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. There continues to be an urgent 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 and management workshops have identified the need to improve the quality of catch reporting, including provision for catch verification. The logbook design is currently under review and this may go some way to addressing these problems.

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, although the 2000/01 survey represents an important baseline about this sector. There is a need to develop an on-going monitoring program for the recreational fishery, since 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. The New Zealand fur seal is restricted to breeding around the Maatsuyker Island group and classified as a threatened species in Tasmania. Their numbers in Tasmania may be as low as only several thousand and they have not repopulated traditional areas such as the Bass Strait (http://www.parks.tas.gov.au/threatened/seal.html). In South Australia and

Western Australia, the New Zealand fur seal has a total population of approximately 58,000 (Goldsworthy *et al*. 2003). The Australian fur seal breeds mainly in Bass Strait (Fig. 2.4), with about 20 000 pups born each year, and the total population is estimated to be around 92 000 (National Seal Strategy Group 2005). Observations of seals at different sites often leads to the idea that numbers are growing fast, although the population recovery of Australian fur seals continues to be slow (DPIW on http://www.dpiw.tas.gov.au/inter.nsf/WebPages/SJON-52H2EJ?open). Seals migrate from Bass Strait to southern waters in the late summer, and this migration is often interpreted as a substantial increase in seal numbers around Tasmania. Seals can cause substantial mortality to some of the fish species assessed in this report. 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).

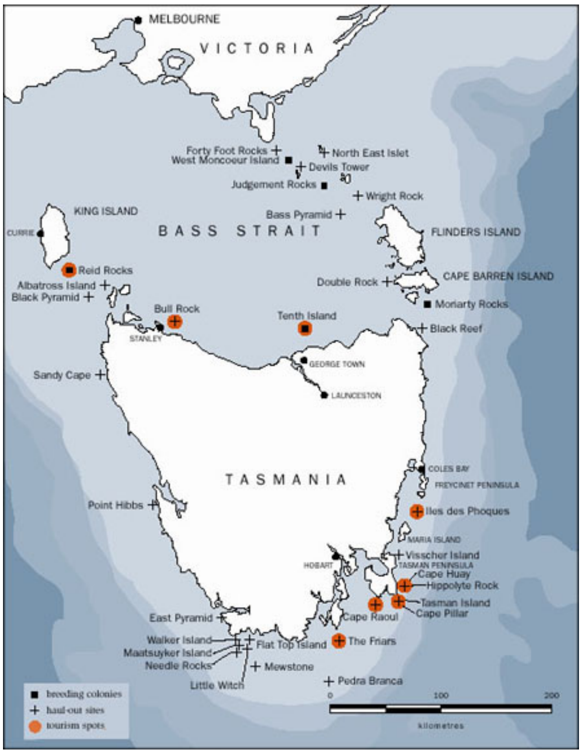

Fig. 2.4: Colonies and haul-out sites for Australian fur seals (from http://www.parks.tas.gov.au /wildlife/care/viewseals.html).

2.8 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; this review has begun.

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 the population on many southern Tasmanian reefs may be less pronounced than in New Zealand due to large changes in depth occur 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.* 2006b
Natural mortality	Low Estimated at $M = 0.05$	Murphy and Lyle 1999
Maximum age	Females: 93 years Males: 96 years	Ziegler *et al.* 2006b
Growth	Initially fast for the first 5-6 years (females) or 10-12 years (males) Males grow to larger sizes than females Growth accelerated between 1996 and 2004 Growth modelled by 2-phase von Bertalanffy function[1]:	Ziegler *et al.* 2006b

	$L\infty_1$	K_1	$t0_1$	σ_1	$L\infty_2$	K_2	$t0_2$	σ_2	t_{trans}
F95-97	372.2	0.58	0.23	15.23	431.1	0.08	-15.99	21.63	5
F01	353	1	0.33	12.95	431.1	0.08	-16.18	21.26	5
F02-04	358.3	0.97	0.33	14.66	431.1	0.08	-19.23	21.15	5
M95-97	387.2	0.58	0.23	16.11	507.6	0.22	-0.27	23.07	5
M01	368.5	0.84	0.32	18.77	507.6	0.19	-1.86	23.35	5
M02-04	387	0.85	0.32	16.1	507.6	0.21	-1.24	21.5	5

Parameter	Estimates	Source
Maturity	Early age and small size at onset of maturity Onset of maturity has accelerated and occurred in 2004 at smaller sizes and younger ages compared to 1996 Age at maturity modelled by logistic function:	Ziegler *et al.* 2006b

	B_0	B_1	*50% maturity*
F95-97	-19.8	0.62	4 years
F01	-23.65	0.76	2-3 years
F02-04	-18.9	0.64	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	The 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. Juveniles appear in shallow water on rocky reefs and tide-pools between September and December after a pelagic phase of around 4-6 months.	B. Bruce pers. comm. Wolf 1998
Recruitment	Age structure of banded morwong populations from some east coast sites provides some evidence of year class (recruitment) variability.	Ziegler *et al.* 2006b

[1] Parameters of the 2-phase von Bertalanffy growth function including the knife-edge age of transition between the two functions (t_{trans}), used in the stock assessment model

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.* 2006b). 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.

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 to 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). There are currently 29 fishing licences for banded morwong.

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.

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 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 shows 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 exploitation (Ziegler *et al.* 2006b), would indicate a resilience of the fish stocks to overfishing. The fact that such significant changes have occurred is a strong indication that stocks have experienced heavy fishing pressure and potentially unsustainable fishing mortality levels. This is all the more 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 regional or block level for the main fishing areas. Regions have been defined as north east coast including Flinders Island (blocks 3F2, 3F4, 3G1, 3G2, 3G3, 3G4, 3H3, 4G2, 4G4, 4H1, 4H2, 4H3 and 4H4), St Helens (5H1), Bicheno (5H3 and 6H1), Maria (6H3 and 6G4) and Tasman (7G2 and 7H1). Collectively, catches from these regions have averaged over 90% of the total banded morwong production each year since the mid-1990s (Fig. 3.2).

This report presents catch and effort analysis and catch rate standardisation, but unlike previous years, no biological information was collected during the fishing season and thus no biological indicators could be investigated. Results from last year can be found in the previous report (Ziegler *et al.* 2006a), together with a summary of the results from a stock assessment model for banded morwong, which was developed for a FRDC-funded project on developing assessments, performance indicators and monitoring strategies for small-scale, data poor temperate reef fish fisheries (FRDC-project 2002/057, Ziegler *et al.* 2006b). It is anticipated that this stock assessment model will be updated every two years, making use of biological information which is planned also every second year with the next sampling to occur in March/April 2007.

The data presented for this assessment derive from the commercial catch and effort logbook returns and have been evaluated against performance indicators specified in the scalefish management plan and detailed in Section 1.3.

3.6.1 Catch

State-wide reported catches have stabilised and the 2005/06 catch of 48 tonnes represented an increase of about 2 tonnes compared with the previous year (Fig. 3.1A). At the regional scale, catches have remained relatively stable compared to the previous year in most regions including Bicheno, where they had been declining sharply up to 2003/04 (Figs. 3.1B and Fig. 3.2).

Results of the National Survey indicated that the recreational catch of banded morwong in 2000/01 was low at around one tonne (Henry and Lyle 2003). This is consistent with estimated recreational gillnet catch levels from the latter part of the 1990s (Lyle 2000) and confirms that the recreational take relative to the commercial fishery is small.

Evaluation of 2005/06 catches against performance indicators

- The State-wide catches were below the 1994/95 to 1997/98 range and therefore exceeded the reference point.
- Regional catches in the Maria and Bicheno fishing regions were below the 1994/95 to 1997/98 range and therefore exceeded the reference point.

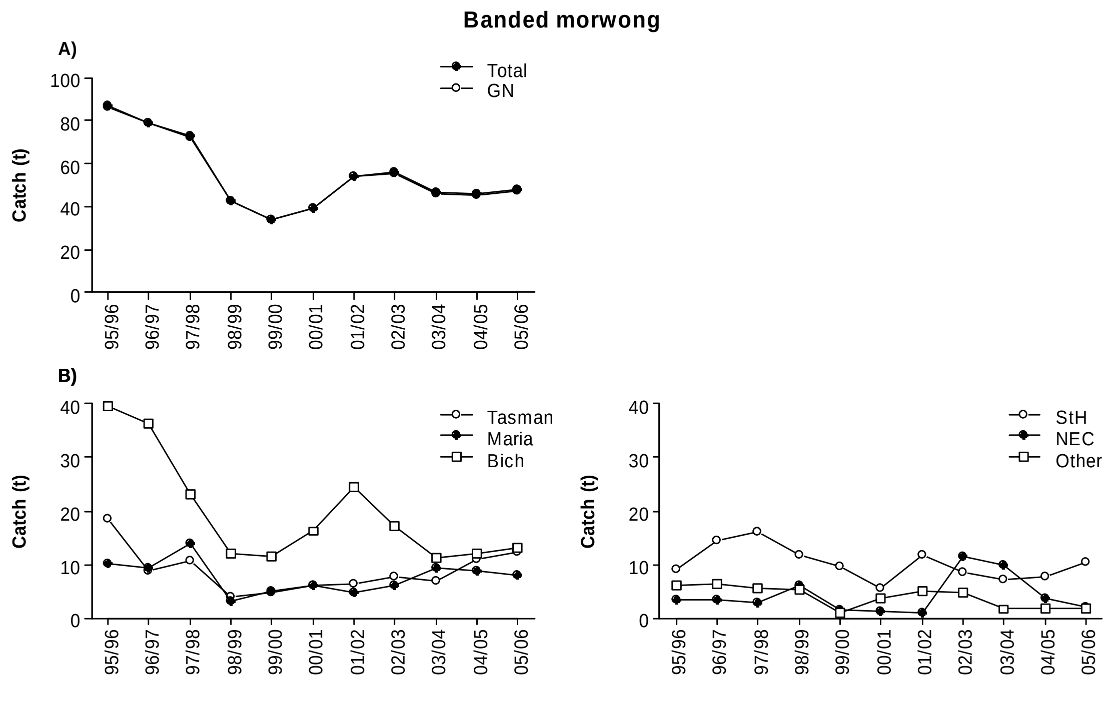

Fig 3.1. Banded morwong graball catches (tonnes) since 1995/96: A) state-wide catches; and B) catches in the Tasman, Maria and Bicheno (Bich) regions (left), and in the St. Helens (StH), north east coast (NEC) and remaining (Other) regions (right).

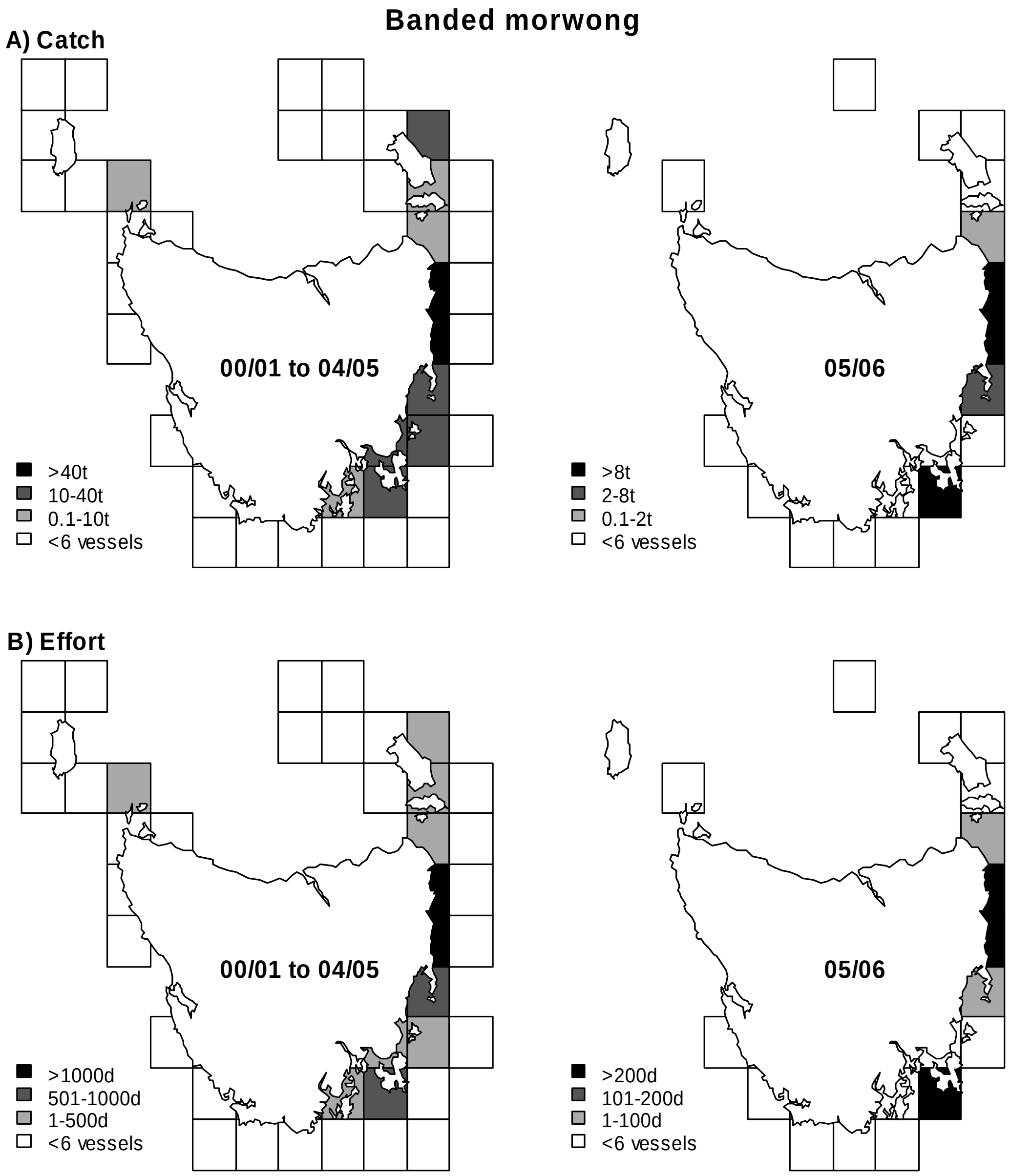

Fig 3.2. (A) Banded morwong catches (tonnes) and (B) effort (days) by fishing block pooled from 2000/01 to 2004/05 (left) and during 2005/06 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

3.6.2 Fishing effort

Total effort expressed as days fished or gear units (100m net hour) has stabilised in 2005/06 (Fig 3.3A). 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 are also numerous industry reports of increasing levels of seal interference over time that have 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.* 2006b).

Regionally, the most conspicuous trends in effort (days fished) have been relative stability of effort in the Bicheno, Maria and Tasman regions, and the continued increase of effort in the St Helens region to a level just below the trigger point. The effort in the north east coast region continued to decrease after a two-year peak between 2002/03 and 2003/04 (Figs. 3.3B and 3.2).

Evaluation of 2005/06 effort against performance indicators

- State-wide and regional graball effort was within reference levels at either regional or state-wide scales.

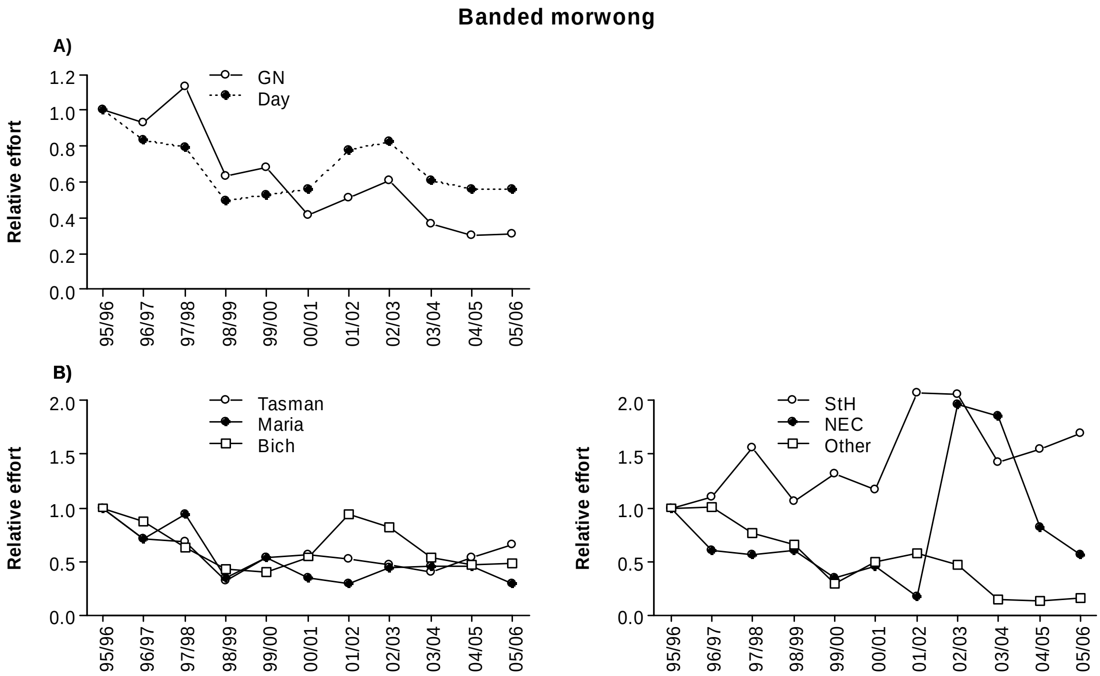

Fig 3.3. Banded morwong graball effort relative to 1995/96 levels: A) state-wide relative effort based on gear units (GN) and days fished (Day); and B) relative effort (days fished) in the Tasman, Maria and Bicheno (Bich) regions (left), and the St. Helens (StH), north east coast (NEC) and remaining (Other) regions (right).

3.6.3 Catch rates

Catch rates of banded morwong have again been standardised using generalized linear models (GLM) to reduce the impact of obscuring effects such as region, depth, season or skipper on the underlying trends (Kimura 1981, 1988). However, while standardisation is preferred to the geometric mean, there remains no guarantee that a 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, at both a state-wide scale and for four separate fishing regions along the east coast (Table 3.1). The data was selected with respect to skippers who had reported catches for at least two years and who had caught a median catch of at least one tonne of banded morwong across all years present in the fishery. These restrictions selected data that accounted for 83% of the total catch reported since 1995/96.

The GLMs were fitted to different combinations of various factors for which information were available, viz. skipper, vessel, fishing block, depth zone fished (<10 m, 10-20 m, 20-30 m, and >30 m), bimonthly period, and seal interference. A bimonthly period rather than month 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 included into the analysis, but it rarely turned out to be an influential factor. Reporting of seal interference (in the catch returns seal interference is reported as 'occurrence') appeared to be very inconsistent, and fishing trips with seal interference and very low catch are often not reported at all. In any case, a report of seal interference did not in any way allow quantification of the severity of the interaction in terms of lost catch or impact 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 1998). Adding the new data from 2005/06 resulted in at times alternative model selection with some differences in the standardised catch rates compared to the previous assessment.

Table 3.1: 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 R2 has been used for the Variation described.

Region		**Model**	**Variation described**
Whole East Coast	Ln cpue =	Constant + year + vessel + bimonth + seals + depth + block + skipper + vessel*bimonth	42.6%
Tasman	Ln cpue =	Constant + year + bimonth + vessel + depth + seals + block + vessel*bimonth	40.4%
Maria	Ln cpue =	Constant + year + vessel + bimonth + depth + seals + block + vessel*bimonth	55.0%
Bicheno	Ln cpue =	Constant + year + vessel + bimonth + depth + seals + block + skipper + vessel*depth	43.9%
St. Helens	Ln cpue =	Constant + year + vessel + seals + bimonth + depth + vessel*bimonth	47.2%

Overall standardised catch rates from the east coast fell steadily between 1995/96 and 1999/2000, accompanying the declines in catch and effort (Fig. 3.5). Since then overall catch rates have risen back to 1995/96 levels. Regionally, catch rates in the Tasman and Maria regions have shown similar trends with initial decreases up to 1999/2000 and subsequent increases to above 1995/96 levels. In contrast, catch rates in the Bicheno and St. Helens regions have fallen continuously since the mid 1990s. While they recovered in the Bicheno region to just above reference levels in 2005/06, catch rates are still below in the St. Helens region.

Evaluation of 2005/06 catch rates against performance indicators

- State-wide standardised catch rates were within reference levels.
- Standardised catch rates in the St. Helens region were less than 80% of the lowest value for the 1995-97 reference period and therefore exceeded the reference point.

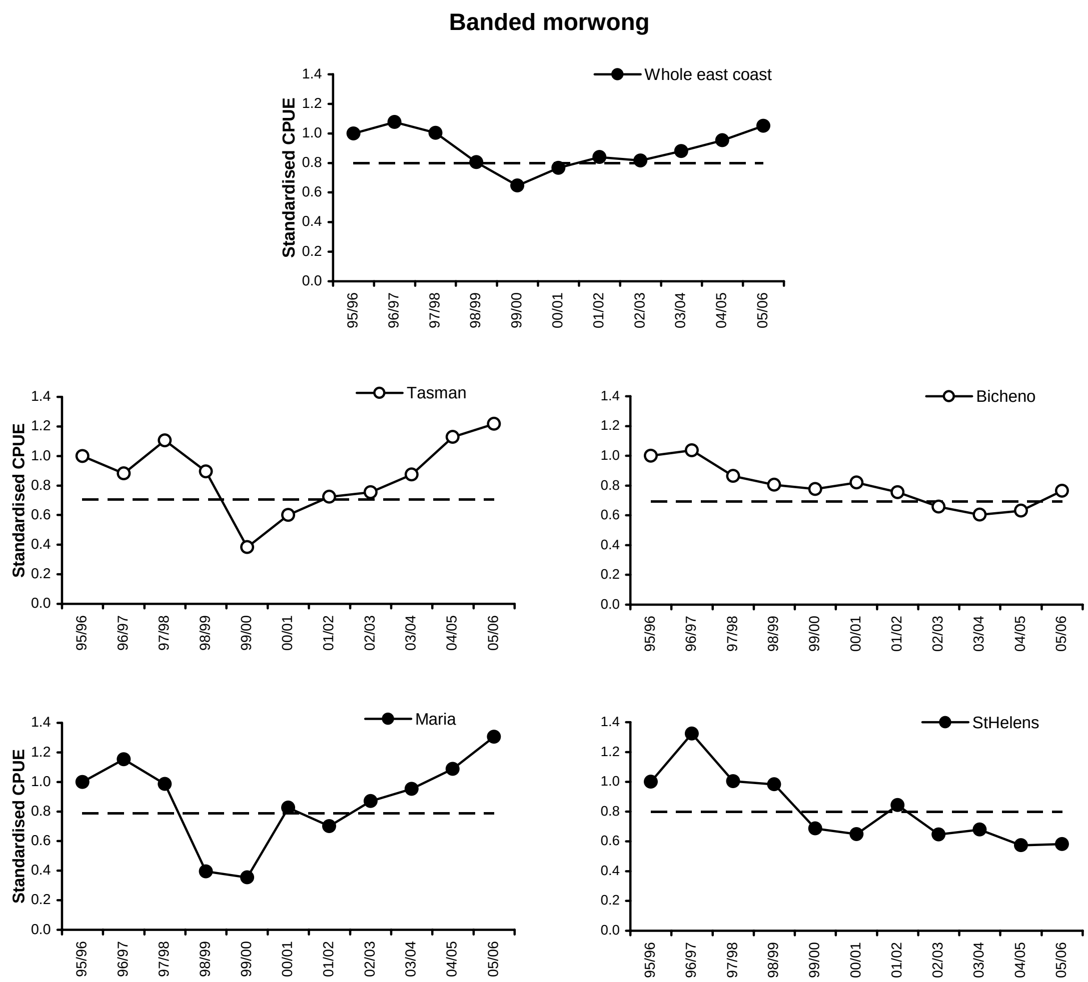

Fig 3.5. Banded morwong standardised graball catch per unit effort (CPUE by days fished) relative to 1995/96 levels from the whole east coast, and from the Tasman, Maria, Bicheno and St. Helens regions. Dotted lines mark the reference limits.

3.6.4 Size and age composition

No new size and age composition data were available for this assessment. Reference should be made to the 2005 assessment for details (Ziegler *et al.* 2006a).

3.7 Stock assessment model

The stock assessment model was not updated and reference should be made to the 2005 assessment for details (Ziegler *et al.* 2006a).

In the 2005 assessment for banded morwong, recruitment variability, together with the regional distribution of recruitment among five regions on east coast of Tasmania, and the depth distribution of biomass combined with movement rates between onshore and offshore populations were found to be significant sources of uncertainty.

Mature biomass in 2004 relative to that in 1990 ($MatB_{04/90}$) differed widely between 0.51 to 0.88 with high recruitment variability ($\sigma = 0.6$) depending on the regional biomass scenario. The estimated range was comparable assuming low recruitment variability $\sigma = 0.1$, but was with 0.46 to 0.84 slightly lower. At a regional level, the estimated range of $MatB_{04/90}$ was most pronounced in the Bicheno region, ranging from 0.33 to 0.88 with high recruitment variability. Differences in the range of estimates of $MatB_{04/90}$ were less extreme in the other stocks, but still ranged considerably from 0.42 to 0.72 in the St. Helens, Maria and Tasman regions, and from 0.49 to 0.81 in the Bruny region where only a small proportion of the biomass was attributed.

Harvest rates were similar for all recruitment variability scenarios and peaked around 1998. Again, the regional biomass distribution added uncertainty to that from onshore biomass and movement rates, and harvest rates in the last year (H_{04}) varied substantially from 0.01 to 0.15 in the St. Helens, Bicheno, Maria and Tasman regions, and from 0.01 to 0.05 in the Bruny region. Thus, even though harvest rates tended to be lower than in previous years, estimates of some scenarios were still likely to exceed reference points from spawning biomass-per-recruit analyses at which harvest rate reduces spawning biomass-per-recruit to 40% or 30% of the unfished level, $H_{40\%} = 0.07$ or $H_{30\%} = 0.11$ (Clark 1993, 2002, Mace and Sissenwine 1993, Mace 1994, Lyle et al. 2003).

This stock assessment model was further used as a so-called ‘operating model’ in a harvest strategy evaluation to assess the future impact of different catch levels on the fished stocks (see also Ziegler *et al.* 2006b). The results were mainly used in a comparative way, rather than as absolute predictions, and the interpretation of its performance obviously depends on the particular management objective(s) selected for the fishery. The objective used was only vaguely defined as to stabilise or rebuild the current catch rates and mature biomass of the fished stock.

In the scenarios examined, reported catch was assumed to be constant over the projected period of 20 years, representing a form of unadjusted allowable catch where the management control is not altered even when catch rates or effort change substantially. Largely based on the current and historical catch, four different catch scenarios and their impact on catch rates, the effort required to achieve the catch, and relative mature biomass were examined. A status quo scenario with a total annual catch of 36 tonnes was compared with two scenarios where 2/3 and 4/3 of the status quo were taken, i.e. 24 tonnes and 48 tonnes respectively. Finally, an extreme scenario of 80 tonnes annual catch was investigated. This latter catch scenario was comparable to historically high catches and had relevance given the intention by industry to explore overseas markets for banded morwong (and other live-fish).

The effects on catch rates, effort, and relative mature biomass gradually increased with increasing catch. With a constant catch scenario of 24 tonnes (equivalent to an average of 29 tonnes total mortality when seal and other mortality sources are included), median relative catch rates, effort and relative mature biomass remained stable over the whole projected period of 20 years. When 36 tonnes were taken annually (equivalent to an average of 44 tonnes total mortality), median catch rates and mature biomass slightly decreased over time, while the effort required to achieve the catch increased. With a constant catch scenario of 48 tonnes (equivalent to an average of 58 tonnes total mortality), median catch rates and mature biomass fell continuously over the 20 years projection to levels well below the current catch rate levels. Finally, as a result of a constant (intended) removal of 80 tonnes, catch rates and mature biomass dropped to very low levels within 10 years and did not recover during the remaining period. The scenario demonstrated that the stocks could not tolerate such high catches over a prolonged period.

Generally, trends were similar for both levels of low and high recruitment variability (σ = 0.1 and 0.6), although observed variation in catch rates, effort and relative mature biomass was slightly higher for the latter. Depending on the regional biomass distribution the catch removal impacted the regions differently, in particular the Bicheno region. In contrast, the trends in catch rates, effort and mature biomass from all combined regions were surprisingly similar. This clearly illustrated how an overall stock assessment can obscure regional trends.

3.8 Implications for Management

Catch and catch rate indicators suggest that, initially at least, the fishery impacted heavily on banded morwong populations up the east coast of Tasmania. However, there has been apparent stability in both measures in the last few years, an observation that is consistent with industry perceptions. Unfortunately, this stability in catch statistics is not reflected in stability of selected biological indicators and so it cannot be concluded that current levels of exploitation are sustainable (Ziegler *et al.* 2006a). There are several limitations related to the use of fishery dependent data with such a long-lived site attached species. These limitations include the masking effects on localised changes in abundance arising from the obscuring effects of the scale of reporting within the original fishing grounds and the expansion of the fishery into new grounds. The mobility of the fishing fleet combined with the site attached nature of banded morwong limit any insights that catch rate data might provide into stock status. Finally, there are serious issues surrounding the data quality of commercial catch returns, especially from early on in the fishery (Ziegler *et al*. 2006a).

The stock assessment model provided some useful insights into banded morwong populations and potential future development of the stocks under different catch scenarios despite concerns about model uncertainty and data quality (Ziegler *et al*. 2006a). Very different trajectories of mature biomass and harvest rates were predicted in the different scenarios tested. Many scenarios indicated high harvest rates over an extended period of the fishery. Only in recent years were these parameters predicted to have been reduced towards or below more sustainable levels within the range of the internationally recognised harvest reference points for mature biomass of $H_{40\%}$ or $H_{30\%}$. All scenarios tested by the model also predicted relatively low estimates of mature biomass in at least some regions. However, the predicted mature biomass levels in 2004 did not particularly decrease in absolute terms, *i.e.* they were higher than 30% or 40% of the initial mature biomass.

The harvest strategy evaluation indicated that maximum future catch levels from the east coast should on average be less than 36 tonnes (current east coast catch level) if the management objective is to maintain catch rates and mature biomass at current levels. Mature biomass was maintained or increased only when the annual catch was below 36 tonnes. However, east coast catches have exceeded this level with over 39 tonnes caught in 2004/05 and over 44 tonnes in 2005/06.

All estimates from the stock assessment model and the harvest strategy evaluation are likely to be best-case scenarios because of the potential for masking of serial depletion due the low spatial resolution of catch rates. If this and the high uncertainty of the results are taken into account, there is a considerable risk that the mature biomass overall, in many stocks or on many individual reefs is in a much worse and potentially critical state.

A public meeting was held in August 2006 to discuss the future management of the banded morwong fishery based on previous assessments. The meeting concluded to set a total allowable catch (TAC) with limit reference points in the core regions of the fishery. DPIW has since drafted a proposal for output control of the fishery outlining the implementation of quota management, including the boundaries of three core assessment areas.

3.9 Research Needs

The Scalefish Fishery Research Advisory Group has accorded stock assessment of banded morwong a high priority. Reliable but simple estimators of stock status together with management reference points that take into account the sedentary character and the specific life-history characteristics of the species are urgently needed as an integral component of the stock assessment.

Spawning season surveys will continue in 2007 and should provide further insights into the impact of fishing on the size, age and sex structure. However, given the level of spatial structuring, sampling needs to be focussed regionally, even at the scale of discrete reef areas. This degree of sampling intensity is in practice difficult to achieve and justify in a fishery of this size. As an alternative, commercial catch and effort data needs to be reported at a much finer scale, an issue that is being addressed as part of a current review of the logbook design.

Information about the character or relative abundance of populations in the deeper reef areas or potential mixing rates with the shallower areas is also missing. 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.

4 Southern calamary (*Sepioteuthis australis*)

4.1 Life-history and Stock Structure

Southern calamary 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 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.	Pecl *et al.* 2006 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 weight: 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. Minimum recorded age and size at maturity for females is approximately 117 days, 0.12 kg and 147 mm ML. Immature females 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 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 have been tracked moving on and off the spawning grounds for up to 3½ months). Frequency of batch deposition is unknown.	Pecl *et al* 2006
	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, although the exact operational sex-ratio has not been quantified. Female calamary 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'. Most observed matings are between females and large paired males, although genetic studies demonstrated that both small and large males sire similar proportions of offspring.	Jantzen and Havenhand 2002 van Camp *et al.* 2004 Moltschaniwskyj *et al.* 2003
	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 between 4-8 weeks, depending on water temperature, bringing the total life span close to annual.	Steer *et al.* 2002
Early life history	Newly hatched calamary 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

During the latter half of the 1990s there was a marked expansion in the fishery for calamary in Tasmania, with catches rising from less than about 20 tonnes p.a. prior to 1995/96 to about 90 tonnes in 1998/99, accompanied by a trebling of effort. Southern calamary are taken by a variety of methods including purse seine, beach seine, squid jig, spear and dipnet, with squid jigs the primary method in recent years. Although some night fishing occurs, fishing is generally conducted during the day over shallow areas of seagrass and macro-algae where squid aggregate to spawn.

4.3 Management Background

The dramatic rise in southern calamary catches prompted a ministerial warning in August 1999 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, as a precautionary measure to protect egg production, Great Oyster Bay was closed to fishing for southern calamary for 2 weeks twice between October and December 1999. 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. During 2003 and again in 2004 the commercial fishery in Great Oyster Bay and Mercury Passage was closed for a three month period (September to November, inclusive) to reduce catches from the spawning population. Recreational fishers were permitted to fish for calamary during this period but with a reduced daily bag limit of five calamary and there was some limited research fishing by commercial fishers, operating under permit. The movements of acoustically-tagged squid monitored throughout the closed areas and periods, suggests that squid were unlikely to have left the protection of the Great Oyster Bay closed area for the boundaries that were in place for 2003. However, tracking data indicate that some leakage out of the protected area probably occurred during the 2004 closed season where the boundaries were reduced (G. 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.

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 November 2001, a combined possession limit of 30 calamary and arrow squid was introduced for all holders of scalefish C licences (but excluding those also holding beach seine or purse seine licences) in an effort to limit further expansion of the fishery. Also in November 2001, a daily bag limit of 20 ‘squid’ (southern calamary and/or arrow squid) and a possession limit of 30 squid were introduced for recreational fishers. Recreational bag limits for squid were replaced in 2004 with a possession limit of 15 calamary (and 15 arrow squid).

Recent deliberations regarding the long-term management of calamary have included consideration of zoning the fishery into “developed” (east and south-east coasts) and “undeveloped” regions (rest of Tasmania) along with the introduction of a specific calamary licence for the developed region. Although arrangements have yet to be finalised, it is likely that they will be implemented within the next year.

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 spawning season closure in all waters between Wineglass Bay and the northern end of Marion Bay from mid-September to mid-December (commercial and recreational fishers), a combined possession limit of 30 calamary and arrow squid for all holders of scalefish C licences (excluding those also holding beach seine or purse seine licences), and general limits on recreational catch (possession limit of 15 fish).

4.5 Relative vulnerability to fishing

Vulnerability of calamary 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. However, if the population is allowed to spawn (during the fishing closures) prior to the main harvest, the population may be able to sustain high fishing mortality rates 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 calamary stocks. Preliminary modelling of catch and effort data for the major fishing areas (Great Oyster Bay and Mercury Passage) was investigated for the 2003 and 2004 assessments using surplus production modelling. 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

The extended fishery closures 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 and December focus (1998/99 - 2002/03) to being heavily concentrated into the single month of December (2003/04 - 2005/06).

Surveys of egg production have been conducted in Great Oyster Bay annually since 1999 and are reported here. An aim of this research is to investigate possible relationships between reproductive output, spawning stock size and subsequent recruitment.

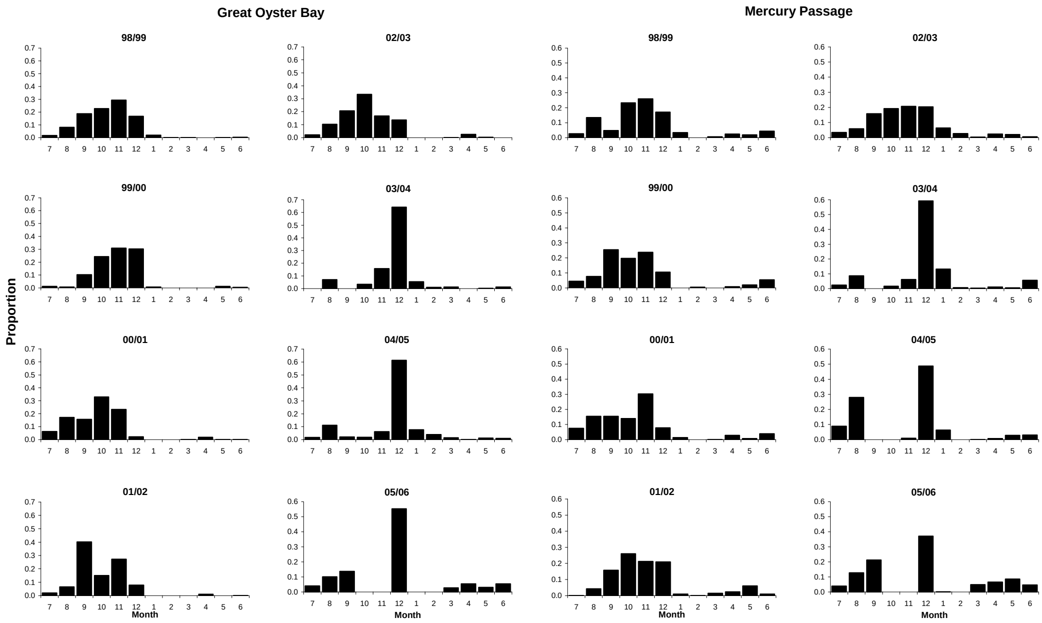

Fig. 4.1 Monthly catch distribution (as proportion of the total catch within the fishing year) for Great Oyster Bay (ES13 and ES14) and Mercury Passage (ES16).

4.7.1 Catch

Over the past eight years a significant fishery for southern calamary has developed in Tasmania, with catches expanding rapidly from less than about 30 tonnes p.a. prior to 1998/99 to over 100 tonnes (Fig. 4.2A). While calamary catches have been reported from all areas apart from the west coast, the fishery is concentrated off the central east and south east coasts (Fig. 4.3). The fishery developed initially in Great Oyster Bay in the mid-1990s and then expanded to the south to include Mercury Passage, Maria Island and Tasman Peninsula (Fig. 4.2B). Over the past couple of years moderate catches of calamary have also been taken from Flinders Island.

The expansion of the fishery was almost exclusively due to increased squid jig catches (Fig. 4.2A). The 2005/06 catch of 40 tonnes represented a 65% decline compared with 2004/05, with declines in production reported in all areas, not just those areas subject to the 3-month closure, *i.e.* Great Oyster Bay and Mercury Passage (Fig. 4.2B). Despite a similar closure in 2004/05, the substantially lower catch in 2005/06 appears to be primarily due to poorer catches immediately after the areas re-opened (6.7 tonnes compared to 30.7 tonnes in those two areas).

Expansion of the fishery in Great Oyster Bay (blocks 6H1, ES13 & ES14) and Mercury Passage (6H3, 6G4 & ES16) was primarily responsible for the initial growth of the fishery, though other regions have become increasingly important in recent years (Fig. 4.2B). In addition to reducing pressure on the main spawning grounds, a secondary objective of the fishery closures was to encourage industry to spread the effort into other regions. There is some evidence of this being achieved, with increased catches from Norfolk-Frederick Henry Bay (ES17, ES18, ES19), Tasman Peninsula (7G2) and a general increase in catches from the north coast and Flinders Island (OTHER in Fig. 4.2B). During 2005/06 catches were concentrated in the south east (including Great

Oyster Bay, Mercury Passage, Norfolk-Frederick Henry Bay and Tasman Peninsula) and in the Tamar region, limited activity was reported from the north-east coast.

The only available estimate of the recreational catch of calamary (18 tonnes in 2000/01) indicates that this sector has the potential to contribute significantly to the overall fishing pressure on the species.

Evaluation of 2005/06 catches against performance indicators

- State-wide catch of 40 tonnes still remained above reference catch levels, but represented a 65% reduction compared with the previous year and therefore also exceeded the rate of change reference point. *Extension of the closure to include a larger area of the east coast and changed timing may have contributed to the decline in production in 2005/06 but is unlikely to have been the major contributing factor.*

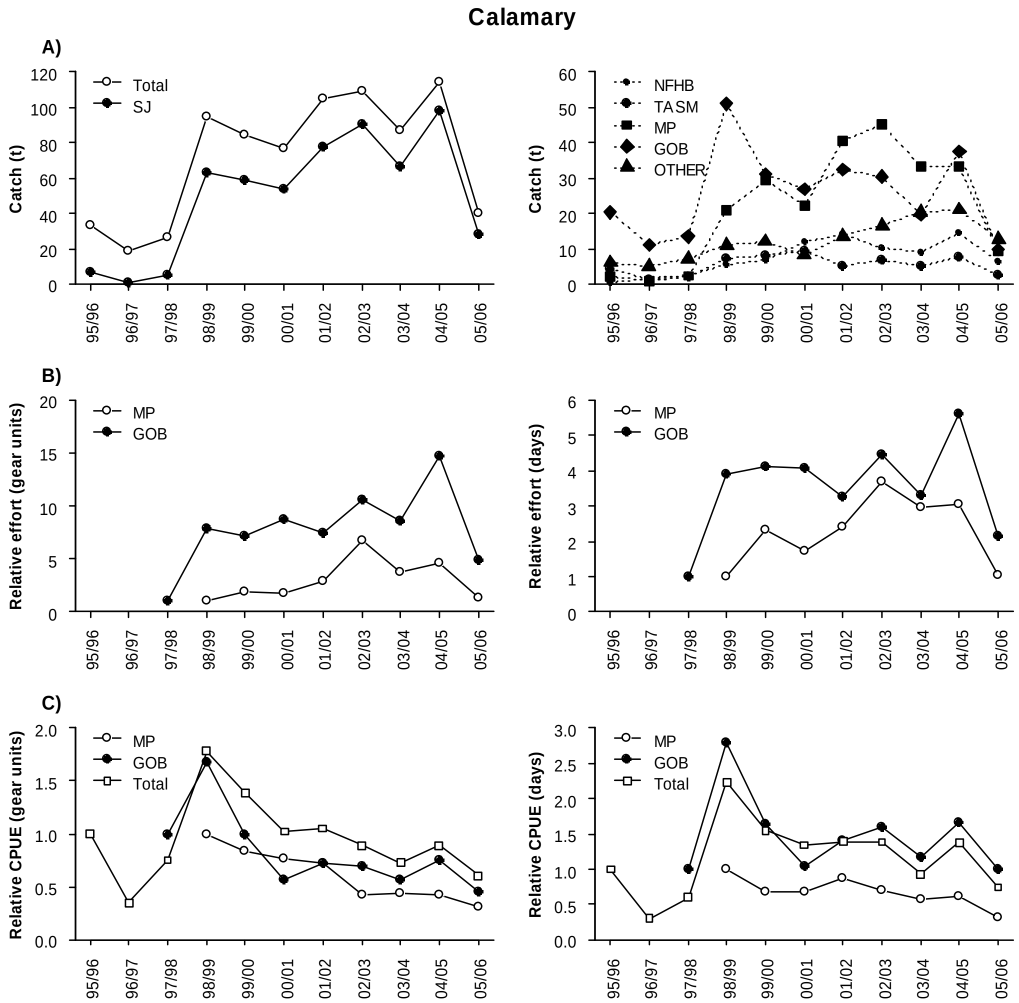

Fig. 4.2 A) Annual catch (tonnes) of calamary by method (left) and by region (right) since 1995/96; B) squid jig effort based on gear units (left) and days fished (right) relative to 1998/99 for MP and 1997/98 for GOB; and C) squid jig catch per unit effort (CPUE) based on weight per gear unit (left) 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 and PS is purse seine; NFHB is Norfolk-Frederick Henry Bay, TASM is Tasman, MP is Mercury Passage, GOB is Great Oyster Bay, and OTHER is all remaining areas. Only years with >5 operators are shown.

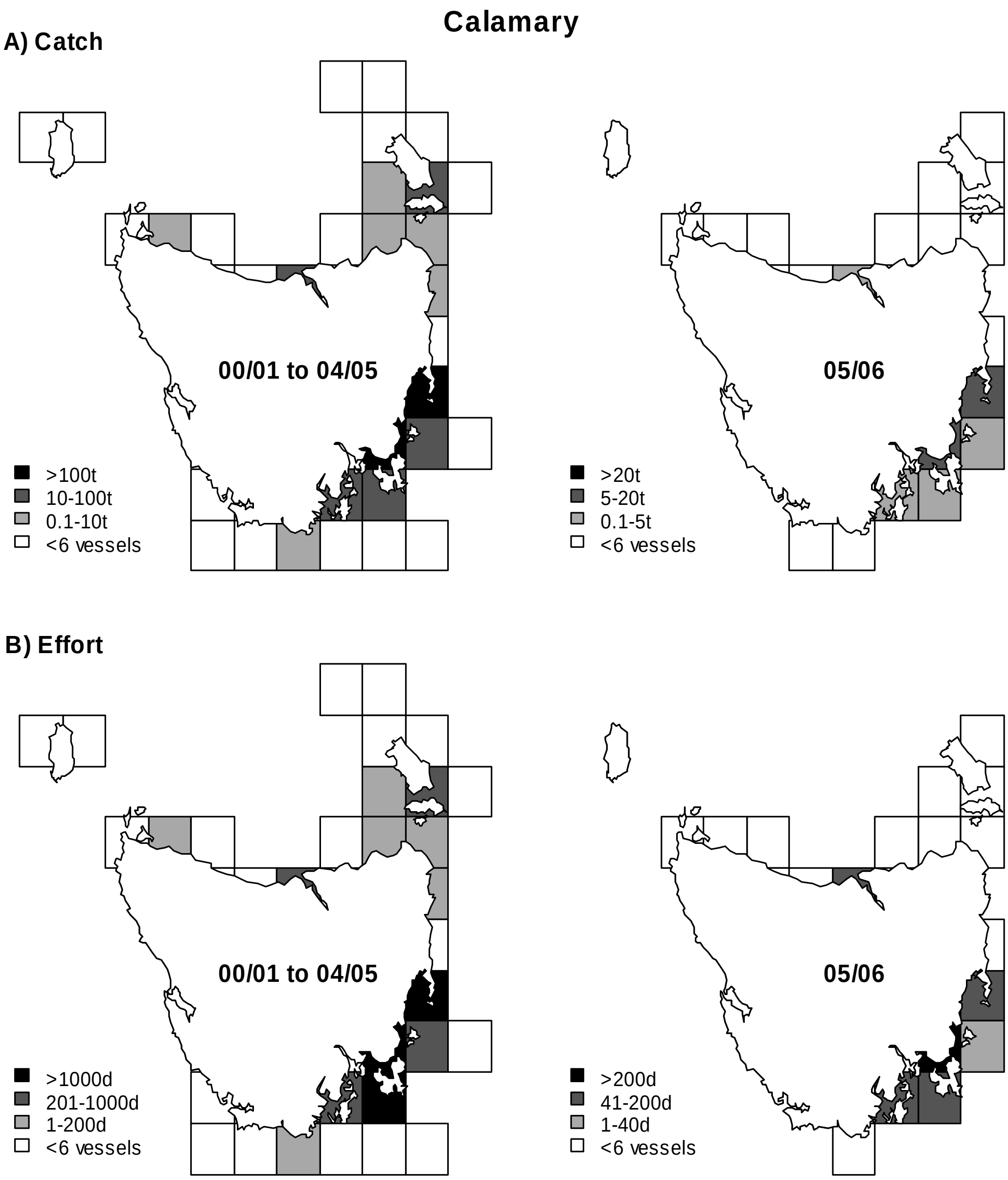

Fig 4.3. (A) Calamary catches (tonnes) and (B) effort (days) by fishing block pooled from 2000/01 to 2004/05 (left) and during 2005/06 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

4.7.2 Fishing effort

The regional distribution of the fishery is clearly evident in terms of effort in Fig. 4.3 and is, not surprisingly, consistent with the pattern observed for catches.

Jig effort in 2005/06 fell sharply in Great Oyster Bay and Mercury Passage compared to 2004/05, largely influenced by lower effort levels especially after the fishery re-opened compared with the previous year (Fig. 4.2B).

Evaluation of 2005/06 effort against performance indicators

- Although jig effort declined sharply in 2005/06, especially in the major fishing regions (Great Oyster Bay and Mercury Passage), effort remained slightly higher than reference levels and therefore exceeded the reference point.

4.7.3 Catch rates

State-wide, catch rates (gear and daily) for jigs declined after the initial expansion of the fishery in 1998/99, with declines in 2005/06 compared with 2004/05 in all regions (Fig. 4.2C).

In the context of catch and effort, these data imply that the lower overall fishing activity for calamary during 2005/06 was in response to generally poorer catch rates as well as the influence of the closure.

Evaluation of 2005/06 catch rate against performance indicator

- Catch rates in 2005/06 remained within reference levels, although this appears to have been due to lower availability.

4.7.4 Egg production surveys

Southern calamary egg surveys have been conducted annually in Great Oyster Bay since 1999, providing seven years of data.

Surveys are conducted at 5-6 sites on the eastern side of Great Oyster Bay, in Coles Bay and Hazards Bay, each site being characterised by a discrete bed of *Amphibolis* seagrass delimited by sand and/or macroalgae. The area of seagrass at each site was determined using differential GPS and a high-resolution depth sounder and ranged from 0.17 to 2.02 ha.

The density of the egg masses was assessed by divers using 20 m^2 belt-transects (10 m by 2 m), the most suitable size based on precision and logistics. The only exception was in 2001 when timed swims were used to estimate egg densities. At most sites 10-20 belt-transects were used and the seagrass searched for the presence of egg masses. Transects were laid haphazardly within the seagrass beds but did not overlap. The numbers and age (based on developmental stage) of eggs in each egg mass was determined and total egg production estimated as a function of the total number of strands in the egg masses, summed across the sites and times, and scaled for the total area of seagrass within the study area. The total number of eggs was calculated by multiplying the total number of strands in each area of seagrass by 5.5, which is the average number of eggs per strand.

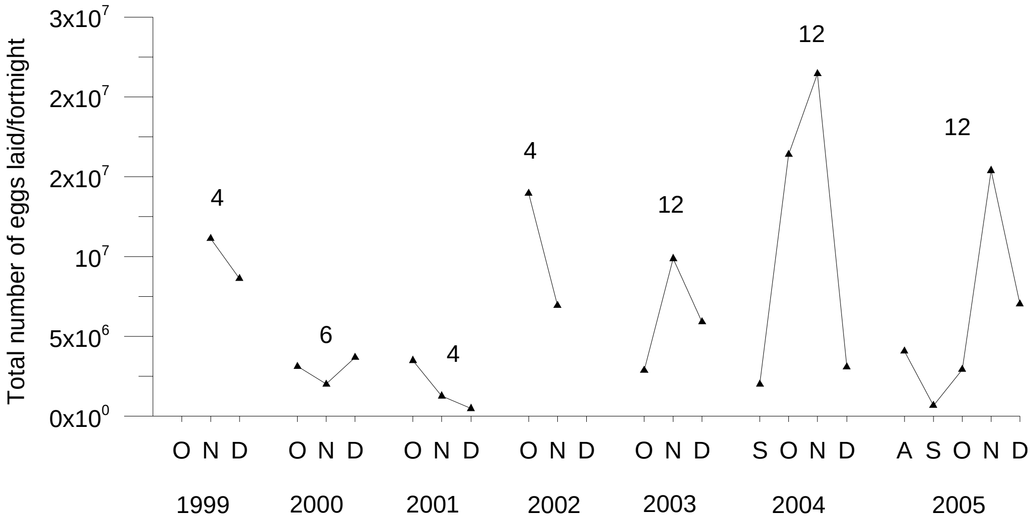

Fig. 4.4 Total estimated egg production over a fortnight period for *Amphibolis* seagrass beds surveyed in Great Oyster Bay, by month sampled. The number of weeks that the fishery was closed is indicated above each year of data.

Estimates of egg production appeared to vary at the time scales of both months and years. Highest egg production typically occurred in November, coinciding with fishing closures during some or all of this month each year since 1999 (Fig 4.4). In both 2000 and 2005 high egg production in December supports the extension of the fishing closure into December.

The range of egg number estimates varied substantially (Fig. 4.5). In 1999, 2002, 2004, and 2005 the total estimated egg production was greater than the average for the seven-year period. There was no evidence that variability in total estimated egg production was associated with the length of the fishing closure (R=0.51, n=7, P>0.05), thus longer fishing closures did not necessarily result in greater egg production.

Cumulative egg production in each year indicated that about 80% of total egg production had occurred by late November, except in 2000 and 2005 (Fig. 4.6), suggesting that fishing closures need to extend at least until this time to provide a high level of spawning protection.

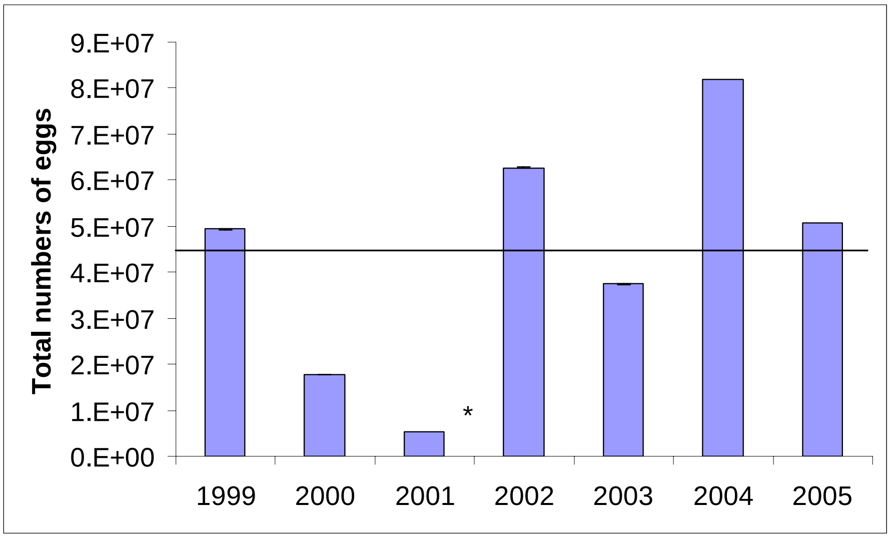

Fig. 4.5 Total estimated egg production for Great Oyster Bay survey sites. * data in this year was estimated from timed counts, not belt transects. The solid line is the mean value across the seven years (1999-2005). Error bars are SE, too small to be seen in most years.

From the surveys there was evidence that egg production may be useful as a fishery independent indicator of stock status, if total commercial catch taken is assumed to be an index of stock size. Total estimated egg production was positively correlated and explained 43% of the variation in total calamary landings and 55% of CPUE in the same year in Great Oyster Bay (Fig 4.7A). However, in both cases the relationship was not significant, which means that egg production estimates cannot be used to predict stock size in that year. There was a stronger negative, but also not significant relationship between egg production in one year and landings and CPUE in the following year (Fig. 4.7B). The difficulty in generating these relationships is that no fishery independent estimates of stock size are available. In addition, the fishery in each year has been greatly influenced by the management arrangements implemented at the time.

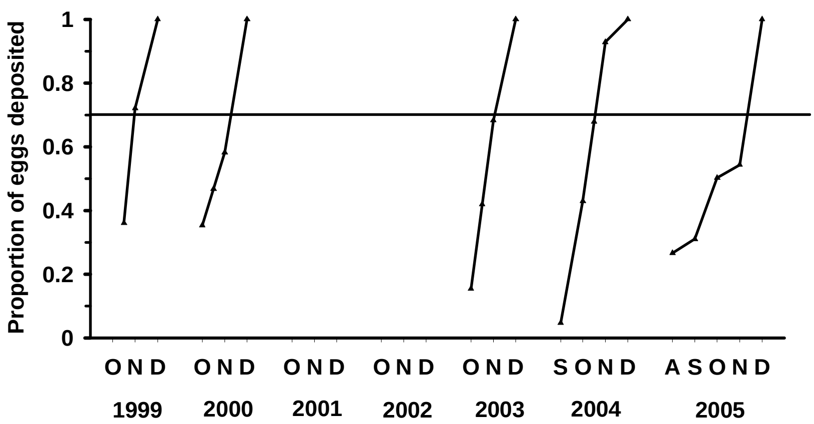

Fig. 4.6 Cumulative proportion of total estimated egg numbers produced by month. Horizontal line represents 70% of cumulated egg production.

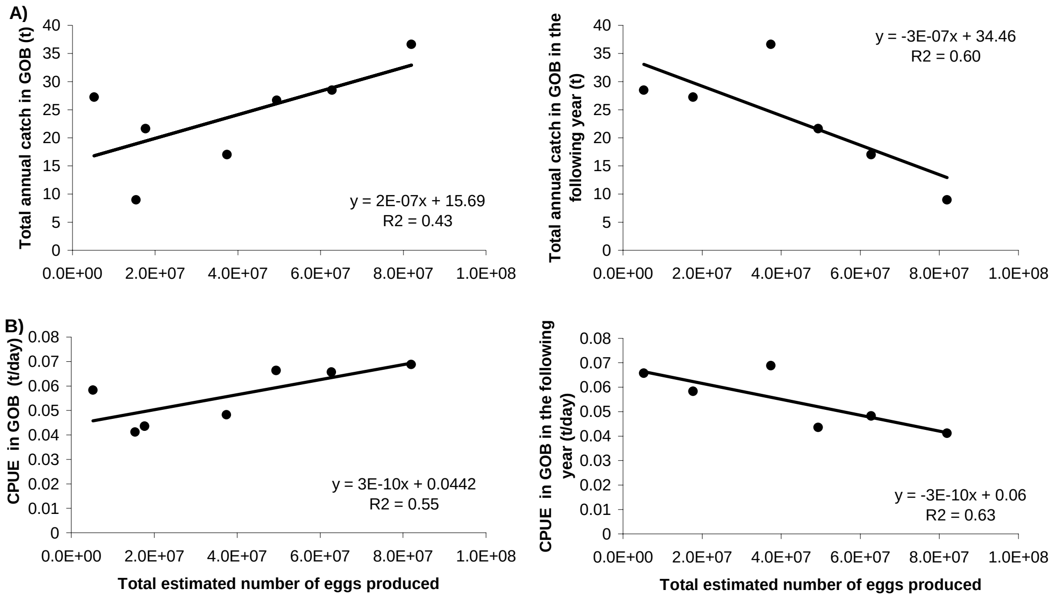

Fig. 4.7 Relationships between the total estimated number of eggs produced in a year and (A) the total annual catch and (B) the CPUE (geometric mean of catch per days) of southern calamary in the same year (left) and the following year (right).

4.8 Population linkages

A critical issue missing from the understanding of the southern calamary fishery and stock is the spatial and temporal links between different components of the Tasmanian population, and an assessment of the relative importance of different spawning areas in contributing recruits to the fished population.

Recent studies identifying trace elements in the otoliths of fish has shown great promise for using trace elements as ‘natural tags’ for determining movement from specific juvenile to adult habitats. Similar approaches applied to calamary have identified differences in the statolith trace elements of calamary hatchlings from different sites. Statoliths taken from hatchlings from six different water bodies along the east and south east (Great Oyster Bay, Mercury Passage, Tasman Peninsula, Fredrick Henry Bay, Storm Bay adjacent to Bruny Island and D’Entrecasteaux Channel) showed significant differences in levels of Iron, Strontium, Manganese and Barium. For example, hatchlings from Great Oyster Bay had very low levels of Barium, Strontium and Manganese but high levels of Iron, while those from the Channel had higher levels of Barium, Strontium and Manganese but low levels of Iron.

Preliminary analyses have shown that an average of 75% of hatchlings could be re-classified back to their correct site of origin based on their trace element profiles alone (Table 4.1). The relatively enclosed water masses of Great Oyster Bay and Fredrick Henry Bay had the highest correct classifications of 95% and 90% respectively as the elemental signatures from these areas were very distinct. In contrast, the trace element signatures of hatchlings from Mercury Passage and Tasman Peninsula regions seemed to overlap which lowered the overall classification success. This may be due to the exposed nature of these coastlines and the relative closeness to each other.

Table 4.1. The percentage of hatchlings from six regions along the east and south east coasts of Tasmania, that could be classified back to their correct location of origin based on trace element profiles within the statolith.

Region	% Hatchlings classified correctly
Great Oyster Bay	94
Mercury Passage	20
Tasman Peninsula	16
Fredrick Henry Bay	64
Outside Bruny Island	64
Channel	85

Adult calamary were also collected from Great Oyster Bay, Mercury Passage and Tasman Peninsula to investigate whether the trace element signals matched those found in hatchlings, which would imply that each location was essentially self-seeding, or whether there was a pattern of recruitment with one area supplying other areas. Most adult calamary from the three regions appeared to have hatched in Great Oyster Bay (61-80%), with a lower level of recruitment from Bruny Island and the Channel (Fig. 4.8). In each region, the origin of 17-28% of the adults could not be determined due to unclear elemental profiles. Some of these are almost certainly calamary that were spawned in Mercury Passage and the Tasman Peninsula, but because animals hatched in these regions had unclear elemental profiles it was impossible to determine how many of the unclassified adults originated from Mercury Passage or the Tasman Peninsula. Adults with undeterminable origin may also have originated at sites from which no hatchlings were examined, like Bicheno or deeper water off the east coast.

This research has shown that most adult calamary caught on the east and south-east coasts during the start of the 2005 season were spawned in Great Oyster Bay (Fig. 4.9). Great Oyster Bay appeared to have a high degree of self-recruitment and also supplied at least part of the east coast with the bulk of recruits. It is very important to note however, that we could not assess the importance of Mercury Passage as a spawning site as the trace element profiles of hatchlings from that region were unclear.

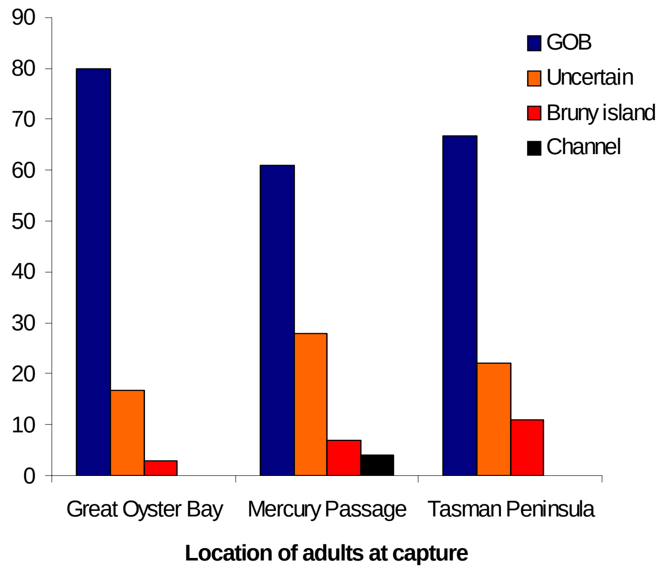

Fig. 4.8. The likely source spawning area (as proportion of the total sample) for adult southern calamary caught in Great Oyster Bay, Mercury Passage, and Tasman Peninsula during August 2005 based on the trace element profiles within the statoliths.

Additionally, research on fish populations has shown that in some cases the source areas of recruits can be highly variable on a year-to-year basis, so it is critical to recognise that the pattern of Great Oyster Bay supplying most of the recruits may only be valid in some years. Further work is needed to confirm the consistency of recruitment patterns on an annual basis.

Furthermore, recent acoustic tracking research on southern calamary has allowed determining the phase of the life cycle during which this apparent movement between regions along the coast may be occurring (Pecl et al. 2006). The acoustic tracking work demonstrated that once squid were within the shallower inshore areas from July to January, they stayed within each broad region of Great Oyster Bay or Mercury Passage. Although squid moved large distances within each region, they were resident in each region for up to four months. Therefore, any movement along the coast must be occurring during the first half to two-thirds of the life cycle. After hatching, squid probably move into deeper water, mix to some extent with squid hatched from different areas along the coast, and then move back into the shallower coastal areas before the onset of spawning.

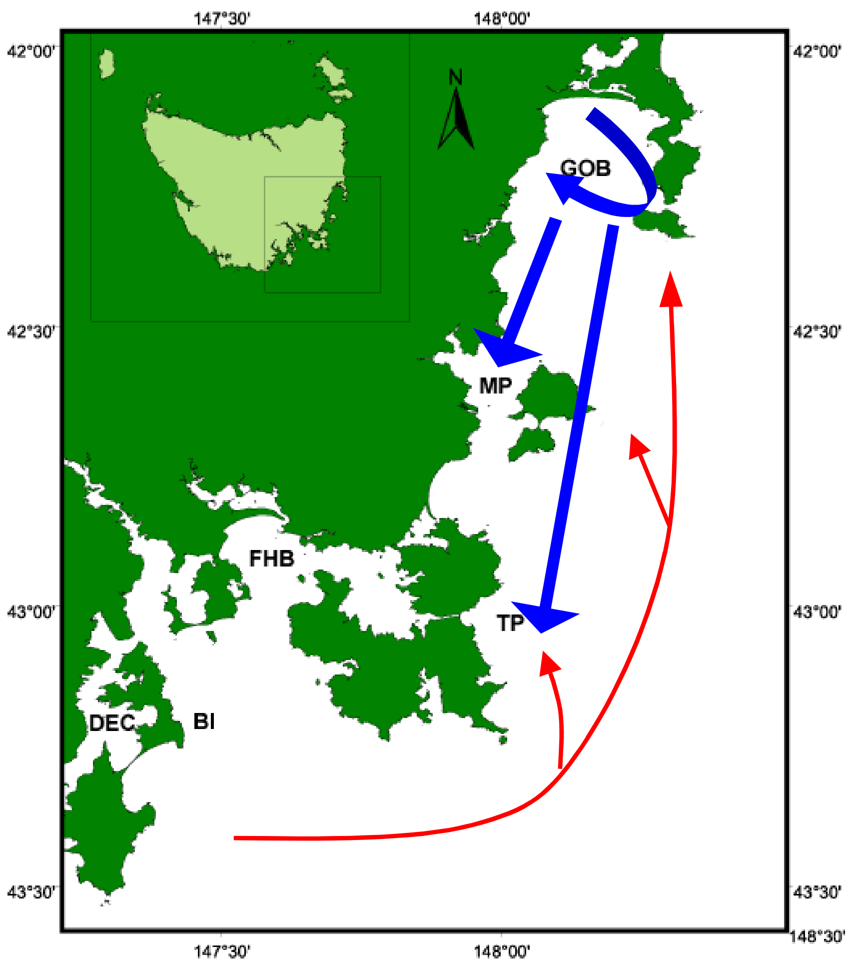

Fig. 4.9. Map showing the suggested population linkages of southern calamary for 2004/2005, and the relative importance of different spawning areas in contributing recruits to fished regions. Thick lines indicate the movement path of hatchlings from Great Oyster Bay, and the thin lines indicate a smaller number of hatchlings moving from south east regions up the east coast.

4.9 Management Implications

For calamary, the reference ranges of catch and effort defined in the management plan derive from a period well before the fishery developed. As such, comparisons between the fishery in an under-developed (pre-1998/99) and developed state will continually result in catch and effort indicators being triggered. In fact, it would be of greater concern if catches were to fall to within 'historic' reference levels rather than remain above them.

Preliminary modelling using surplus production models (2003 and 2004 assessments) implied that, within the main area of the fishery, harvest rates were very high. Closures have been applied to reduce fishing pressure as well as provide protection to the spawning stock. The extension of the closure to three months since 2003 has, not surprisingly, resulted in substantial changes in the dynamics of the fishery and compromised the validity of several model assumptions; hence it could no longer be used.

As an alternative assessment approach, egg production shows some potential as an indicator of current year relative spawning biomass, but may not be useful as a pre-recruit index due to the weak (negative) relationship between egg production and catches in the subsequent year. However, with the limited time series of data available these observations are very preliminary.

Based on cumulative egg production, 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. Moreover, since calamary have a life span of generally less than one year, intense fishing pressure immediately after the fishery is opened will have a limited impact on subsequent recruitment, assuming that most calamary caught would have already spawned and would die anyway within in a short period of time. In this context, the current management strategy of spawning closures should have considerable stock benefits. Impacts on the economic viability of operators and markets arising from the resultant pulse fishery are likely but whether management options are available or desirable to modify this behaviour is beyond the scope of this present assessment.

As the spawning dynamics and relationships between egg production and subsequent recruitment are better understood, there may be potential to use egg surveys in a real-time monitoring capability, whereby consideration could be given to shortening or extending closures depending on the level of accumulated egg production at a given point in time. However, since growth and reproductive characteristics of individual calamary appear to differ substantially depending upon the timing of hatching and subsequent environmental conditions, environmental factors may ultimately prove as important as fishing mortality in driving the population structure and dynamics.

Because stable isotope analyses indicate that the most adult calamary caught on the east and south-east coasts are probably spawned in Great Oyster Bay, this area exhibits a high degree of self-recruitment as well as supplying other parts of the south-east coast with the bulk of recruits. These findings reinforce the value and effectiveness of management arrangements that involve the closure of this region during the main spawning period.

Interest in calamary continues at a high level and there is substantial capacity within the Tasmanian scalefish industry to increase effort levels, an issue that is being tackled as part of the current management review through consideration of licensing and limited entry. As for the recreational sector, interest in the species is also high and effort directed at the species is likely to increase. Areas such as the D'Entrecasteaux Channel, Norfolk and Frederick Henry Bay and Great Oyster Bay are recognised hotspots.

Although a high degree of uncertainty is associated with the present assessment, the extended closure of the major spawning grounds (implemented again in 2006) appears to be effective in protecting the main (known) spawning event and ensuring relatively high egg production. Any major shift in the fishery to increased effort prior to the closure could adversely impact on the spawning stock prior to the main spawning season. Expansion of catches in space and time will need to be 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 calamary populations as high priority research areas. The continued lack of information concerning the recreational catch, especially from Great Oyster Bay, remains a significant hole in the assessment of calamary.

Information on the stock structure and level of fishing pressure that can be sustained on southern calamary is required. Integral to this is the need to quantify the relationships between reproductive output, spawning stock size and subsequent recruitment. Critically the source and sink populations supporting the Tasmanian calamary fishing industry need to be identified to ensure sustainable use of this resource. While recent research has progressed this area it is important to note that calamary are 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	Unknown stock structure in Australian waters though a recent genetic study has indicated no significant genetic separation of populations around Tasmania. 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. 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, unpubl. data Tracey et al. Lyle and Jordan 1999 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 after two years and 42 cm 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.	Gomon *et al.* 1994 Murphy and Lyle 1999 Tracey and Lyle 2005
Maturity	Females reach maturity at a smaller size and age (44 cm and 5 years) than males (53 cm and 8 years). However, more recent data suggest that size at 50% maturity in females is somewhat larger, around 54 cm (6.8 years), with male attaining 50% maturity at 53 cm (6.2 years).	Hutchinson 1994 Tracey *et al.* in press.
Spawning	Spawning occurs from July to early October, depending on geographical location, with spawning commencing and finishing earlier 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 1994
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 fork length (FL) have been caught on shallow reefs off the southeast 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 and apparently increasing 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 (within 3 nautical miles) 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 southwest 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 of 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 effort 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. The recreational bag limit was also replaced with a possession limit of eight fish.

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 combination of trip limit (250 kg) for commercial operators, a minimum size (450 mm total length) and recreational possession limit of eight fish.

5.5 Relative vulnerability to fishing

Juvenile striped trumpeter are particularly vulnerable to inshore gillnetting and although the recent size limit increase will offer protection, it is possible that incidental capture of sub-legal striped trumpeter in gillnets may result in significant 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 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. Based on an analysis of size and age composition data in 2005 it was concluded that striped trumpeter recruitment had been generally poor over the past decade, with updated spawner biomass-per-recruit analysis indicating that a further increase in the minimum size limit was required to reduce the risk of recruit 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 Commonwealth data up to 2005/06.

Opportunistic catch sampling was undertaken during 2005/06, however, in the absence of significant new data the biological analyses undertaken for the 2005 assessment have not been updated here.

Data presented for this assessment have been evaluated against the reference levels of performance indicators specified in the scalefish management plan and detailed in Section 1.3.

5.7.1 Catch

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.

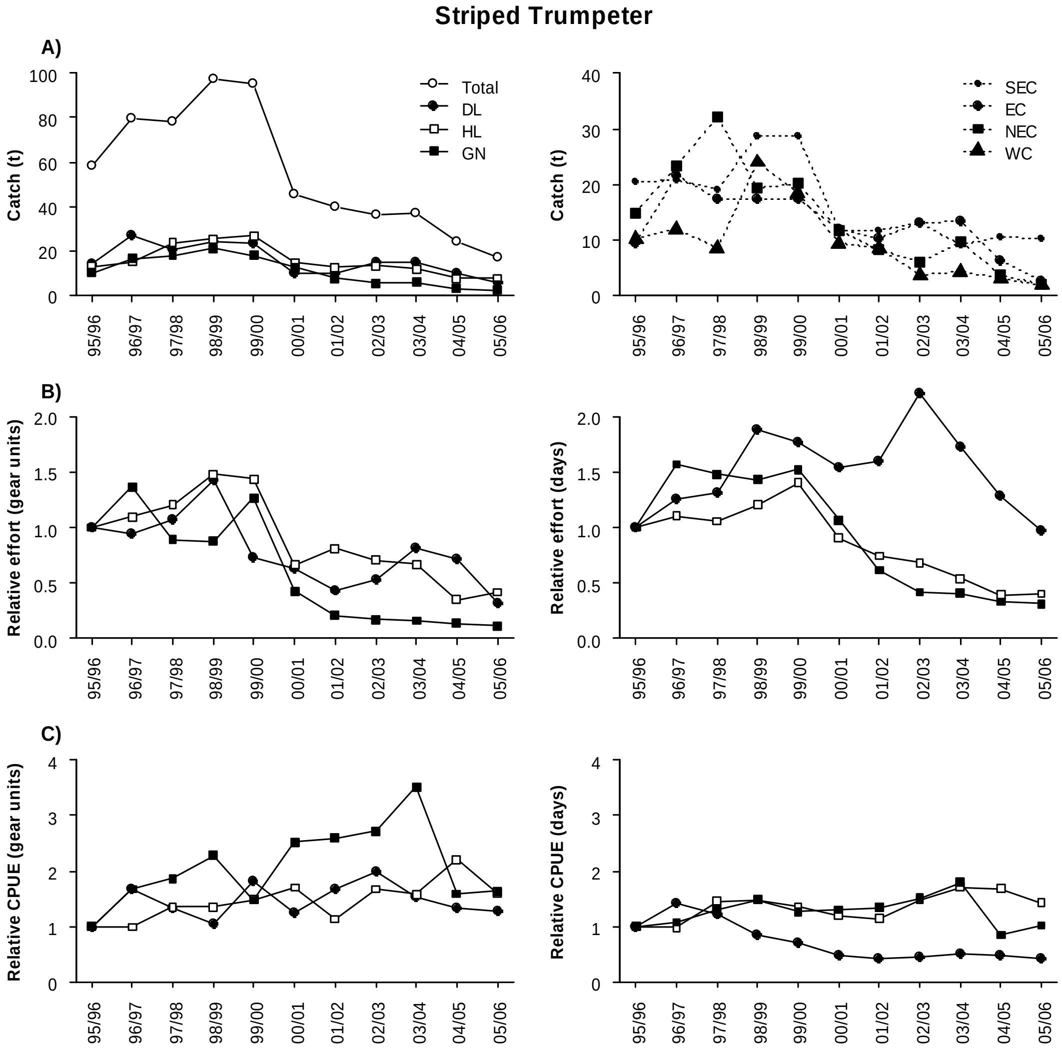

Fig. 5.1. A) Annual catch (tonnes) of striped trumpeter by method (left) and region (right) since 1995/96; B) effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and C) catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (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, NWC is north west coast and WC is west coast.

Annual production was high at over 110 tonnes in the early 1990s (with Victorian vessels taking between 17-39% of the reported catch) but then fluctuated generally between 70-80 tonnes through the early to 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. The reported catch of 23 tonnes for 2005/06 was about 14% lower that in the previous year and represented the lowest catch reported since the mid 1980s. However, Commonwealth catches are believed to be substantially under-reported and together with an unknown level of recreational catch, represent a major source of uncertainty in estimating the total mortality.

Striped trumpeter catches have been reported from all areas apart from the north coast, with the fishery focussed off the north-east, east, south-east, south and north-west coasts (Figs. 5.1A and 5.2). With the decline in catches over recent years the area of the fishery appears to have contracted and catches are now concentrated off the south east coast.

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. Commonwealth catches are likely to be underreported.

	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	17.1		4.7	22.5

The most conspicuous trend in catches was the initial increase in production for all methods up until 1999/00, followed by general declines in catches for graball and handline methods (Fig. 5.1A). By contrast, dropline catches rose slightly between 2002/03 and 2003/04 but declined again in 2005/06. Regionally, expansion of the fishery during the late 1990s was the result of increased catches from all areas. Subsequent declines also occurred in all regions, with the most recent drop in catches influenced particularly by further falls in landings from north-east and east coast regions. South-east coast catches have remained relatively stable over the past three years, at around 10 tonnes per annum, whereas with less than 3 tonnes taken from each of the east and north east coasts during 2005/06.

Strong 1993 and 1994 year-classes entered the fishery between 1995/96 and 1997/98 and influenced subsequent catches (and catch rates). 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 suggest that the trip limit of 250 kg 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.

An estimate of the recreational take of striped trumpeter (48 tonnes in 2000/01) indicates that the recreational catch may well be comparable to the commercial catch and, therefore, a significant component of the overall fishery. While more recent estimates of recreational catches are missing, recreational fishing activity has probably increased in recent years.

Evaluation of 2005/06 catches against performance indicators

- State-wide catches were well below the reference range and therefore exceeded the reference point.

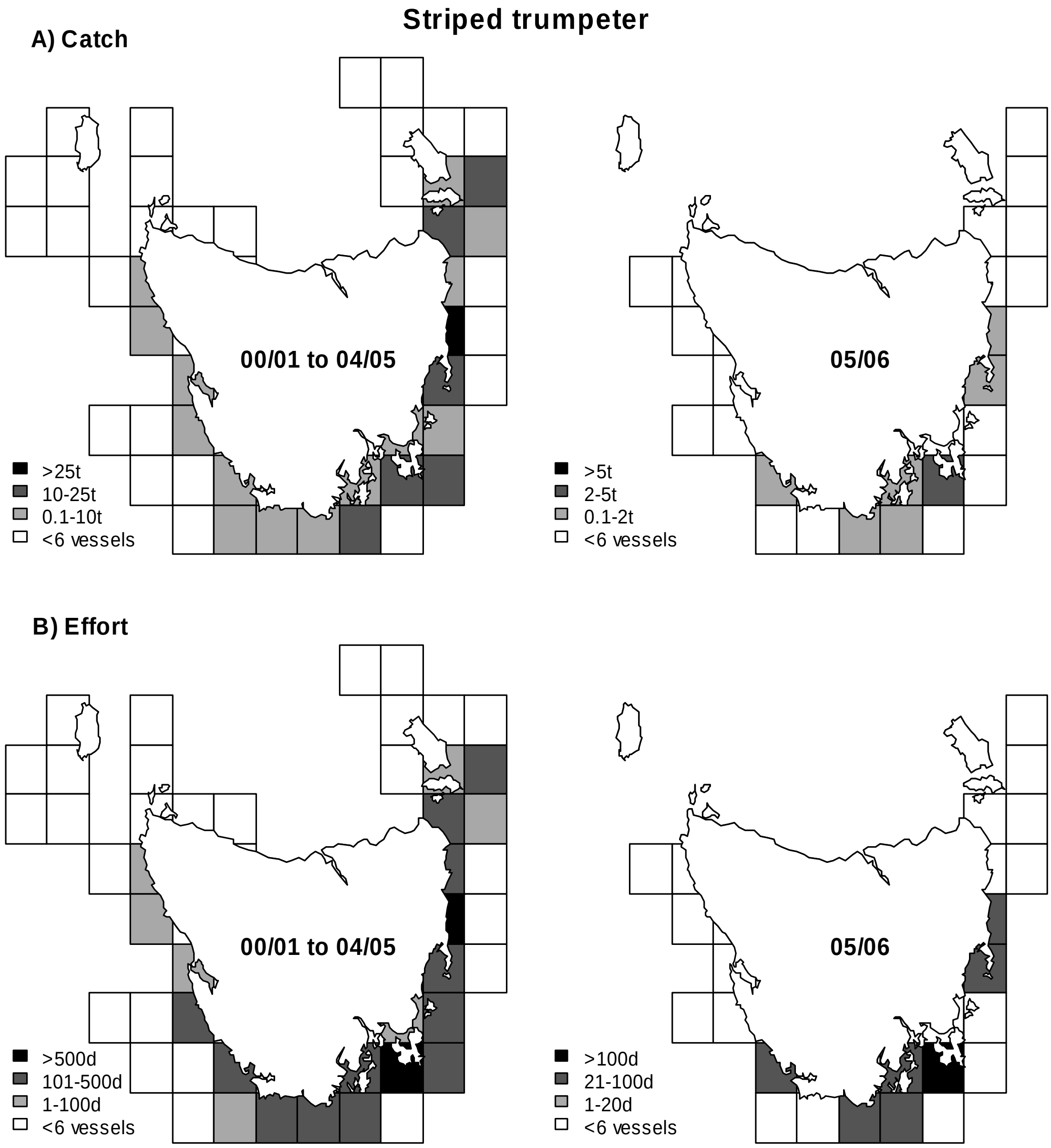

Fig. 5.2. (A) Striped trumpeter catches (tonnes) and (B) effort (days) by fishing block pooled from 2000/01 to 2004/05 (left) and during 2005/06 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

5.7.2 Fishing effort

The regional distribution of effort clearly indicates the recent focus of fishing activity in the south-east, and in particular in those waters adjacent to the Tasman Peninsula (7G2) (Fig. 5.2B).

Following increases in effort during the latter part of the 1990s, presumably linked to the increased availability of striped trumpeter, graball and handline effort generally declined (Fig. 5.1B). By contrast, dropline effort remained relatively high up until recently, falling sharply in 2005/06 to their lowest level since the mid-1990s.

Evaluation of 2005/06 effort against performance indicator

- Handline, dropline and graball effort were within reference levels.

5.7.3 Catch rates

Graball catch rates increased steadily up until 2003/04, despite declining catches during the latter half of the period (Fig. 5.1C). 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. Handline catch rates have experienced an underlying increasing trend through time although there was a slight reduction in the 2005/06 catch rate compared with 2004/05. Dropline catch rates, based on catch per hook-lift, have fallen slightly over the past three years though were still within the range of reference values. Daily catch rates for droplines have changed little since 2000/01, remaining at about half of the minimum reference level

The influence of the trip limit on catch rates (daily catches) is unclear, although logbook data suggest that few operators would have been affected by the trip limit, at least on the basis of trips of a single day's duration (i.e. daily catch rates rarely exceeded 250 kg).

Evaluation of 2005/06 catch rate against performance indicator

- Handline and graball catch rates were within reference values. Catch rates for droplines were either within reference levels (gear units) or less than 80% of the lowest reference level (days fished). This latter exceeded the reference point for the seventh year in a row.

5.8 Implications for Management

The sharp decline in catches since 2000/01 gives rise to concern about the current 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, with the fishery becoming dependent upon relatively few year classes. Size and age composition data presented in the previous assessment imply that this may in fact be the case for striped trumpeter, with no evidence of strong recruitment for over a decade and the prevalence of the strong 1993 cohort in the adult population. Based on this assessment, the average size of hook-caught fish is expected to continue to increase as recruited cohorts grow but spawner biomass will decline as a consequence of natural and fishing mortality acting on the adult population. Furthermore, if catch declines do in fact reflect falling abundance, then it is likely that fishing mortality is too high and may lead to recruit overfishing, a situation exacerbated by the minimum size limit still being set smaller than the size at maturity.

However, as noted in previous assessments the impact of recent management changes cannot be discounted as a contributing factor to the downturn in catches. Reduced incentives for fishers to target striped trumpeter due to the 250 kg trip limit appear to have been reflected in reduced line fishing effort over the past three years.

Catches reported in Commonwealth returns in recent years have averaged about 3 tonnes per annum, 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.

Growing interest from the recreational sector coupled with declining commercial catches, suggest that recreational catches will become an increasingly significant component of the total mortality and thus should be factored explicitly into the future assessment and management of this fishery.

The sharp fall in the graball catch observed since 2004/05 may be linked to a combination of low numbers of striped trumpeter in inshore waters and/or size structuring within the population (immature fish inshore/mature fish offshore) that means that few if any fish captured in the inshore gillnet catch will be of legal size. During 2005 there were anecdotal reports of juvenile striped trumpeter present in some coastal areas, suggesting recent recruitment success, although the relative size of the cohort is unknown.

Spawner biomass-per-recruit analyses imply that either fishing mortality needs to be reduced or that the minimum size limit should be increased further, noting that the current limit of 45 cm is still below the size at maturity at about 53-54 cm.

Although a more rigorous assessment is required to assess the sustainability of the fishery, the apparent lack of recent recruitment means that the stock will continue to decline. Management action is required in all sectors to reduce fishing mortality, including consideration of a boat limit for recreational fishers, recognising that this sector is likely to have expanded over the past five years.

5.9 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. In addition, there is a need to estimate the recreational catch and reduce uncertainty in the magnitude of the catch by Commonwealth operators.

There is an urgent need to characterize the commercial and recreational fisheries for this species in terms of size composition and age-structure. Quantification of the recreational harvest remains a major uncertainty and hence a priority for the fishery assessment. There is a need to further examine the impacts of present and alternative harvest strategies.

Fishery independent gillnet surveys have the potential to assess the relative abundance/presence of pre-recruits which could be valuable in predicting and interpreting future catch trends.

6 Other key scalefish

6.1 Sea Garfish (*Hyporhamphus melanochir*)

6.1.1 Catch

Garfish catches have remained relatively stable since the early 1990s, at between 80-90 tonnes in most years (Fig. 6.1A). Catches in 2005/06 dropped by about 12% to 75 tonnes, mainly due to a fall in beach seine catches, the primary capture method. Following an initial expansion in dipnet catches to 34 tonnes in 1998/99, catches taken by this method have generally declined and were just 11 tonnes in the current year.

Regionally, the north east coast including Flinders Island has dominated catches (Figs. 6.1B and 6.2). The east coast was of secondary importance until 2000/01, but catches remained low for several years before recovering more recently. There has been limited variability in catches from the south east coast. Off the south east and east coasts dipnetting represents the main fishing method, accounting for around 85% and 70%, respectively to the total catch in these regions. By contrast, north east coast catches are almost exclusively taken by beach seine.

Evaluation of 2005/06 catches against performance indicators

- Current State-wide catches were within reference levels.

6.1.2 Fishing effort

Dipnet effort increased initially to a peak during 1998/99 but has subsequently stabilised at a lower level over the past six years (Fig. 6.1B). On the other hand, beach seine effort has fluctuated without obvious trend over time, falling slightly in 2005/06. Fishing occurred mainly in the north east coast and south east coast, consistent with the regional catch distribution (Fig. 6.3).

Evaluation of 2005/06 effort against performance indicators

- Beach seine and dipnet effort was within reference levels.

6.1.3 Catch rates

Beach seine catch rates generally rose during the late 1990s and early 2000s and have been maintained at a higher level since that time (Fig. 6.1C). By contrast, dipnet catch rates underwent an initial decline but subsequently have stabilised at a lower level. In the context of schooling species such as garfish, catch rates may, however, be relatively insensitive to changes in abundance.

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 reducing opportunities to use beach seines to target the species and possibly affecting catch rates. As such interactions tend to be very localised our analyses are unlikely to be sensitive enough to detect such impacts.

Evaluation of 2005/06 catch rates against performance indicator

- Dipnet catch rates (gear units and days fished) were below reference levels and therefore exceeded the reference point.

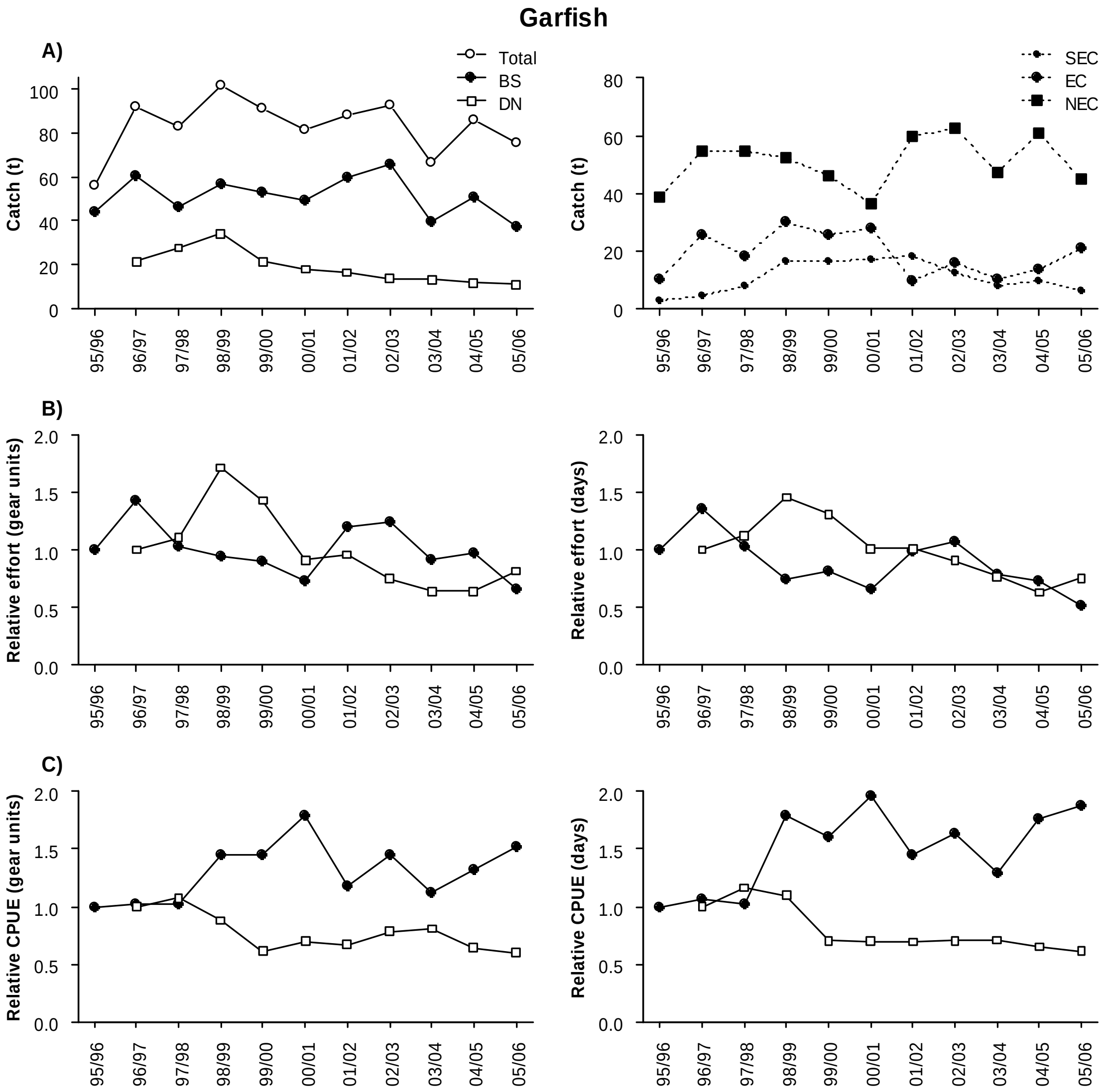

Fig. 6.1. A) Annual catch (tonnes) of garfish by method (left) and region (right) since 1995/96; B) effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and C) catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative 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.

6.1.4 Implications for management

The fishery data provide no evidence to support concern over garfish stock status. There remains, however, potential for effort to increase, particularly within the dipnet sector.

While it is not known whether present catch levels are sustainable, it would be prudent to consider management options that limit further expansion in this fishery until more is known about the stock dynamics.

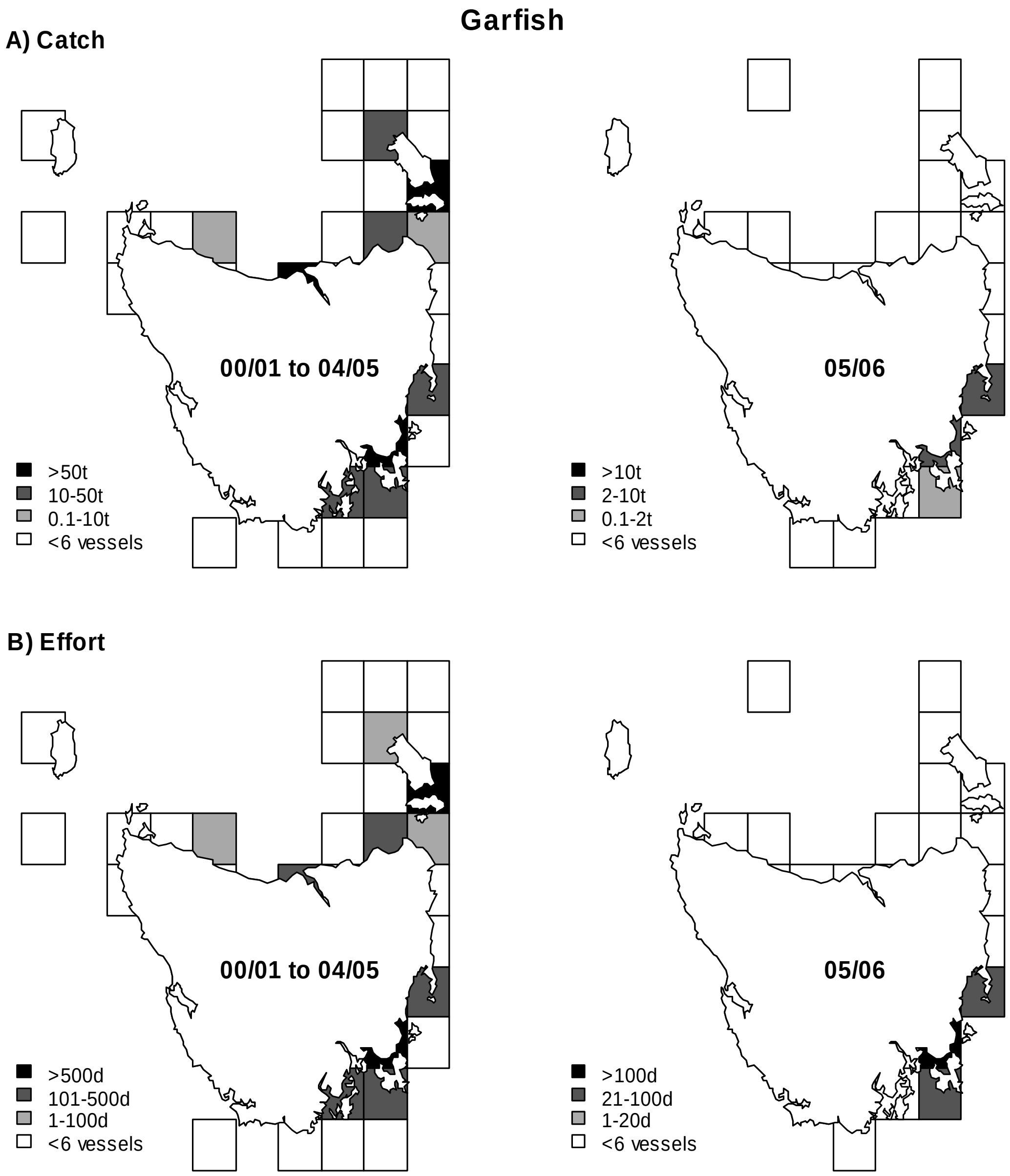

Fig 6.2. (A) Garfish catches (tonnes) and (B) effort (days) by fishing block pooled from 2000/01 to 2004/05 (left) and during 2005/06 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

6.2 Wrasse (Fam. Labridae)

6.2.1 Catch

Several species of wrasse occur in Tasmanian waters with purple wrasse (*Notolabrus fucicola*) and blue-throat wrasse (*N. tetricus*) 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. Over the past four years 'live' wrasse have accounted for between 66-76% of the total reported catch, and thus trends in the live-fish fishery will ultimately be reflected in overall production levels. The two species of wrasse are not routinely distinguished in catch returns. While there is an apparent market preference for blue-throat wrasse, purple wrasse are more robust for live handling.

Between 1997/98 and 2001/02, wrasse catches were relatively stable at between 85-100 tonnes. Compared to the previous year, overall catches decreased by 14% to 85 tonnes in 2005/06, largely due to lower handline catches (Fig. 6.3A). Fish trap catches decreased only marginally. Handline and fish trap represent the primary capture methods for wrasse, with blue-throat wrasse more susceptible to line methods and purple wrasse more vulnerable to trap capture. On this basis it would appear blue-throat wrasse are taken in larger quantities in the live fishery. Gillnets account for the bulk of the remaining catch (< 6 tonnes in 2005/06) but because survival in nets is poor, graball caught wrasse are rarely marketed live.

The overall decline in catches was reflected in all areas except the south east, where they increased substantially in 2005/06 (Fig. 6.3A and 6.4). The underlying drivers for the regional shifts in the fishery have not been investigated but may relate to fishers entering and exiting the fishery and/or species availability and market influence.

Evaluation of 2005/06 catches against performance indicators

- State-wide catches were within reference levels.

6.2.2 Fishing effort

Trends in handline effort generally reflected those of catches, while trap effort indicated a sharp increase in gear units (trap-lifts) days fished has remained relatively stable fro several years (Fig. 6.3B).

Evaluation of 2005/06 effort against performance indicator

- Trap and handline effort was within reference levels.

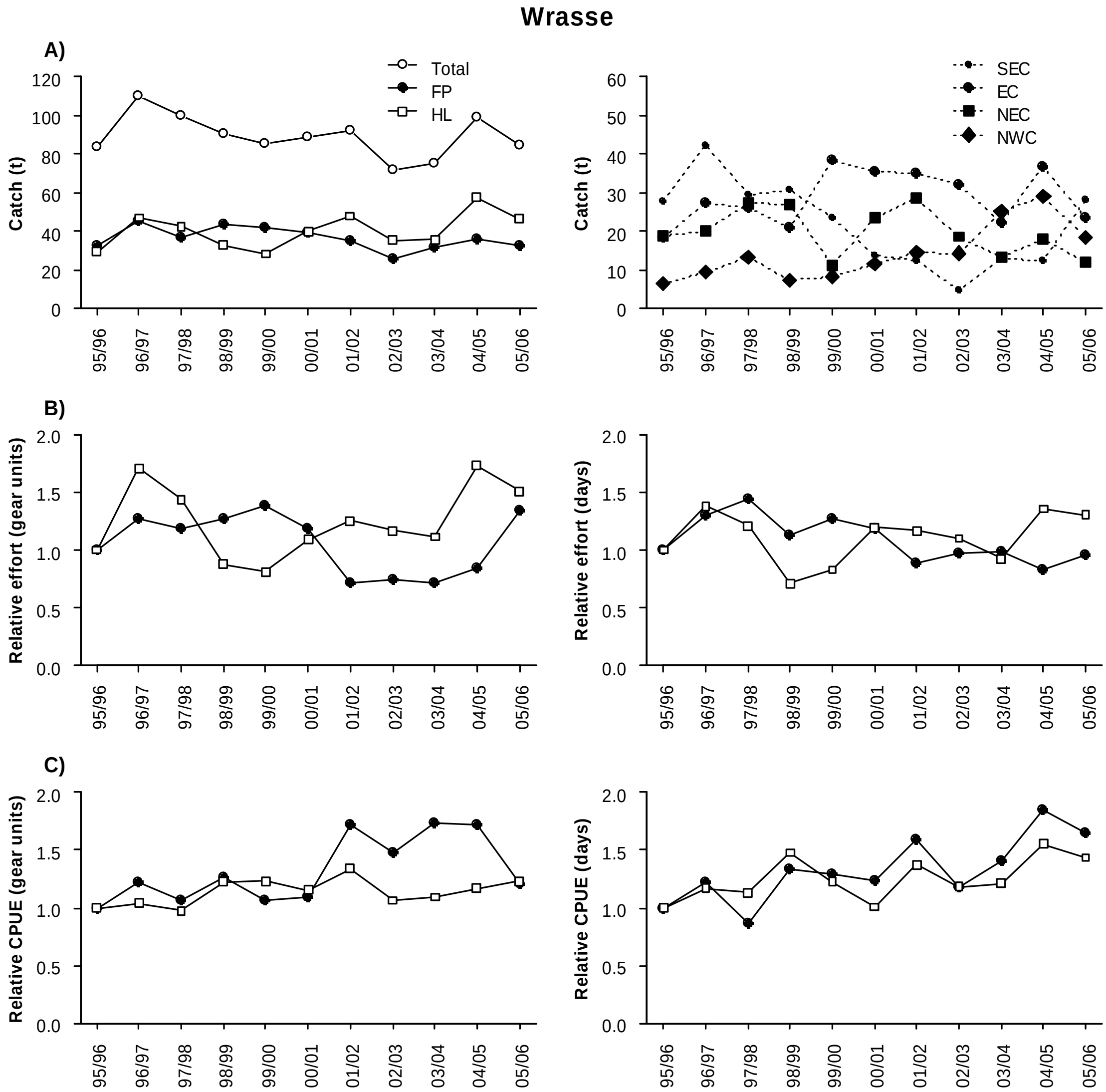

Fig. 6.3. A) Annual catch (tonnes) of wrasse by method (left) and region (right) since 1995/96; B) effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and C) catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative 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.

6.2.3 Catch rates

Since the mid 1990s, catch rates based on gear units for handline (kg per line hour) have remained stable, whereas trap catch rates (kg per trap lift) fell, after a 4-year period at high levels, to levels experienced during the 1990s (Fig. 6.3C). Daily catches for both handline and trap methods have increased gradually since the mid-1990s.

Catch rate trends imply that wrasse stocks have not been impacted significantly by the fishery. However, these broad-scale analyses are insensitive to changes in abundance at the level of individual reefs at which the fishery impacts the populations. In fact, there is evidence on some east coast reefs that exploitation rates of legal-sized purple wrasse are extremely high (Ewing 2004). The marked regional shifts that have occurred in the fishery may also mask localised depletions, with fishers moving to new or lightly fished areas to maintain catches. As a consequence, caution needs to be exercised when making inferences about the status of the wrasse stocks though key fishery indicators do not suggest significant fishery impacts.

Evaluation of 2005/06 catch rates against performance indicator

- Catch rates were within reference levels.

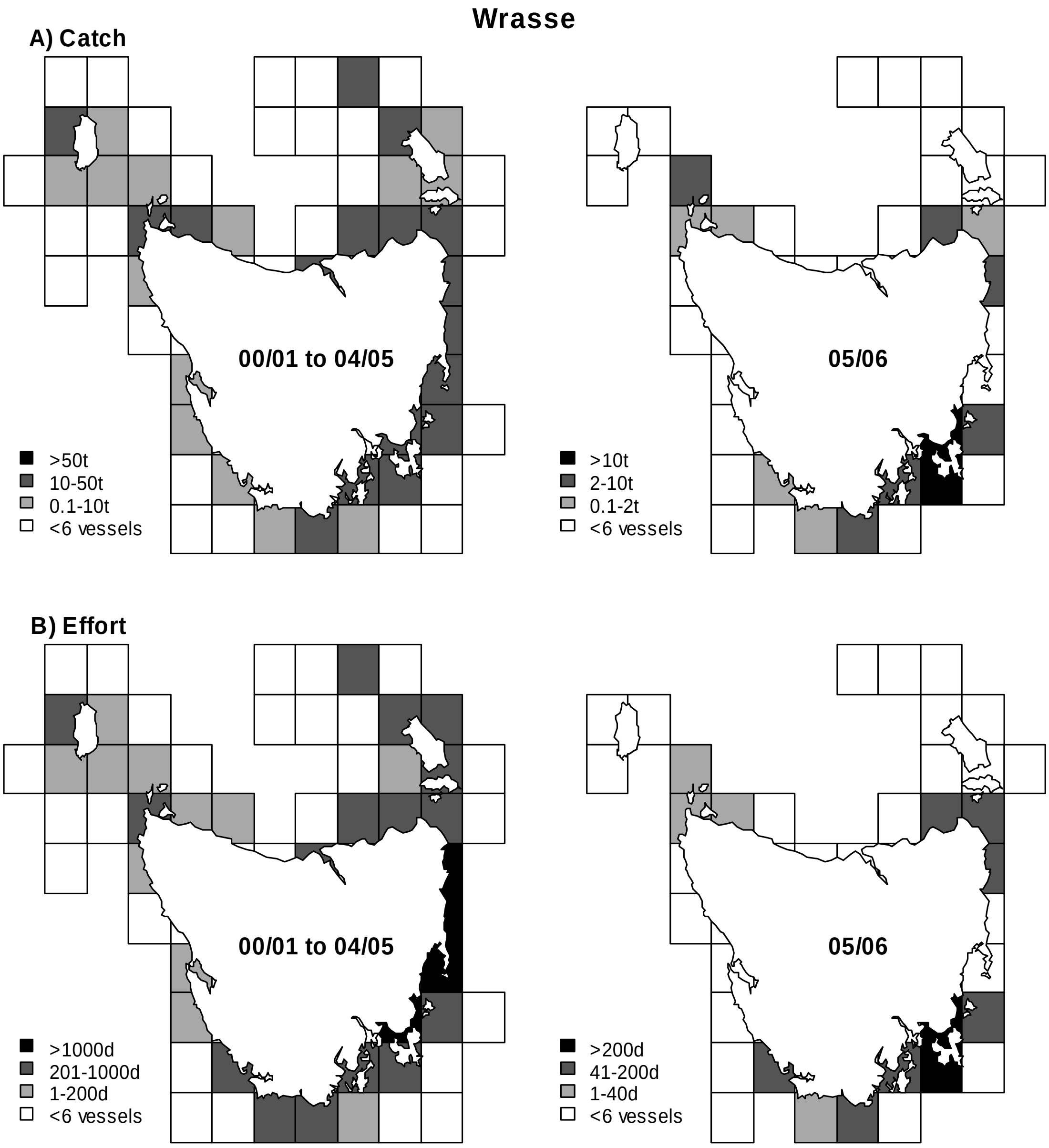

Fig. 6.4. (A) Wrasse catches (tonnes) and (B) effort (days) by fishing block pooled from 2000/01 to 2004/05 (left) and during 2005/06 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

6.2.4 Implications for management

While input controls (limited entry) have capped participation in the live wrasse fishery, it is unknown whether current effort levels are 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 post 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 may have exacerbated this potential problem. However, neither in Tasmania nor in Victoria, where the blue wrasse fishery is larger, are there any clear indications of spawning stock shortages.

6.3 Blue warehou (*Seriolella brama*)

6.3.1 Catch

Recent studies have indicated that there are two stocks of blue warehou in 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 southeast and east coast and thus probably targets the eastern stock (Figs. 6.5A and 6.6). Catches are also taken off the northeast and northwest coasts, the latter potentially involving the western stock.

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. 6.5A. Due to low availability since the early 2000s, the species has been rarely targeted. The current catch of 19 tonnes is similar to that for the previous year, and was the lowest catch reported since the mid-1980s. The species is taken primarily in graball nets (Fig. 6.5A), 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 16 tonnes (Lyle 2005), substantially lower than recreational catches taken in 1997 and 1998 (Lyle 2000) but consistent with the depressed state of the commercial catches.

Evaluation of 2005/06 catches against performance indicator

- State-wide catches were below reference levels and therefore exceeded the catch reference point.

6.3.2 Fishing effort

Following an increase in graball effort between 1995/96 and 1998/99 that resulted in increased catches, effort has since fallen to a substantially lower level which was maintained in the present year (Fig. 6.5B). Low effort is largely in response to the reduced availability of the target species.

Evaluation of 2005/06 effort against performance indicator

- Graball effort was within reference limits.

6.3.3 Catch rates

Graball catch rates increased markedly between 1995/96 and 1998/99 reflecting increased availability and targeting of warehou around Tasmania at the time (Fig. 6.5C). Since then catch rates have declined to levels similar to the mid-1990s.

Evaluation of 2005/06 catch rates against performance indicators

- Catch rates were within reference levels.

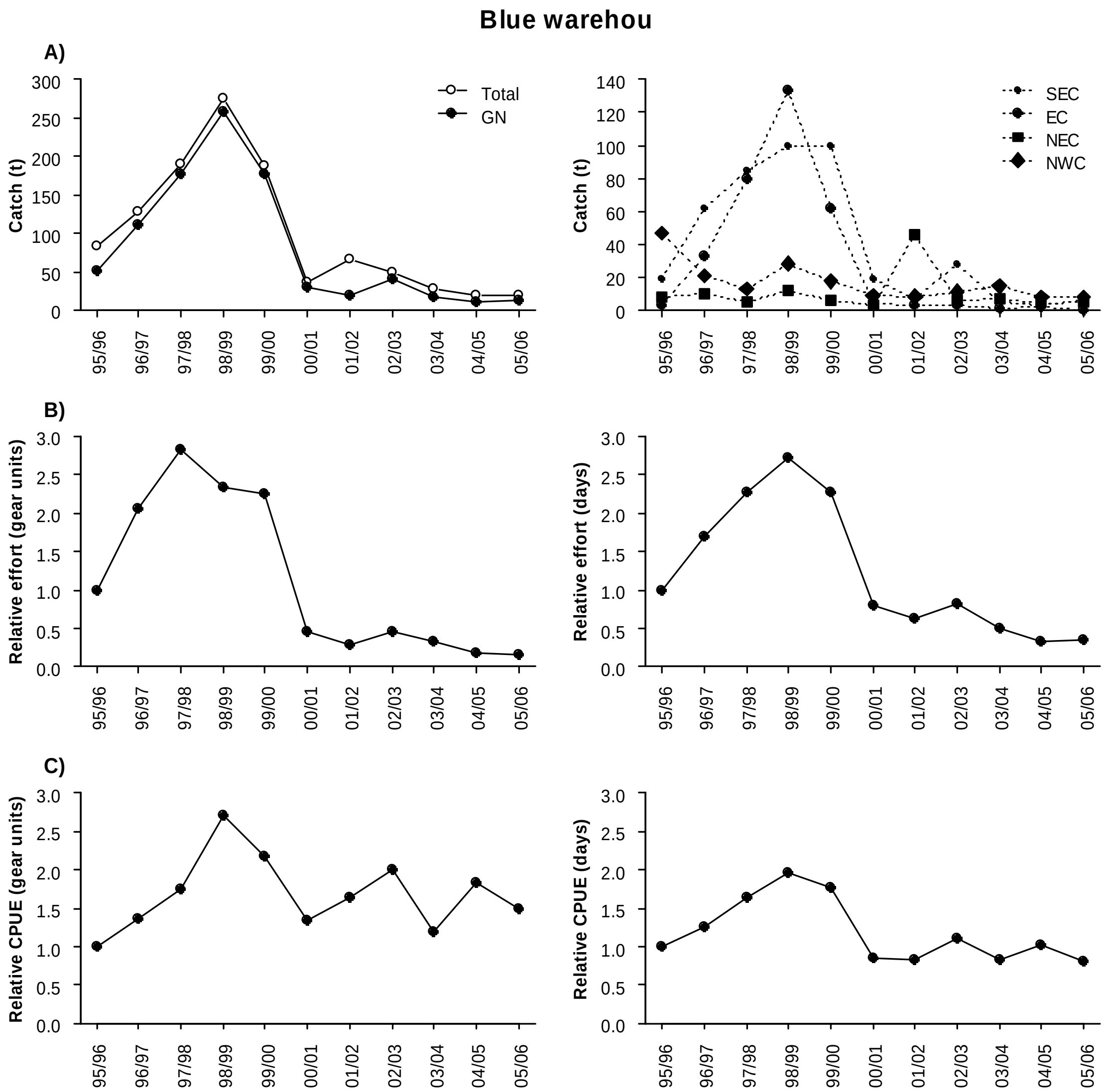

Fig. 6.5. A) Annual catch (tonnes) of blue warehou by method (left) and region (right) since 1995/96; B) effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and C) catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) 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.

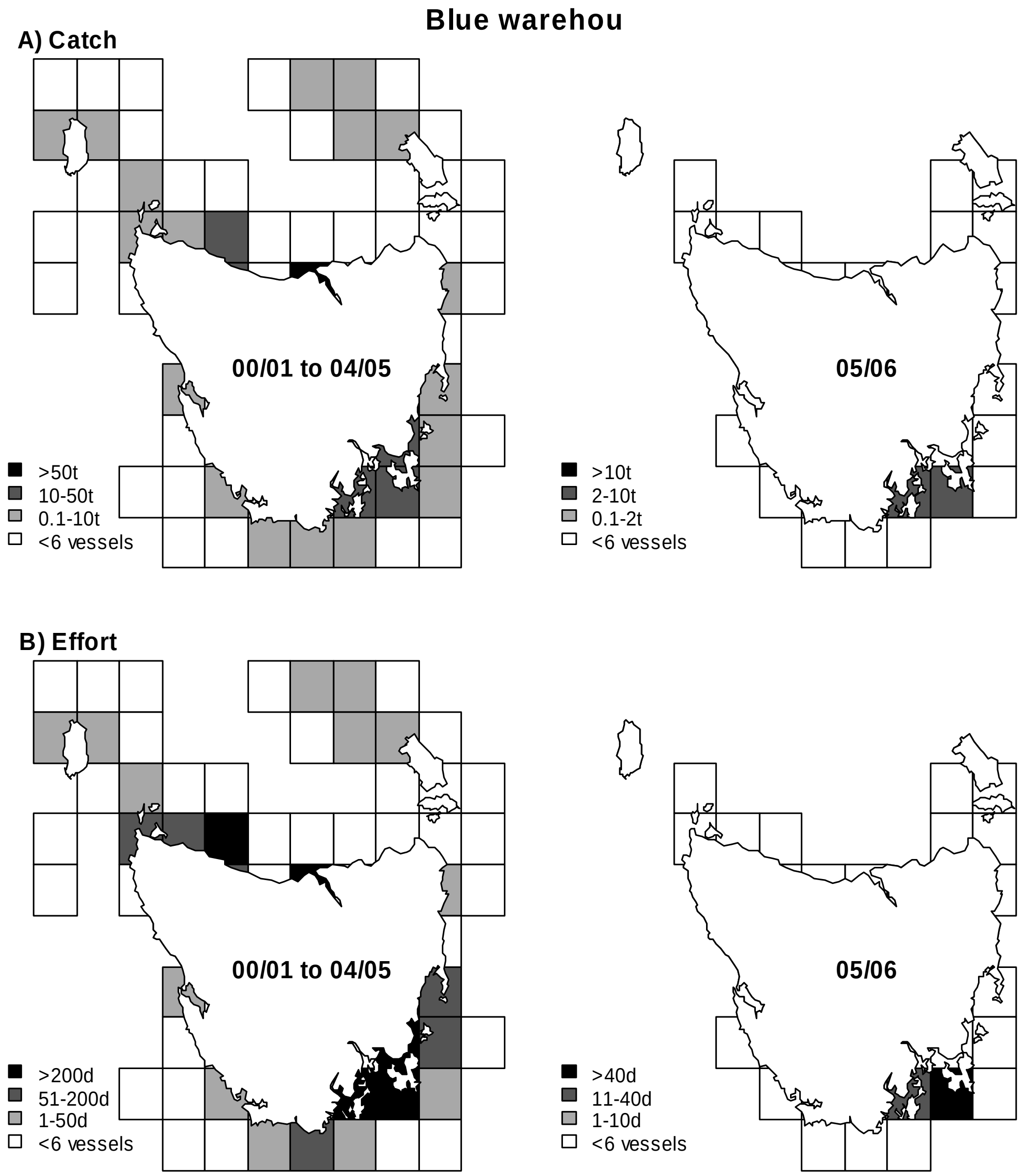

Fig. 6.6. (A) Blue warehou catches (tonnes) and (B) effort (days) by fishing block pooled from 2000/01 to 2004/05 (left) and during 2005/06 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

6.3.4 Implications for management

Blue warehou is a Commonwealth managed species and an 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 had been set at 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 2004/05 stock assessment of the Commonwealth fishery concluded that the blue warehou stocks required a stock rebuilding strategy (Tuck 2006), however for 2006 the TAC has been increased again to 650 tonnes (100 tonnes for eastern stock, 550 tonnes for western stock) due to some signs of stock recovery in the west.

6.4 Bastard trumpeter (*Latridopsis forsteri*)

6.4.1 Catch

Bastard trumpeter catches declined steadily from the mid 1990s but have remained stable at around 20 tonnes for the past five years (2005/06 catch was 22 tonnes, Fig. 6.7A). Bastard trumpeter are taken almost exclusively by graball from inshore waters off the east, south and west coasts (Fig. 6.8).

The species 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.

Evaluation of 2005/06 catches against performance indicators

- State-wide catches were below the reference catch range and therefore exceeded the reference point for the sixth consecutive year.

6.4.2 Fishing effort

Graball effort for bastard trumpeter has followed a similar downward trend to catches since the mid-1990s (Figs. 6.7B and 6.8).

Evaluation of 2005/06 effort against performance indicators

- Graball effort has been stable at low levels and remained within reference levels.

6.4.3 Catch rates

Catch rates have remained relatively stable over time (Fig. 6.7C). 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.

Evaluation of 2005/06 catch rates against performance indicator

- Catch rates were within reference levels.

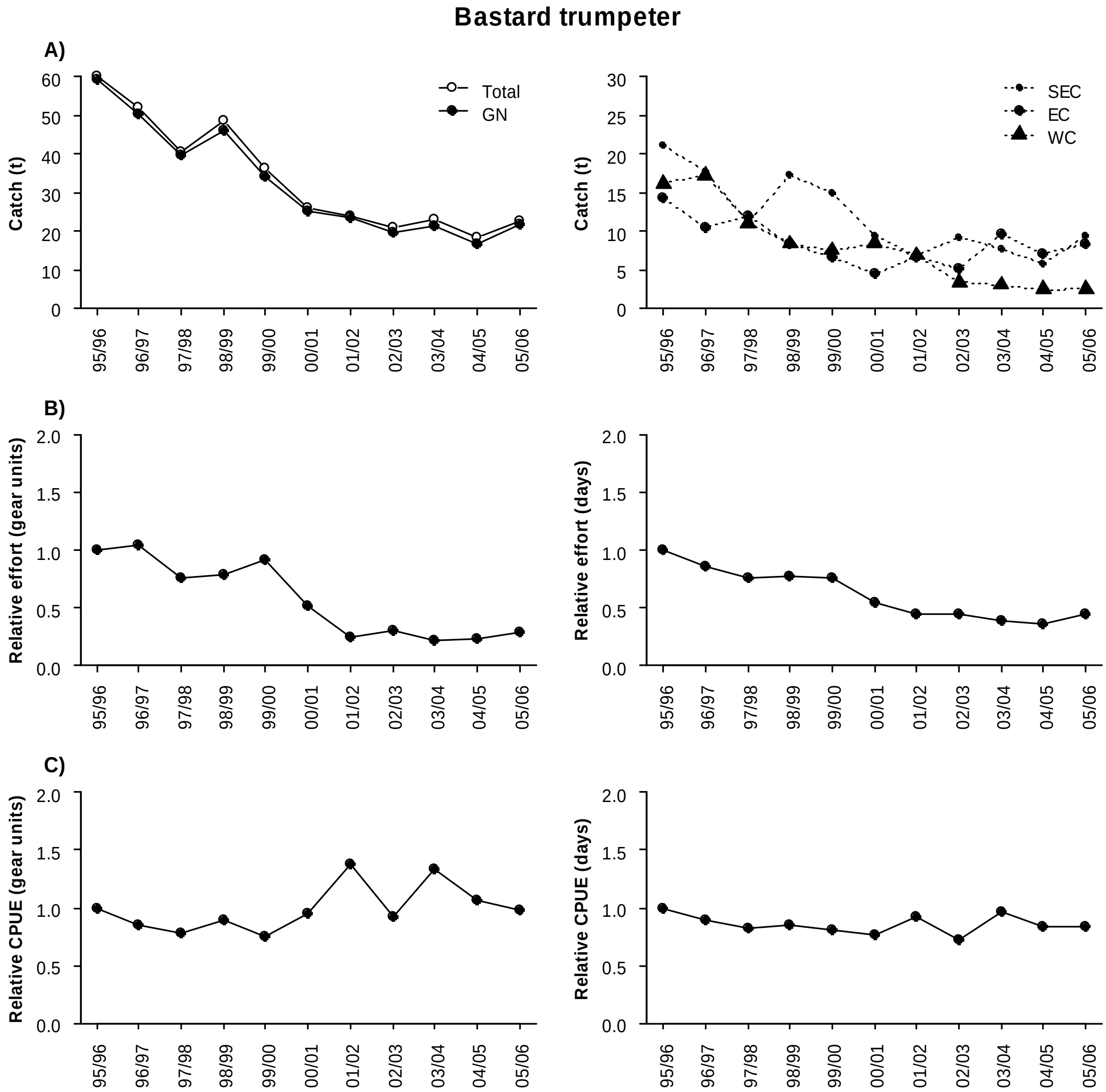

Fig. 6.7. A) Annual catch (tonnes) of bastard trumpeter by method (left) and region (right) since 1995/96; B) effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and C) catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. GN is graball; SEC is south east coast, EC is east coast and WC is west coast.

6.4.4 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.

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. 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 are possibilities. Increasing the minimum size limit to above the size at maturity, which appears to be greater than 50 cm FL, would be beneficial to the stock but would also effectively close down the current commercial and recreational fisheries for the species. Reducing the recreational possession limits and discouraging targeting by the commercial fishery through the introduction of trip limits may be possible alternatives to reduce mortality.

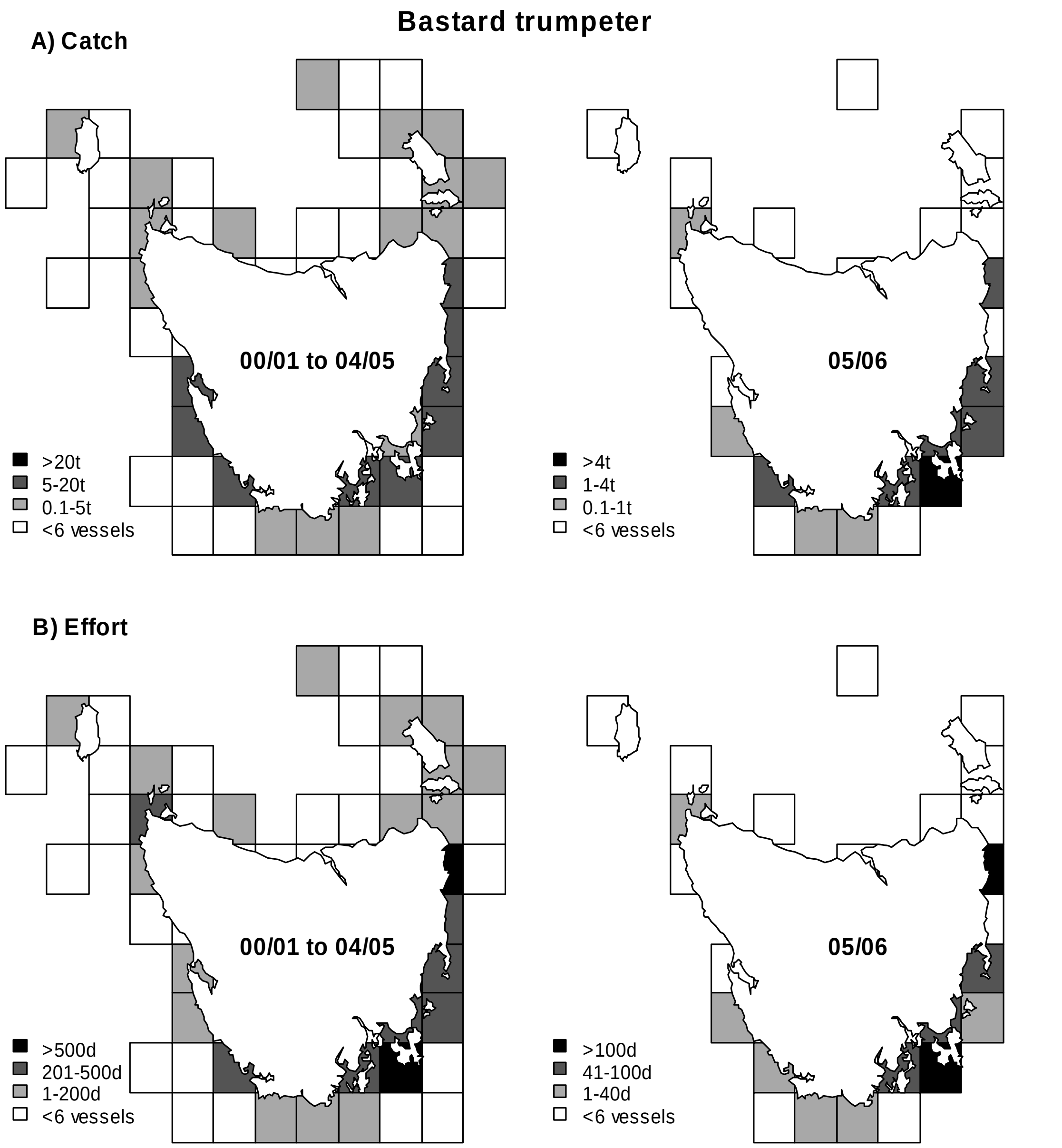

Fig. 6.8. (A) Bastard trumpeter catches (tonnes) and (B) effort (days) by fishing block pooled from 2000/01 to 2004/05 (left) and during 2005/06 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

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

6.5.1 Catch

The commercial catch of Australian salmon dropped by 25% from the catch in 2004/05 to 252 tonnes in 2005/06 and was the second lowest on record (Fig. 6.9A). Beach seines account for the vast majority of the catch. While Australian salmon were caught predominantly in the north east coast until 1998/99, more recent catches have been spread more evenly between the south east, east, north east and north west coasts (Figs. 6.9A and 6.10)

Australian salmon represent the second most commonly caught species in the recreational fishery, with an estimated harvest of 111 tonnes in 2000/01 (Lyle 2005).

Evaluation of 2005/06 catches against performance indicator

- State-wide catches were below the reference range and therefore exceeded the reference point.

6.5.2 Fishing effort

Beach seine effort was virtually unchanged compared with 2004/05 and has remained at a relatively low level since the late 1990s (Figs. 6.9B and 6.10).

Evaluation of 2005/06 effort against performance indicator

- Beach seine effort has remained at the lowest level since the mid-1990s therefore remained within reference levels.

6.5.3 Catch rates

Beach seine catch rates by gear units and days fished during 2005/06 were the lowest on record (Fig. 6.19C). 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 particularly sensitive indicator of stock condition especially if search time is not taken into account.

Evaluation of 2005/06 catch rates against performance indicator

- Beach seine catch rates were below reference levels and therefore exceeded the reference point.

6.5.4 Implications for management

Australian salmon catches are, to a large extent, linked to market demand, specifically the bait market, and are thus not a good indicator of stock status. There is capacity for industry to significantly expand production should new markets be found (there is interest in developing export markets) and under such circumstances management may need to be proactive in managing any such expansion. While stock status is unknown, the species has sustained substantially higher catches in the past and therefore in the absence of indicators to the contrary 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.

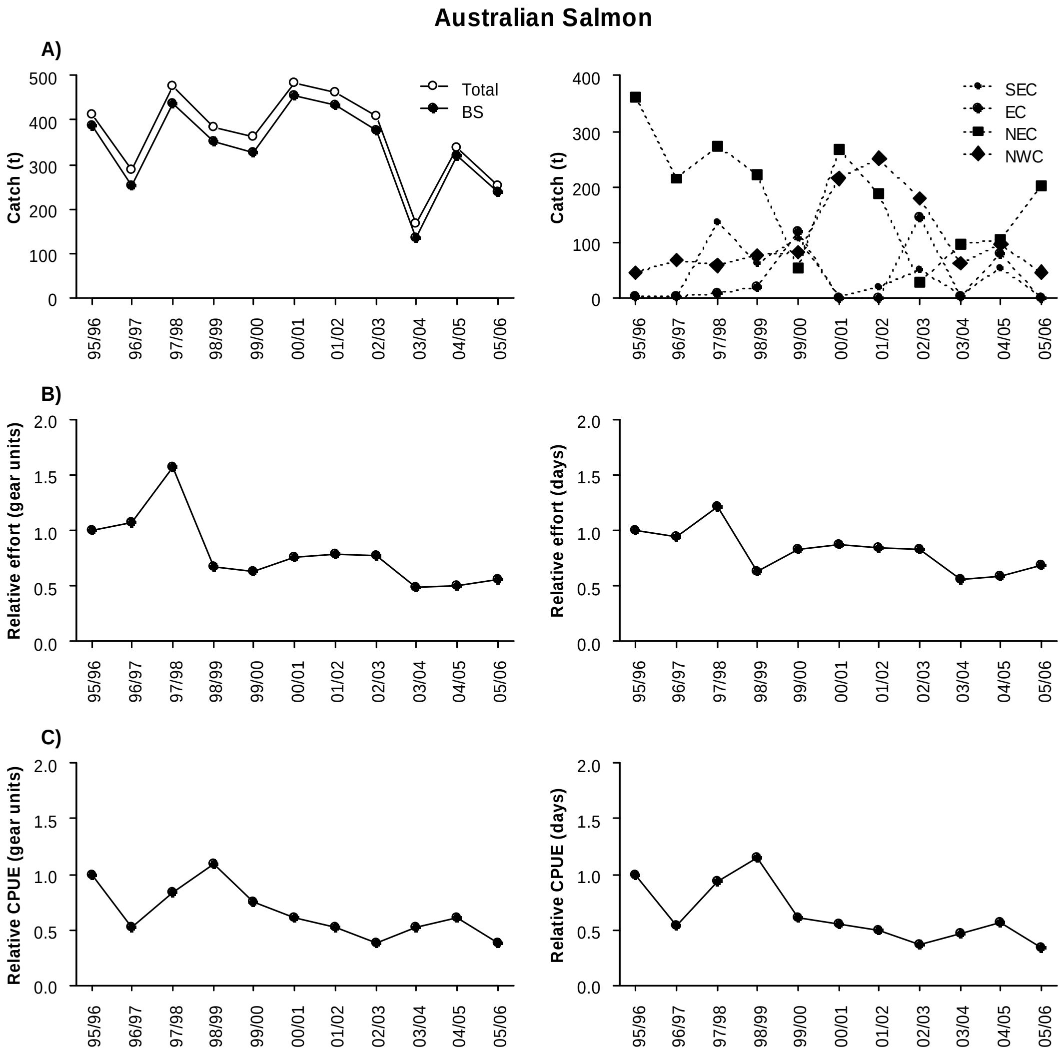

Fig. 6.9. A) Annual catch (tonnes) of Australian salmon by method (left) and region (right) since 1995/96; B) effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and C) catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (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.

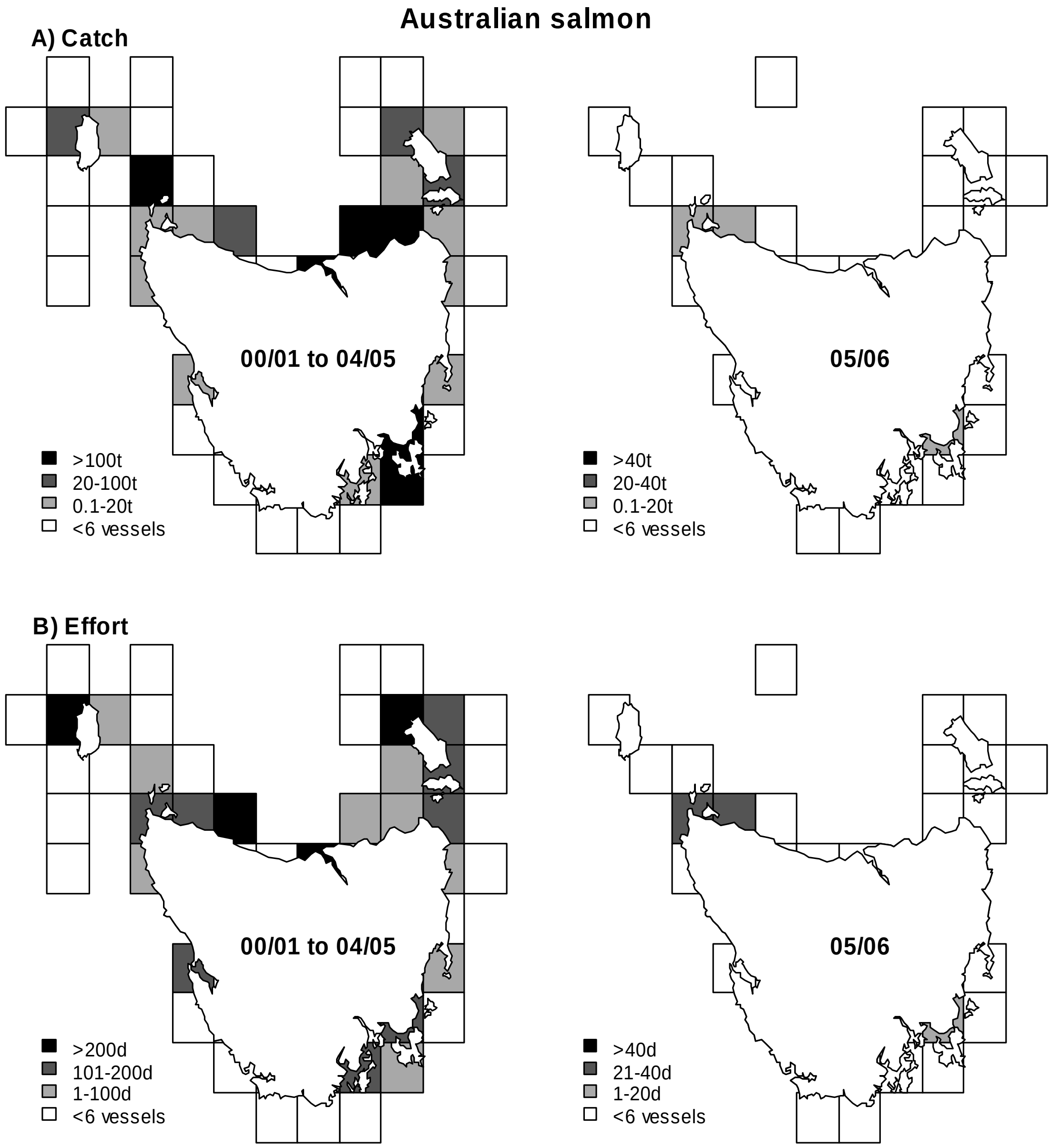

Fig. 6.10. (A) Australian salmon catches (tonnes) and (B) effort (days) by fishing block pooled from 2000/01 to 2004/05 (left) and during 2005/06 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

6.6 Flounder (Fam. Pleuronectidae)

6.6.1 Catch

Several species of flounder occur in Tasmanian waters, but catches are dominated by greenback flounder (*Rhombosolea tapirina*) and to a lesser extent long-snouted flounder (*Ammotretis rostratus*).

Flounder catches declined steadily from over 40 tonnes p.a. during the early 1990s to around 12 tonnes in 2000/01 and have remained low since then (Fig. 6.11A). The current catch of 10 tonnes was the lowest on record and well below reference catches. Graball (‘flounder’) nets and spears represent the primary fishing methods, with roughly equal quantities taken by each method. Flounder are mainly caught in shallow waters of the south east, east and north east coasts (Figs. 6.11A and 6.12).

The estimated recreational catch of flounder in 2000/01 of 21 tonnes was double the size of commercial catch for the corresponding period, indicating the relative importance of the recreational component of this fishery (Lyle 2005).

Evaluation of 2005/06 catches against performance indicator

- State-wide catches were below the reference range and therefore exceeded the reference point for the eighth consecutive year.

6.6.2 Fishing effort

Graball effort for flounder has declined steadily since 1995/96 whereas spear effort increased initially and then fell over a period of several years up to 2000/01. Spear effort dropped sharply during 2005/06 to the lowest level on record (Fig. 6.11). The overall regional distribution of effort based on days fished has changed little over time, being focussed in the south east and Tamar regions (Fig. 6.12).

Evaluation of 2005/06 effort against performance indicator

- Graball and spear effort was within reference levels.

6.6.3 Catch rates

Graball catch rates based on gear units (kg per net-metre-hour) have increased over time, whereas catch per day declined initially before increasing steadily to within reference levels (Fig. 6.11C). Spear catch rates have generally declined over time such that by 2005/06 catch rates represented about 70% of the lowest reference value.

Evaluation of 2005/06 catch rates against performance measures

- Spear catch rates were below reference levels and therefore exceeded the reference point, while catch rates for graball remained within reference levels.

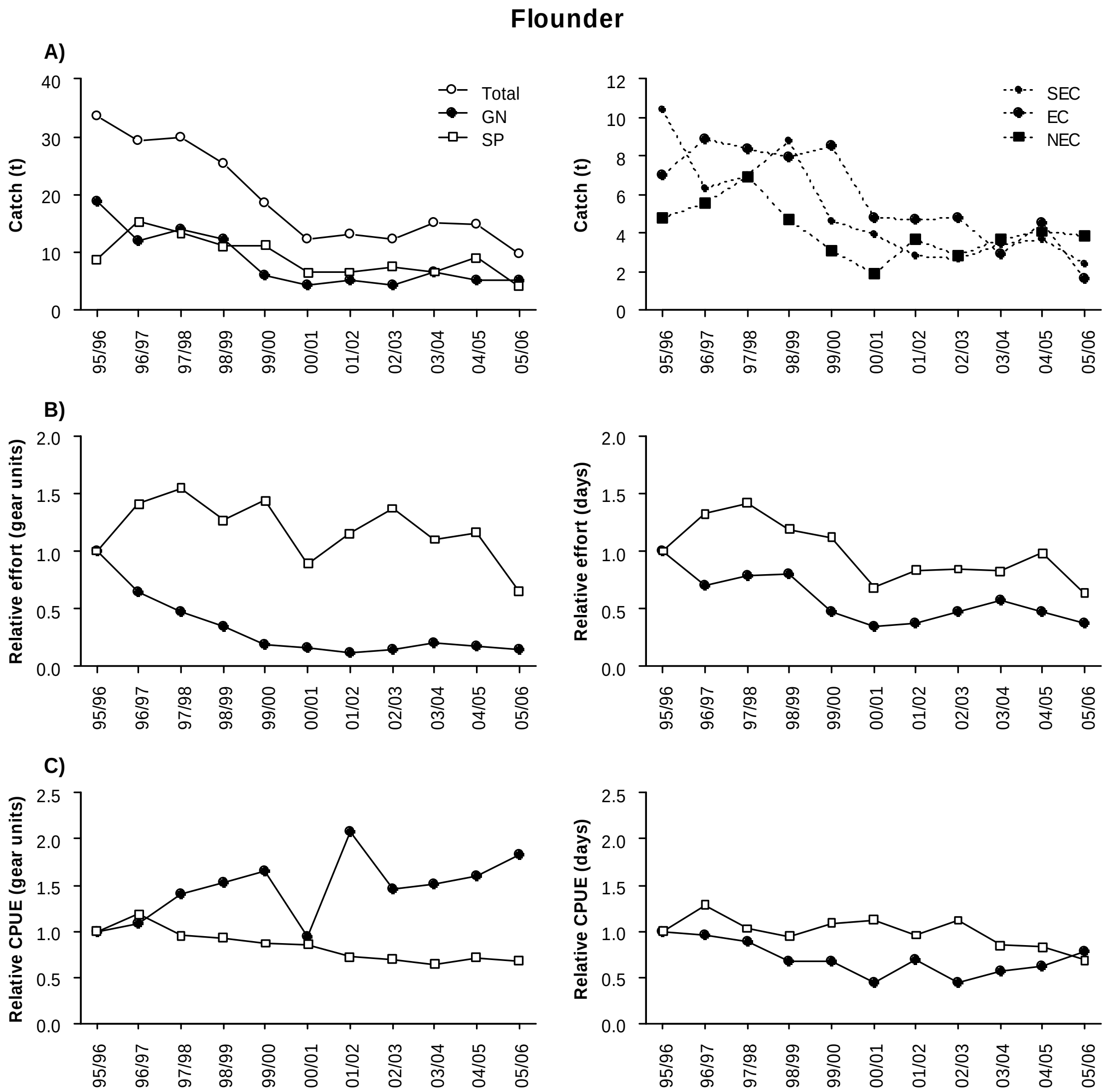

Fig. 6.11. A) Annual catch (tonnes) of flounder by method (left) and region (right) since 1995/96; B) effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and C) catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. GN is graball and SP is spear; SEC is south east coast, EC is east coast, NEC is north east coast and WC is west coast.

6.6.4 Implications for management

The apparent inconsistency in catch rate trends for graball and spear methods does not provide a clear indication of likely stock status. Industry members have, however, commented that while there have been declines in flounder stocks, there have also been market changes for the species that have impacted on the amount of effort directed at flounder.

Recreational catches of flounder clearly represent a significant component of the harvest and trends in that fishery may ultimately be more informative of stock condition. The recent prohibition on overnight gillnetting amongst recreational fishers

(2004) is likely to result in a shift to spear fishing, noting that regardless of this management change spears accounted for the majority of recreational catch taken during 2000/01 (Lyle 2005).

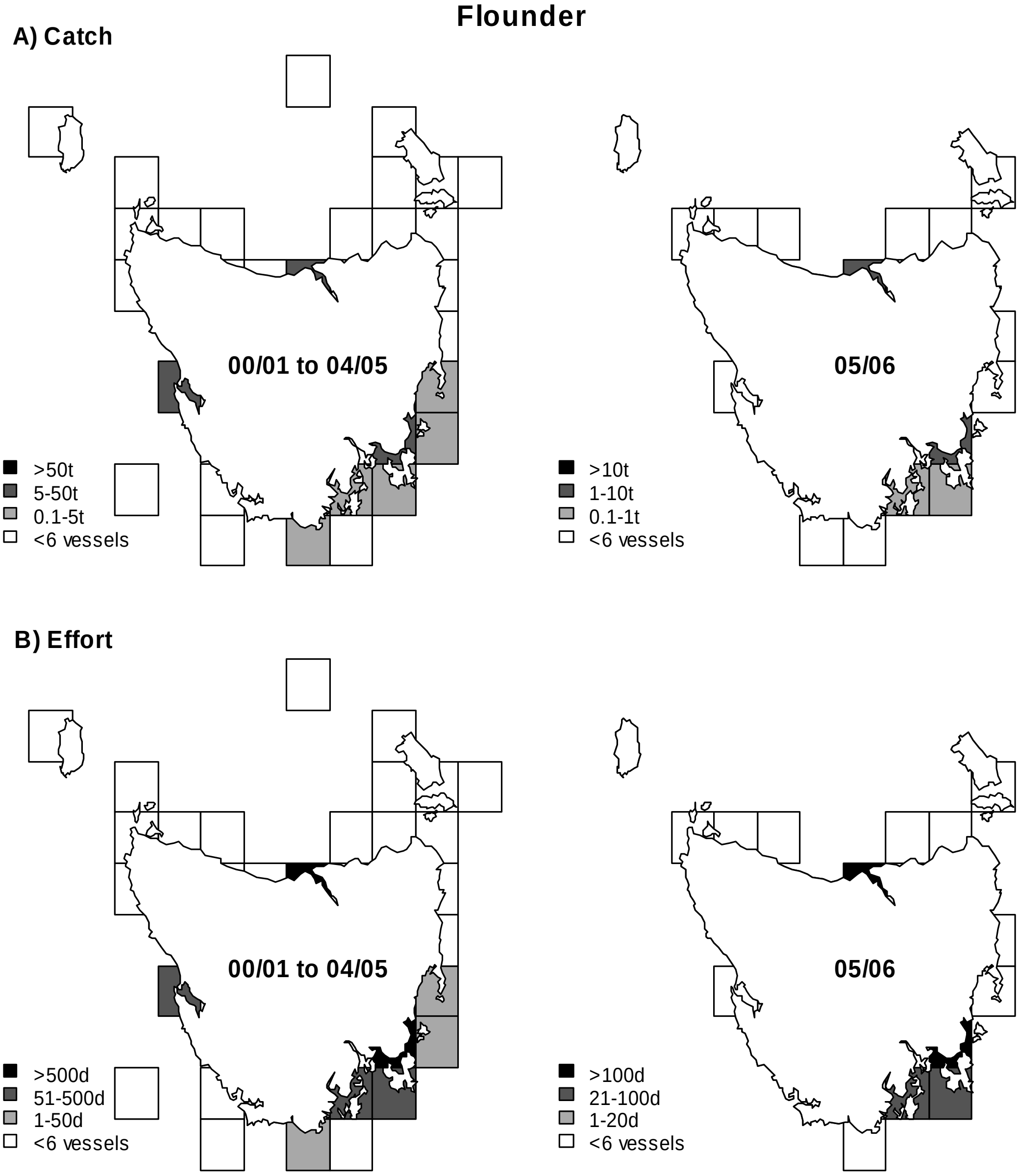

Fig. 6.12. (A) Flounder catches (tonnes) and (B) effort (days) by fishing block pooled from 2000/01 to 2004/05 (left) and during 2005/06 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

6.7 Flathead (Fam. Platycephalidae)

6.7.1 Catch

Several species of flathead occur in Tasmanian waters, but commercial catches are believed to be dominated by tiger flathead (*Neoplatycephalus richardsoni*), in particular those taken by Danish seining. Sand flathead (*Platycephalus bassensis*) are also caught to a lesser extent, but the two species are not routinely distinguished in catch returns.

Flathead catches declined steadily between 2000/01 and 2003/04 but have since more than doubled to 91 tonnes, a level more consistent with catches taken during the early 1990s (Fig. 6.13 and Fig. 2.2). Increased production was mainly due to increased Danish seine catches (not shown due to the 5 vessel rule). There are reports that a number of dormant Danish seine licences may be activated in the near future, which should result in a further increase in catches. By contrast, handline catches, mainly targeting sand flathead, have remained stable since the mid 1990s. Small quantities of flathead were also taken by graball nets and spears. 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. 6.13A and 6.14). The increased production of the past two years has been mainly focussed in the east and south east of the state.

By contrast, recreational catches are dominated by sand flathead, with tiger flathead only comprising a minor component of the harvest (Lyle 2005). The estimated recreational catch of flathead in 2000/01 was 361 tonnes, almost six times the size of commercial catch (63 tonnes) for the corresponding period.

Evaluation of 2005/06 catches against performance indicator

- State-wide catches were within the reference levels.

6.7.2 Fishing effort

Hand line effort has fluctuated without obvious trend and, overall, has remained relatively stable since the mid 1990s (note, Danish seine effort is not presented owing to the small number of operators involved) (6.13B). 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. 6.14).

Evaluation of 2005/06 effort against performance indicator

- Effort was within reference levels.

6.7.3 Catch rates

Hand line catch rates have remained stable over time (Fig. 6.13C). Although not shown, Danish seine catch rates rose further after the sharp increase in 2004/05 and presumably reflect the impact of increased targeting for the species.

Evaluation of 2005/06 catch rates against performance indicator

- Flathead catch rates were within reference levels.

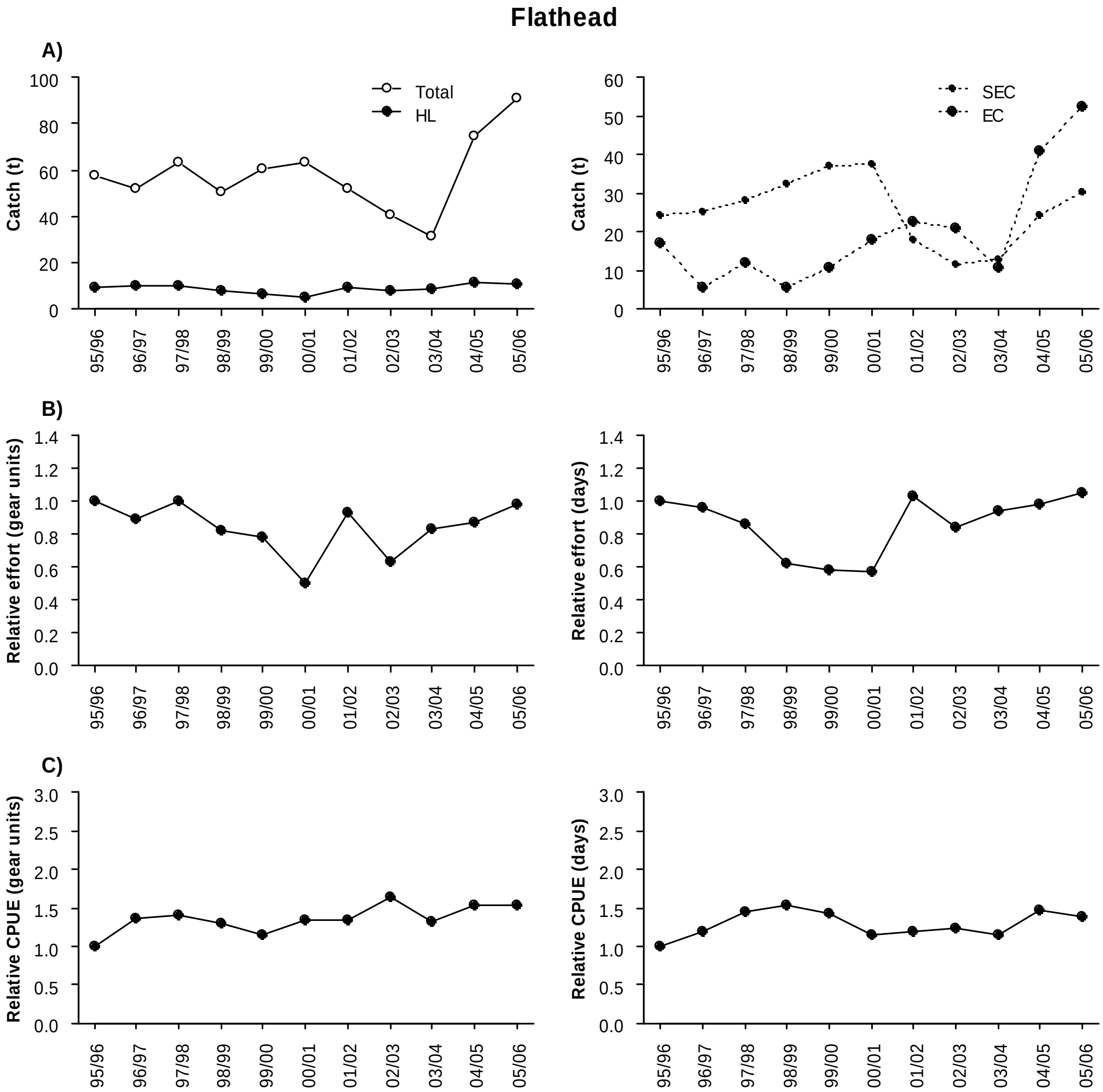

Fig. 6.13. A) Annual catch (tonnes) of flathead by method (left) and region (right) since 1995/96; B) effort by method based on gear units (left) and by days fished (right) relative to 1995/96; and C) catch per unit effort (CPUE) based on weight per gear unit (left) and weight per day fished (right) relative to 1995/96. HL is hand line; SEC is south east coast and EC is east coast.

6.7.4 Implications for management

The recent increase in the Danish seine catches was mainly due to a switch in targeting from whiting to flathead, noting that whiting catches were at their lowest level on record in 2005/06 (refer Table 2.2 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 stock classified as not overfished (Tuck 2006). Sand flathead stock status is not known, though clearly the main impact on 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 avoid the regional concentration of effort.

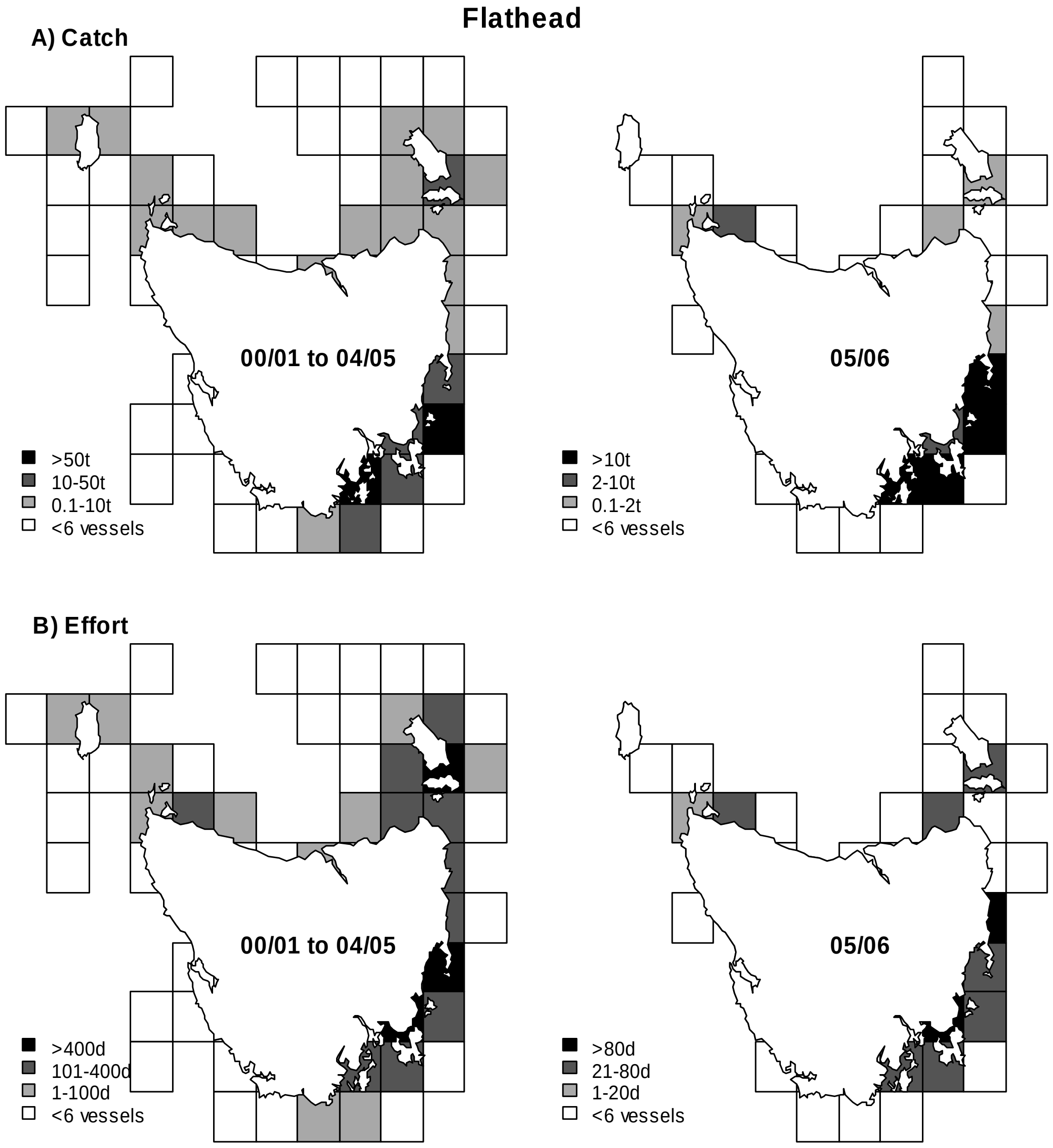

Fig. 6.14. (A) Flathead catches (tonnes) and (B) effort (days) by fishing block pooled from 2000/01 to 2004/05 (left) and during 2005/06 (right). The levels in the right graphs are 1/5 of those in the left graphs where data from 5 years have been pooled. Blocks with less than 6 vessels reporting catch are shown as empty.

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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*	Calamary	*Sepioteuthis australis*
Perch, ocean	*Helicolenus* spp.	Cuttlefish	*Sepia* spp.
Pike, long-finned	*Dinolestes lewini*	Octopus	*Octopus* spp.
Pike, short-finned	*Sphyraena novaehollandiae*	Squid, arrow	*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[2].

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.

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

Commonwealth logbook data:

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

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.

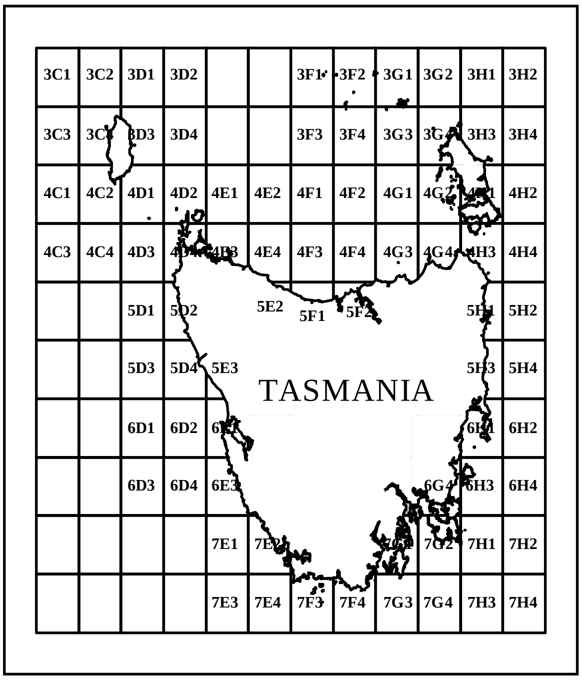

Fig. A1. Numbers for fishing blocks used in calculation of catch figures.

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.