FISHERY ASSESSMENT REPORT

TASMANIAN SCALEFISH FISHERY – 2003

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

The SFAWG met on 14 May 2004 to consider the draft assessment report and provide input into the assessments. The Working Group participants were:

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Scalefish Fishery Assessment - 2003

Executive Summary

The Tasmanian scalefish fishery is a multi-species fishery operating in state fishing waters and encompasses a wide variety of capture methods. The Scalefish Management Plan, introduced in 1998 and reviewed in 2001, provides the management framework for the fishery. An important element of the management plan is the explicit identification of performance indicators that have two primary functions:

- to monitor performance of the fishery in relation to catch and effort, and
- to 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 catch composition, catch and effort. Commercial catch history for the period 1990/91 to 2002/03 is presented, with more detailed analyses of catch and effort by method for the period 1995/96 to 2002/03. In addition to information provided in the General Fishing Returns (Tasmanian commercial catch and effort data), 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. Catch estimates for the recreational fishery in 2000/01 were available for a number of key species.

Commercial catch and effort information was available for an eight year period, the first three years being used to define reference effort and catch rate levels against which subsequent performance was evaluated. In this regard there were only five years of data against which to assess fishery performance.

The most important development in the fishery since the introduction of the management plan has been the expansion of dipnet, dropline and squid jig effort to historically high levels. However, apart from squid jigs and days fished with droplines, effort levels for these methods had fallen to within or below reference levels by 2002/03 (Table 1). The dramatic increase in squid jig effort occurred primarily in response to the expansion of the fishery for southern calamary.

Notwithstanding the fact that effort performance indicators were not triggered for the other methods, there are continuing concerns regarding the level of latent effort within the fishery from licence holders who are either not active or participating at low levels.

Table 1 Effort performance indicator assessment by major fishing methods for 2002/03
Y triggered, N not triggered.

	Effort >10% peak 1995-97 levels	
Method	*Gear units*	*Days fished*
Beach seine	N	N
Purse seine	N	N
Graball net	N	N
Small mesh	N	N
Dropline (<200m)	N	Y
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 provided for banded morwong, southern calamary and striped trumpeter while other key species were considered more briefly. Catch, effort and catch rates were examined for sea garfish, wrasse, blue warehou, bastard trumpeter, Australian salmon and flounder. Descriptions of these fisheries, including fishing methods, seasonality and spatial distribution of catches have been provided in previous assessment reports and are updated here.

Species assessments evaluate fishery dependent information (catch, effort and catch rate trends) against performance criteria detailed in the Scalefish Management Plan. Specifically, these criteria relate to levels of catch, effort and catch rates. The management plan also provides for biological indicators to be used as reference points against which stock status can be evaluated. Such indicators are expected to become more important in future assessments as such information becomes available.

Banded morwong

Performance indicators

- Catch indicators were triggered for banded morwong in 2002/03, with the current catch below the reference level. A sharp increase in catches from the northeast coast indicates continued spatial expansion of the fishery.
- Increased effort in the St Helens region triggered the effort indicator.
- The State-wide catch rate indicator was not triggered, however, standardised catch rates for Bicheno and St Helens triggered the indicator, as did the unstandardised catch rate for Bicheno.
- Significant changes in size and age composition, and sex ratios indicate that the fishery has impacted on stock structure.

Resource status

- Evidence suggests that current exploitation rates are too high and not sustainable and that management action is required to reduce fishing mortality in this fishery.

The fishery for banded morwong expanded in the early 1990s with the development of live fish markets for the species. Between 1994/95 and 1999/00 annual production declined steadily with catches generally tracking changes in effort. The 2002/03 catch of 54 tonnes was very similar to 2001/02 and lower than reference levels. There had been a recent increase in catches from the northeast, set against an overall decline in catches from the more traditional fishing areas off the east coast.

State-wide effort (days fished) increased slightly over 20001/02 but remained slightly lower than during the reference period. There had, however, been a steady and gradual increase in effort since the mid 1990s in the St Helens region. Other regions were within or below reference levels. Standardisation of catch rates using generalised linear models was attempted for the first time and compared with unstandardised catch rate trends. State-wide catch rates (kg/day) were within reference levels, with catch rates for Tasman Peninsula increasing in the current year. Standardised catch rates in Bicheno and St Helens and unstandardised catch rates in Bicheno were below 80% of the lowest levels during the reference period.

Catch and catch rate indicators suggest that, initially at least, the fishery impacted on banded morwong populations. There has been stability in both measures in the last few years, an observation that was consistent with industry perceptions. However, this stability does not necessarily indicate the sustainability of current levels of exploitation. There are at least three limitations related to the use of fishery dependent data. These include the masking of localised changes in abundance arising from the expansion of the fishery within and outside of traditional fishing grounds, the limited insights that catch rates provide into stock status for a species such as banded morwong, and issues of data quality of commercial catch returns. Seal interactions also represented a significant factor in this fishery, in terms of incidental mortality and impacts on catch rates and fisher activity.

For the first time a range of biological measures including size structure, age structure, and sex ratios were investigated. Each of these measures indicated that the fishery had impacted on the stocks. Some of these changes were dramatic, such as the decrease of median age for females from around 20 to 7 years and the shift in sex ratio away from a dominance of females in the catch. Changes in the stock structure with exploitation were to be expected, however, at sustainable levels of exploitation it was expected that the biological measures would attain some form of dynamic equilibrium. This has not yet happened. Instead, the changes have continued through time at a rate and direction that suggested exploitation rates were too high. Yield-per-recruit and spawning biomass-per-recruit analyses were the only methods to provide some measure of fishing mortality, and even these methods did not ensure sustainability. Nevertheless, both methods recommend very low fishing mortality levels at around $F = 0.1$ to obtain optimal long term yields from the fishery. Catch curve analysis suggested that these levels have been exceeded and in some regions by a considerable amount. Based on life history, in particular the longevity of the species, productivity of banded morwong is expected to be low. Thus, if over-fishing has occurred, stock recovery will be slow even if the fishing effort was significantly reduced.

Therefore, despite uncertainty in the significance of the biological changes in relation to stock status, the general downward trend in all biological indicators, set against low productivity, suggest that current fishing pressure is too high and not sustainable and that management action is required to reduce fishing mortality in this fishery. This will require a real reduction in fishing effort and due to the limited mobility of this species, any management action should explicitly include reference to the spatial distribution of effort.

Southern calamary

Performance indicators

- Catch and jig effort performance indicators for southern calamary were triggered for the fifth consecutive year.
- Preliminary modelling suggested that current exploitation rates in the main area of the fishery were very high and unlikely to be sustainable.

Resource status

- There was a high degree of uncertainty with the assessment model but key indicators do suggest the need for management action to reduce exploitation rates in the main region of the fishery.

The fishery for southern calamary expanded markedly in 1998/99. Subsequent catches have exceeded those for the reference period reflecting the development of this as a target fishery. The 2002/03 catch of 108 tonnes was the highest on record. Jig effort continued to escalate, up by 40% compared to 2001/02. State-wide jig catch rates declined but were within reference levels. Regionally declines were evident for Mercury Passage and the Tasman Peninsula, whereas catch rates rose in Great Oyster Bay. However, all regional catch rates were within or above reference levels.

Preliminary modelling of catch and effort data for the major fishing areas (Great Oyster Bay and Mercury Passage) was investigated using surplus production analysis. The analysis suggested that the unfished, mid-season exploitable biomass was in the order of 200-245 tonnes but had been reduced to below 50% of this level, implying that current harvest rates were very high. Considerable uncertainty is associated with this analysis. Nevertheless, the increasing trend in the implied harvest rate was consistent with declining catch rates, declining levels of estimated egg-production and the increasing effort being imposed on this species.

Evaluation of catch and effort performance indicators for calamary was compromised, because the fishery effectively developed after the management plan was introduced. As such, catch and effort indicators are likely to continue to be triggered and, in fact, it would be of greater concern if catches fell to within historic levels (potentially indicating the collapse of the fishery) than remained above reference levels.

Although there was a high degree of uncertainty with the present assessment, key indicators suggest that maintaining the *status quo* for the Tasmanian southern calamary fishery is a high risk strategy. For the fishery to remain sustainable a more precautionary approach is required including consideration of options that will effectively reduce harvest rates.

Striped trumpeter

Performance indicators

- Further falls in the catch of striped trumpeter occurred in 2002/03 resulting in the catch performance indicator being triggered, with the catch being the lowest recorded since the late 1980s.
- Dropline effort increased sharply and although catch rates have remained stable over the past three years, both effort and catch rate performance limits were exceeded. By contrast, effort and catch rates for handline and graball methods did not exceed their performance limits.

Resource status

- Resource status was uncertain though potentially depleted due the effects of fishing coupled with apparent poor recruitment. Increased minimum legal length would increase potential yield.

The 2002/03 catch of striped trumpeter of 36 tonnes was the lowest recorded since the late 1980s. Falls in catches were apparent for handline and graball methods but there was a slight increase in the dropline catch due to a 36% increase in effort (days fished) compared to 2001/02. Catch rates (kg/day) for handline and graball methods have exhibited no obvious trends over time, but have proven relatively insensitive in the past even when strong recruitment pulses were passing through the fishery. Dropline catch rates declined since the late 1990s, but have stabilised over the past three years at around 50% of the mid 1990s levels.

Falling graball net catches (primarily juvenile fish) over the past four years and reductions in offshore hook catches (mainly adult fish) over the past three years suggest that the biomass of new recruits and adults may have declined significantly. While fishing will have acted to reduce biomass, noting that commercial catches in 1998/99 and 1999/00 were historically very high, striped trumpeter do exhibit strong recruitment variability that will produce inter-annual variability in fishable biomass. Recent graball catches provided no evidence to support strong recruitment over the past few years.

The introduction of a 250 kg trip limit may have contributed to the downturn in catches. There was evidence that the quantities of gear fished each day had declined (presumably to limit catches) and there were reports that many operators had simply decided not to bother targeting the species because of the low catch limit. There was also a possibility that available catch data were not comprehensive. Reporting requirements for Commonwealth operators changed recently and catches from this sector have not been taken into account in the assessment, suggesting that the decline may not have been as pronounced as indicated by available information.

Based on yield-per-recruit, the current minimum size limit would appear to be sub-optimal and consideration should be given to increasing the size limit substantially to increase yield and reduce the likelihood of growth over-fishing. Furthermore, under the current size limit many fish were taken before reaching maturity, which may impact on future egg production and recruitment. 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.

Although a more rigorous assessment is required to assess the sustainability of the fishery, this fishery seemed to have declined and is expected to continue to do so without management action or a period of sustained good recruitment. It would be prudent to act to reduce fishing mortality, both commercial and recreational, and review the minimum size limit.

Sea garfish

Performance indicators

- No performance indicators were triggered for sea garfish in 2002/03.

Resource status

- Fishery dependent indicators provide no basis for concern over resource status.

The 2002/03 garfish catch of 92 tonnes was slightly above 2001/02 but within the reference range for the species. Beach seine effort had increased slightly over the past 3 years (but within reference levels), whereas dipnet effort had declined. Dipnet and beach seine catch rates remained relatively stable over the past 4-5 years and were above (beach seine) or within (dipnet) reference levels. Sea garfish are a schooling species and thus catch rate trends may not be reliable nor sensitive indicators of abundance.

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

Wrasse

Performance indicators

- Wrasse catches had fallen below reference levels in 2002/03 and therefore triggered the catch performance indicator for the first time.
- Effort and catch rate indicators were not triggered.

Resource status

- Resource status was unknown though the species are vulnerable to localised depletion of legal-size biomass. However, minimum size limits provide considerable protection to female spawner biomass of both of the key wrasse species.

The development of live fish markets for wrasse resulted in increased catches since the early 1990s. Two main species are involved, purple wrasse and blue-throat wrasse, though catches of these species were not generally distinguished in catch returns. The

2002/03 catch of 72 tonnes represented a 22% reduction over the previous year and was just below reference levels for the first time.

Purple and blue-throat wrasse accounted for the bulk of the catches reported as wrasse for fish trap and handline methods, respectively. In the absence of species information, catch and catch rate trends for these two gear types were used as proxies for the relevant species, thus overcoming some of the uncertainties caused by grouping the species. General stability or even increasing catch rates for both of the major fishing methods implied that they had not been impacted significantly by the fishery. However, broad-scale analyses may be relatively insensitive to changes in abundance at the scale at which the fishery impacts on the fish populations, that is at the individual reef level. Marked regional shifts that have occurred in the fishery may have also masked localised depletions, with fishers moving to new or lightly fished areas to maintain catches. As a consequence, caution needed to be exercised when making inferences about the status of the wrasse stocks even though key fishery indicators did not indicate significant fishery impacts.

Blue-throat males may not be adequately protected by the current minimum size limit since the size at sex change was generally larger than the size at which fish recruit to the fishery. This coupled with the fact that they are strongly site attached and have higher catchability (being more aggressive than females), suggested that males were particularly vulnerable to over-fishing. Localised heavy fishing pressure could, in extreme situations, 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 has exacerbated this situation.

Blue warehou

Performance indicators

- Blue warehou catches have remained poor, triggering the catch performance indicator for the third year.
- Effort and catch rate indicators were not triggered.

Resource status

- Stocks were over-fished and availability of warehou in Tasmanian waters continued to be low. Management action to reduce catches has been implemented in the Commonwealth fishery.

Recent studies have indicated that there are two stocks of blue warehou in Australian waters, one to the west and one to the east of Bass Strait. The fishery for blue warehou in state fishing waters was centred off the southeast coast and thus probably targeted the eastern stock. Catches were also taken off the northeast and northwest coasts, the latter potentially involving the western stock.

The blue warehou catch of 49 tonnes in 2002/03 represented the third year of catches below the minimum level for the reference period. Graball effort remained low and catch rates, although below reference levels, did not trigger the catch rate performance indicator.

A range of environmental factors, as well as stock size, influences the availability of blue warehou in Tasmanian inshore waters. Recent depressed catches were 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 were likely to remain low for some time.

Bastard trumpeter

Performance indicators

- Current catches of bastard trumpeter were below reference levels, triggering the catch performance indicator for the third year.
- Effort and catch rate indicators were not triggered.

Resource status

- Resource status was uncertain though potentially depleted due to the effects of fishing coupled with poor recruitment.

Bastard trumpeter catches have declined steadily since the mid 1990s and the current catch of 20 tonnes was the lowest reported since the late 1980s.

Since bastard trumpeter were taken largely as a by-product, catch rates were probably a poor indicator of stock status. Total catch may, therefore, be a better indicator of abundance. As such, trends in commercial production suggested that current inshore populations were at low levels.

The species exhibits strong recruitment variability, and there is 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 stocks, but would effectively close down the fishery for the species.

Australian salmon

Performance indicators

- Australian salmon catches had fallen in 2002/03 but were within reference levels.
- Catch rate performance indicators based on beach seine catches were triggered, while effort has remained stable since the mid 1990s.

Resource status

- Resource status was unknown.

The total catch of Australian salmon in 2002/03 of 407 tonnes was about 10% lower than the previous year but within reference levels.

Beach seine catch rates were just over half the minimum for the reference period, but it was recognised that catch rate estimation was influenced by the extremely skewed nature of the data, i.e. the majority of catches were small but the total catch was influenced by a very small number of extremely large catches. In this respect, catch rates are not a particularly sensitive indicator for schooling species such as Australian salmon.

To a large extent, commercial catches of Australian salmon are linked to market demand, specifically the bait market, and are thus probably not a good indicator of stock status. There is capacity within industry to significantly expand production should new markets be found, and under such circumstances management may need to be proactive in moderating such expansion.

Flounder

Performance indicators

- Flounder catches in 2002/03 were below reference levels and thus the catch performance indicator was triggered.
- Spear and graball effort for flounder has remained low and did not exceed indicators.
- While spear catch rates have remained stable over time and were within the reference range, graball catch rates have continued to decline and triggered performance indicator levels.

Resource status

- Resource status was unknown.

Flounder catches had declined steadily since the mid 1990s, and at just 10 tonnes in 2002/03 the catch was below the minimum reference level. Fishing effort for the major methods, spear and graball, had been stable at low levels over the past 4 years. Spear catch rates had been consistent since the mid 1990s, while graball catch rates had declined to about 66% of the lowest reference level.

The degree of interest by the commercial sector in flounder appeared to be quite low. It was unclear whether this was market or resource driven. The current status of flounder stocks was therefore unknown.

2002/03 performance indicator summary

Performance indicator analysis for key species 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.

Y triggered; N not triggered; arrows indicate direction of change; na not assessed; # applies only to particular methods or regions; Catch history period is *1994/95 to 1997/98 & ** 1995/96 to 1997/98; H high risk, M medium risk; ˣ management action being taken in Commonwealth fishery.

Species	*Catch*		*Effort*	*Catch rate*	*Biological*	*Risk of no*
	Outside 90-97 range	*Decline/ increase by >30%*	*Increase by >10% from highest 95-97 level*	*< 80% min. 95-97 range*	*Indicators of stock stress*	*management action*
Banded morwong*	Y ↓	N	N	Y #	Y	H
Southern calamary	Y ↑	N	Y	N	Y	H
Striped trumpeter	Y ↓	N	Y #	Y #	na	M
Garfish	N	N	N	N	na	
Wrasse**	Y ↓	N	N	N	na	
Blue warehou	Y ↓	N	N	N	na	Hˣ
Bastard trumpeter	Y ↓	N	N	N	na	
Australian salmon	N	N	Y	N	na	
Flounder	Y ↓	N	N	Y #	na	

Table of Contents

1 Management Objectives and Strategies

The Scalefish Management Plan was first introduced in 1998 (DPIF 1998) and reviewed in 2001. The plan provides the management 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 some developing fisheries under permit conditions.

1.3 Performance Indicators

In the absence of more quantitatively rigorous stock assessments, the Scalefish Fishery Management Plan includes a number of performance indicators that are applied generically to the fishery and specifically at the species level. 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, trigger points 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. Trigger points are reached 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 scalefish fishery is a multi-gear and multi-species fishery. Jurisdictional issues complicate its management, with several key species harvested across a number of jurisdictions (Lyle and Jordan 1999).

A wide range of fishing gears, the most important being gillnet, hooks and seine nets, are used to harvest 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 fishery is dynamic, with fishers readily adapting and changing their operations in response to changes in fish availability and in response to market requirements. As a consequence, only a small proportion of the fleet has specialised in a single activity or to targeting a primary species. For many operators, scalefish represent an adjunct to other activities, for instance rock lobster fishing.

This report represents the sixth in a series of annual assessments of the scalefish fishery and incorporates catch and effort information available up to and including June 2003. Copies of previous assessment reports (Lyle and Jordan 1999, Jordan and Lyle 2000, Lyle and Hodgson 2001, 2002, Lyle 2003) are available on the Tasmanian Aquaculture and Fisheries Institute web page http://www.utas.edu.au/docs/tafi/TAFI_Download.htm

2.2 Data sources

Commercial catch and effort data are based on Tasmanian General Fishing Returns and Commonwealth non-trawl (GN01 and GN01A) and Southern Squid Jig Fishery (SSFJ) logbook returns. Unless noted otherwise, catch and effort data reported in this assessment relate to the commercial sector.

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 provided 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. Recent amendments (1999) to the catch return have included provision to nominate target species and indicate interference to fishing operations from marine mammals (seals or killer whales).

In the analysis of 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 has to some extent removed the necessity to include subsequent Commonwealth catch and effort data into analyses. However, it has become apparent that there may be some confusion amongst fishers about reporting requirements and there are concerns that catches of species such as striped trumpeter taken by Commonwealth operators, have not been routinely reported in the Tasmania catch returns as instructed.

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 2003. All catch returns available as at October 2003 have been incorporated in the analyses.

Catch returns for which effort was incomplete or unrealistically high or low (either due to data entry error or misinterpretation of information requirements by fishers) have been flagged and excluded when calculating effort levels and catch rates. Effort information for approximately 0.2% of all fishing records was excluded in this manner. These records were, however, included when reporting catches.

A fishing year from 1st July to 30th June in the following year has been adopted for annual reporting. The primary justification being that this period better reflects the seasonality of the fisheries for most species, 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.

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, for dropline and longline, effort is expressed as number of hooks set, while handline fishing as the product of the number of lines fished and fishing time. A table of effort measures is provided in Table 2.3.

In generating catch rate statistics, the arithmetic mean of catch rates does not accurately describe 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 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 differ slightly from the more simplistic approaches of dividing total catch by total effort or using an arithmetic average of all catch records.

2.2.4 Recreational fishery

Catch and effort information for the recreational sector are available from a national survey of recreational fishing undertaken during between May 2000 and April 2001 (Henry and Lyle 2003) and a state-wide survey of licensed fishing activity for the period December 1996 to April 1998 (Lyle 2000).

2.3 Recent catch trends

Annual commercial catches since 1990/91 are presented in Table 2.1 and catch trends for the major species are summarised in Fig. 2.1. Overall, scalefish catches have declined from over 2,000 tonnes in the early 1990s to between 1,000-1,500 tonnes in recent years. The 2002/03 catch of 1,015 tonnes represented a fall of about 170 tonnes compared to the previous year. Lower catches of Australian salmon, barracouta, blue warehou and wrasse were the primary contributors to the overall decline in scalefish catches.

In assessing trends within the scalefish fishery it is important to recognise that some species, such as blue warehou, barracouta and arrow squid, occur seasonally within Tasmanian waters and that availability can vary markedly between years. It is generally recognised that such variability does not necessarily reflect changes in stock condition and as such these species represent ‘bonus’ or opportunistic fisheries when available. By contrast, species such as banded morwong, garfish, wrasse, the trumpeters and calamary are resident coastal species and catch variability reflects a combination of factors including market influences, management intervention and stock status.

Australian salmon have consistently dominated the scalefish catch, with catches in excess of 650 tonnes p.a. prior to 1995/96. More recent landings of this species have remained lower, fluctuating between about 300-480 tonnes. The 2002/03 catch of 407 tonnes represented a decline of just over 10% compared with 2001/02, but was within 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.

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 65 tonnes, although about half that for 2001/02, was higher than for the preceding three years and was within reference catch levels.

Flathead catches declined from over 150 tonnes p.a. in the early 1990s to around 50 tonnes, largely due to reductions in inshore trawl (demersal trawl and Danish seine) activity (Lyle and Jordan 1999). Demersal trawling was banned in State Fishing Waters in 2001 and there are currently very few active Danish seine operations. Since 1995/96, flathead catches have ranged between 50-60 tonnes, though the 2002/03 catch of 40 tonnes represented a 33% decline compared to the previous year to fall below the lower reference catch level for the first time.

Catches of flounder have typically ranged between 30-40 tonnes, but over the past four years have fallen to below 20 tonnes. Just 10 tonnes were reported in 2002/03. It is unclear whether this is a reflection of reduced abundance or changed market demand, but recent catches remain well below the lower catch reference level.

Apart from the mid 1990s, sea garfish production has remained relatively stable at between 80-100 tonnes p.a. Current landings of 92 tonnes represent a slight increase over 2001/02.

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 subsequent to 1995/96 have generally declined, from almost 90 tonnes to less than 35 tonnes in 1999/00. Production has increased over the past three years, to 54 tonnes in 2002/03, but current catches still remain below reference levels.

Corresponding to the reduction in inshore trawl activity in the early 1990s, jackass morwong landings declined from over 100 tonnes to 15-30 tonnes p.a. in more recent years. The current catch was just below reference levels and virtually unchanged compared to 2001/02.

Landings of mullet declined gradually from around 30 tonnes to 10 tonnes p.a. in the mid 1990s. Since that time catches have fluctuated between 10-20 tonnes. The most recent catch is below the lower reference catch level for the first time.

Whiting catches experienced a marked decline during the early 1990s, largely in response to reduced inshore trawl activity, but have stabilised since 1996/97 with landings of between 30-40 tonnes p.a.

Up until the mid 1990s, bastard trumpeter catches fluctuated between 35-65 tonnes p.a., but have since declined steadily to just 20 tonnes in 2002/03, the lowest level reported since the late 1980s. By contrast, striped trumpeter production expanded from the early 1990s to over 100 tonnes in 1999/00 before dropping sharply to just 36 tonnes in the current year. The reasons for recent declines in catches of both trumpeter species remain unclear, but may be linked to reduced availability, since markets especially for striped trumpeter are well established.

Blue warehou production has fluctuated widely, between around 100-300 tonnes p.a. since the early 1990s. The most recent catch of 49 tonnes represented a 27% decrease compared to the previous year and was well below the minimum reference catch level.

The marked increase in wrasse landings in the early 1990s was due to the expansion of live fish markets. Subsequent to 1995/96, however, wrasse production stabilised at around 85-100 tonnes p.a. The most recent catch of 72 tonnes was 23% lower than for 2001/02 and lower than the reference catch level for the first time.

Cephalopod production at 180 tonnes was slightly higher than in 2001/02 due to small increases in calamary and octopus catches. 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. Subsequent catches have remained high and peaked in the current year at 108 tonnes, the highest catch on record. Octopus production increased gradually from around 30 to 75 tonnes p.a. by the mid 1990s and despite some variability since, appears to have stabilised at around 60 tonnes p.a. After increasing sharply in 1999/00 to 480 tonnes, arrow squid catches fell to 40 tonnes in 2000/01 and then to just 2 tonnes in both 2001/02 and 2002/03.

Table 2.1. Annual 'Tasmanian' scalefish and cephalopod production (whole weight) by species for the period 1990/91 to 2002/03

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**
Scalefish													
Australian salmon	815.9	651.9	867.0	878.8	682.1	412.7	287.3	476.0	384.7	363.7	485.0	462.1	406.8
Barracouta	351.5	268.3	205.4	59.6	25.2	19.9	53.8	65.2	27.6	25.0	15.1	132.1	65.4
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	3.3
Bream	5.7	3.5	1.4	7.4	7.2	2.5	9.9	1.0	0	0.1	0	0.1	0.4
Cod	10.0	11.3	11.6	14.5	12.7	22.4	15.3	10.2	9.8	9.0	4.0	3.0	2.2
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
Eel	0.2	0.5	0.9	2.2	3.1	2.1	1.4	1.7	2	1.2	0.8	0.4	0.4
Flathead	165.3	118.1	98.8	121.4	91.1	57.8	51.8	62.9	50.6	60.3	63.4	52.1	40.5
Flounder	44.0	36.8	31.8	27.3	27.1	33.3	29.3	26.7	22.8	15.4	10.5	11.6	10.1
Garfish	80.9	80.1	82.3	82.9	69.3	56.0	91.6	83	101.7	91.2	81.4	87.8	91.8
Gurnard	20.5	19	19.3	19.3	14.0	14.2	12.4	9.9	7.1	9.9	7.8	5.4	9.7
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
Leatherjacket	12.2	14.0	13.1	23.3	27.7	14.5	12.6	13.3	12.9	16.5	16.7	16.6	13.7
Ling	5.1	13.6	30.0	41.6	33.2	21.7	23.8	11.8	5.0	2.2	5.2	1.1	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	0.1
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
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
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	54.1
Morwong, jackass	136.9	111.9	83.2	117.6	63.1	27.2	19.2	34.1	18.2	16.7	13.7	14.8	14.4
Morwong, other	3.8	5.6	5.2	13.9	8.1	5.4	7.5	7.5	6.3	1.5	0.6	1.4	1.8
Mullet	31.2	22.2	26.2	19.5	23.8	10.4	11.2	16.0	14.5	21.0	13.7	12.1	7.3
Other	106.8	92.1	77.6	60.0	25.2	21.1	23.8	21.2	19.4	10.6	9.7	10.9	33.3
Pike, long-finned	0.1	0	0.1	0.3	0.2	0.3	3.1	3.9	9.5	10.0	6.6	12.2	10.7
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
Pilchard/anchovy	0.1	0	3.8	14.6	12.1	6.2	4.3	15.4	2.8	1.7	3.2	0.7	0
Stargazer	10.7	3.0	1.2	4.3	1.5	0.2	0	0.3	0.1	0.2	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	5.4
Trevally, unspec.	5.6	1.4	9.5	2.4	6.1	0	0	0	0	0	0	0	0
Trumpeter, bastard	63.3	37.2	34	54.8	50.8	60.1	51.8	40.7	47.7	36.4	26.2	23.9	20.4
Trumpeter, striped	74.5	58.2	52.7	56.5	72.4	60.3	80.4	81.1	107.4	100.9	49.6	40.0	35.9
Trumpeter, unspec.	0.7	0	0	0.4	0.1	0.2	0.1	0.6	3.5	0	0	0	0
Warehou, blue	257.6	317.6	187.7	250.1	205.4	82.2	128.9	189.5	274.3	187.6	36.3	66.4	48.9
Warehou, spotted	0.7	0.4	4.2	8.8	3.4	14.6	15.6	4.8	0	0	0	0	0.2
Whiting	124.2	152.3	84.3	97.9	81.4	25.3	39.3	48.1	30.4	31.4	42.5	39.9	35.9
Wrasse	57.2	71.7	97.3	142.4	178.0	83.4	110.1	100.0	90.7	85.4	88.4	92.0	71.6
Total scalefish	**2450**	**2154**	**2135**	**2367**	**1933**	**1206**	**1224**	**1459**	**1374**	**1169**	**1050**	**1182**	**1015**
Cephalopod													
Calamary	8.2	7.5	5.8	9.7	12.6	33.0	19.0	26.6	90.6	84.6	76.6	104.8	108.4
Cuttlefish	0.5	0.7	0	1.1	0.8	0.2	0.3	0.2	0	0	0	0.7	2.4
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	67.6
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
Total cephalopod	**76.0**	**50.6**	**60.2**	**76.7**	**77.3**	**115.8**	**67.9**	**83.0**	**255.8**	**626.7**	**178.3**	**170.9**	**180.3**

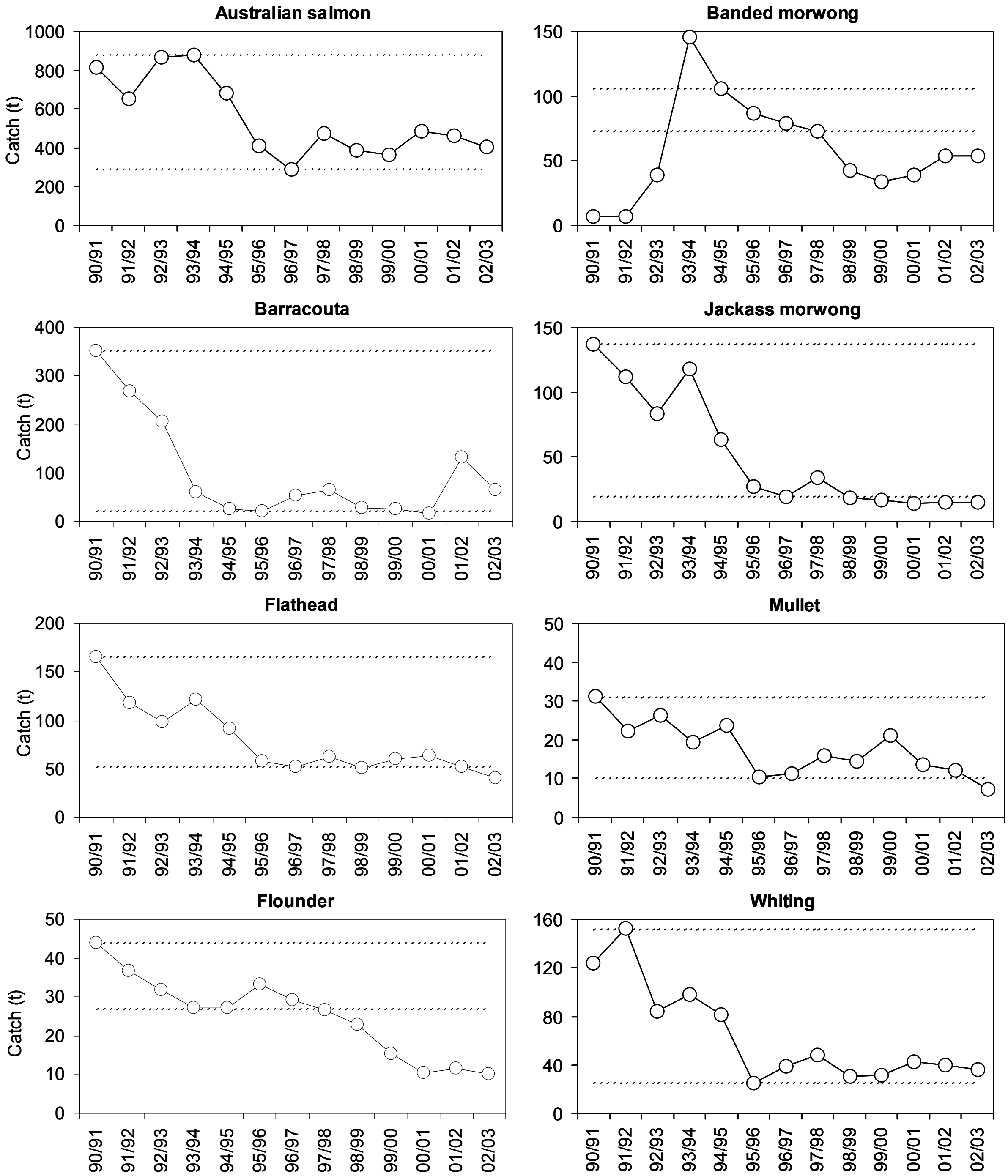


Fig. 2.1. Annual catches for key scalefish species 1990/91 to 2002/03. Dotted lines indicate upper and lower catch levels for the catch reference period (1990/91-1997/98 for all species except banded morwong [1994/95-1997/98] and wrasse [1995/96-1997/98]).

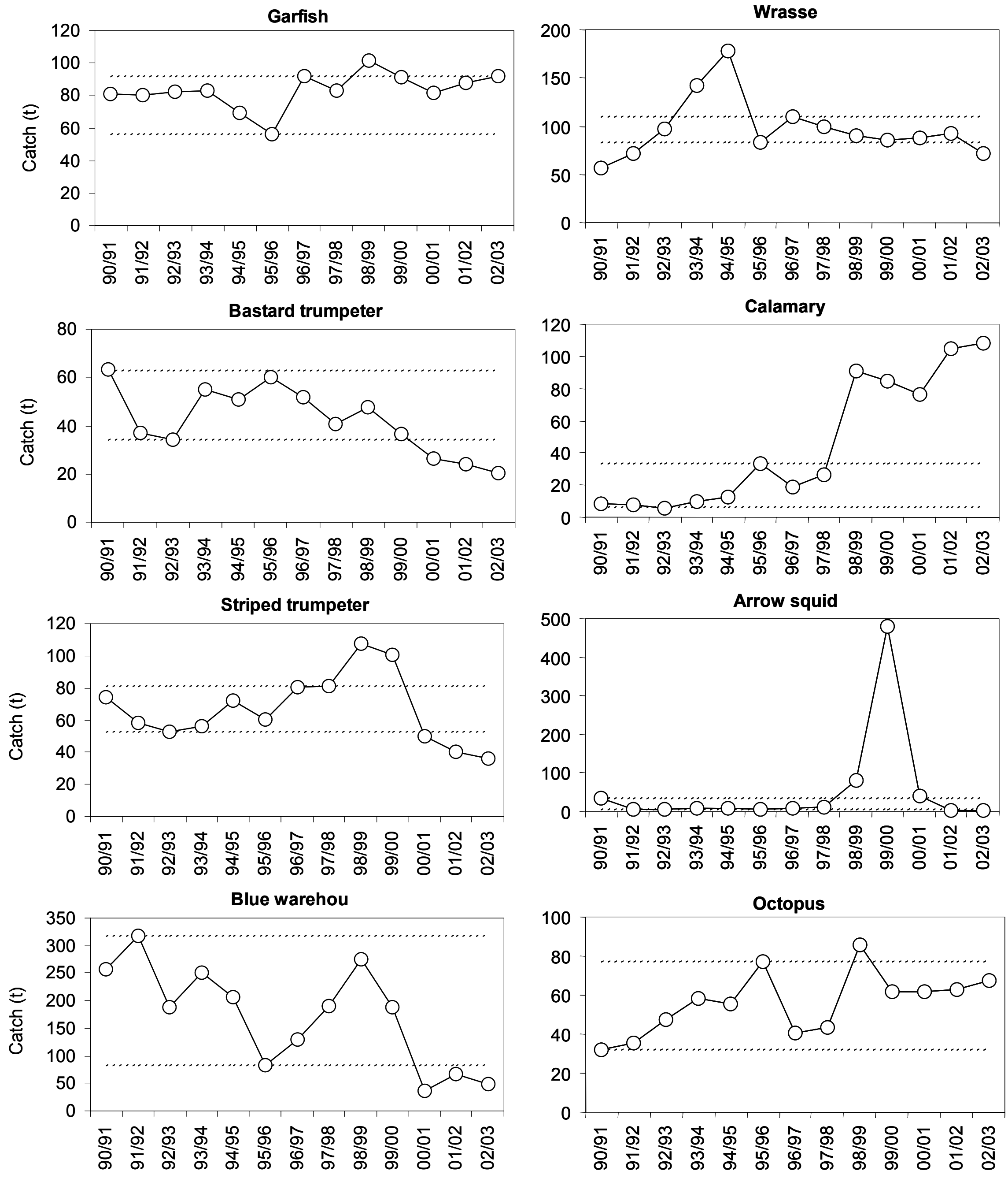


Fig. 2.1. Continued.

2.4 Effort

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 2.2. Since a variety of gear types are represented, it has been necessary to express effort in units appropriate to each specific fishing method (Table 2.3). 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 is 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 has been limited to depths of less than 200 m. This restriction effectively excludes fishing for blue-eye trevalla (now managed by the Commonwealth) and, as less than 1% of the striped trumpeter catch is reported from depths greater than about 200 m, it effectively encompasses the target dropline fishery for that species. Catch and effort for shark net and bottom longline methods has been excluded from this analysis, since these methods relate specifically to the shark fishery, now managed by the Commonwealth.

By comparison with the reference period from 1995/96 to1997/98, effort levels in 2002/03 for most gear types were within range (handline and dipnet methods) or lower (purse seine, graball, fish traps and spear methods) (Table 2.2). In the case of beach seine and small mesh net effort, days fished were lower or within reference levels but effort units were higher (though less than 10% higher), indicating greater amount of gear fished each day. Conversely, the number of days fished with droplines was significantly higher (around 55%) than during the reference period, although the amount of gear used was lower. The introduction of trip limits in late 2000 for striped trumpeter, the primary target species for droplines, may have resulted in fishers using fewer hooks/lines per day in an effort to restrict catches to within the trip limit. Squid jig effort, by contrast, continued to be significantly higher than during the reference period, a direct consequence of the development of the calamary fishery.

Compared to 2001/02, effort levels in 2002/03 were generally similar or lower for all gear types apart from graball, dropline, and squid jig, which had experienced increases in effort.

Since 1995/96, effort trends for the major gear types have included general decline (purse seine and graball), initial increases or stability but recent decline (dipnet and fish trap), relative stability (beach seine, handline and small mesh net) and sharp increases (squid jig) (Table 2.2 and Fig. 2.2). Following the introduction of the new management arrangements in November 1998, beach seine, purse seine, graball and handline effort fell whereas dropline, squid jig and dipnet effort increased sharply. While a range of factors including availability of target species and market developments have had an influence, there is little doubt that the management change has had a direct impact on effort. 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[1] methods (hooks, jigs and dipnets).

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

[1] That is, the gear is equally available to all licence-holders.

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 (Fig. 2.2). For instance, beach seines are primarily used to target either Australian salmon or garfish. While effort for Australian salmon has remained relatively stable since 1995/96, there has been a slight increase in garfish effort in the past two years to a level generally comparable to that immediately prior to the introduction of the management plan. The decline in purse seine effort has been driven largely by falls in effort directed at calamary, whereas there has been only minor variation in effort for garfish in recent years.

Lyle (1998) noted that there are effectively three main sub-fisheries within the graball fishery, i.e. targeted at blue warehou, banded morwong and flounder. A variety of other species are commonly taken as by-catch of these sub-fisheries. If graball effort is analysed based on the occurrence of these target species, an initial increase in effort for blue warehou was evident, peaking in 1997/98 (gear units) and 1998/99 (days fished), followed by a rapid decline especially between 1999/00 and 2000/01. In the subsequent years, effort has remained at a low level. By comparison, effort directed at banded morwong and at flounder declined steadily although the decline for banded morwong appears to have been arrested in the two most recent years.

Striped trumpeter and wrasse are the two main species targeted with handlines and these fisheries demonstrate different trends in effort. There was a slight increase in handline effort for striped trumpeter up until 1999/00, but since then effort has gradually fallen. This pattern contrasts the wrasse fishery, where effort rose to an initial peak in 1996/97, declined to 1998/99, before climbing steadily once again to levels similar to the mid 1990s.

The overall decline in spear effort can be attributed largely to the decline in effort directed at flounder (not shown).

The 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 (not shown). Effort for calamary has continued to rise to the present year, whereas effort directed at arrow squid fell sharply after the 1999/00 peak and arrow squid effort levels have remained very low especially in the last two years due to the effective absence of a fishery.

The remaining key 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, droplines for striped trumpeter and fish traps for wrasse. Species based effort is also considered in more detail in Chapters 3-6.

In terms of the effort based performance criterion, squid jig effort and dropline days fished were over 10% greater than the peak for the reference period (see Table 2.2). Effort limits were not exceeded for the remaining methods. 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.

Table 2.2. Total annual catch, effort and number of vessels by fishing methods - 1995/96-2002/03
Effort unites are defined in Table 2.3. * Catch data not shown where five or fewer vessels involved.

Gear	Year	Catch (tonnes)	Effort#	Days fished	No. vessels
Beach seine	95/96	467.3	1024	524	54
	96/97	364.1	1351	681	50
	97/98	520.7	1184	573	44
	98/99	440.4	869	397	41
	99/00	422.7	970	428	33
	00/01	528.1	1130	372	32
	01/02	570.9	1497	494	30
	02/03	489.6	1371	508	35
Purse seine	95/96	35.2	418	185	11
	96/97	30.4	337	153	10
	97/98	41.8	319	154	7
	98/99	73.0	228	142	9
	99/00	33.7	268	123	10
	00/01	*	275	104	4
	01/02	*	274	91	5
	02/03	*	182	76	4
Graball	95/96	347.9	223679	5439	261
	96/97	378.7	231305	5182	233
	97/98	446.3	232088	5249	217
	98/99	494.1	167664	4706	210
	99/00	360.1	205131	4174	206
	00/01	173.6	104511	3192	187
	01/02	196.0	100240	3303	180
	02/03	227.3	117756	3340	168
Small mesh net	95/96	38.7	11019	286	20
	96/97	27.0	7964	260	14
	97/98	21.8	7875	246	17
	98/99	31.0	7767	272	14
	99/00	22.4	6840	202	15
	00/01	20.3	10406	238	14
	01/02	24.6	13047	259	12
	02/03	22.7	11972	274	11
Dropline	95/96	19.9	438	158	31
	96/97	30.0	433	203	27
	97/98	24.7	540	222	42
	98/99	31.8	669	309	38
	99/00	30.5	424	288	47
	00/01	15.8	604	248	36
	01/02	12.7	313	257	35
	02/03	18.2	338	345	43
Handline	95/96	76.0	17188	1627	147
	96/97	94.5	21583	1895	135
	97/98	97.7	21131	1703	145
	98/99	87.9	17884	1271	131
	99/00	90.9	19197	1464	134
	00/01	81.7	15657	1588	131
	01/02	98.5	20277	1661	137
	02/03	80.3	18841	1584	122

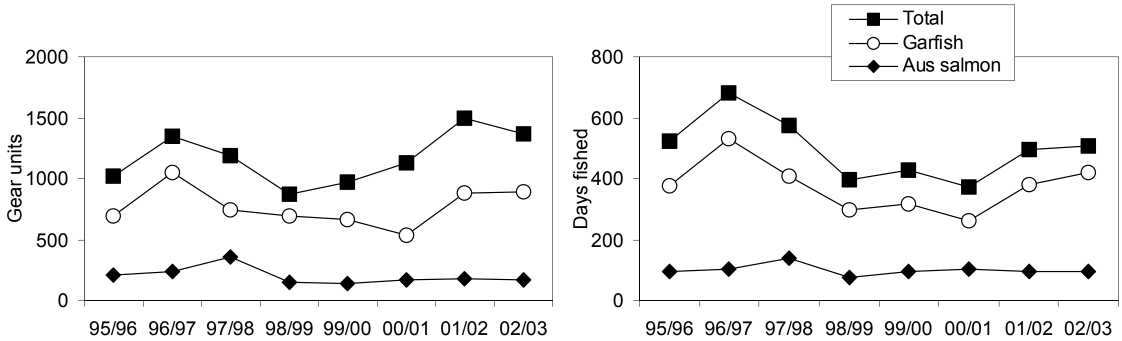
Table 2.2. Continued

Gear	Year	Catch (tonnes)	Effort#	Days fished	No. vessels
Fish trap	95/96	41.8	8265	1401	67
	96/97	57.2	10710	1796	66
	97/98	49.9	9880	1875	71
	98/99	53.7	10893	1558	56
	99/00	56.1	11292	1637	63
	00/01	54.3	10581	1548	68
	01/02	49.0	6600	1278	62
	02/03	38.2	6950	1239	58
Squid jig	95/96	8.7	8022	94	17
	96/97	6.5	10491	71	16
	97/98	15.0	4133	186	17
	98/99	89.6	10014	591	45
	99/00	173.7	173309	1000	60
	00/01	59.2	16120	730	48
	01/02	74.6	21622	807	62
	02/03	82.2	25261	1115	65
Dipnet	95/96	*	317	78	5
	96/97	24.1	1511	361	11
	97/98	33.4	1711	409	22
	98/99	42.4	2708	557	29
	99/00	29.3	2390	500	35
	00/01	22.8	1822	371	27
	01/02	23.9	1896	372	26
	02/03	18.5	1364	335	19
Spear	95/96	14.0	1383	361	21
	96/97	19.2	1845	462	28
	97/98	13.8	1554	437	41
	98/99	17.2	1377	390	41
	99/00	16.0	1500	375	25
	00/01	12.6	1192	289	22
	01/02	11.7	1463	279	20
	02/03	9.5	1416	242	22

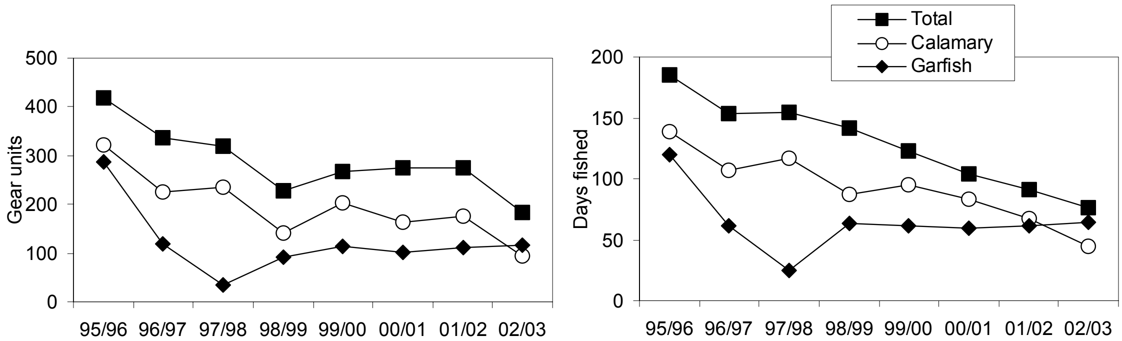
Table 2.3. Table of effort gear units by fishing method

Method(s)	*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

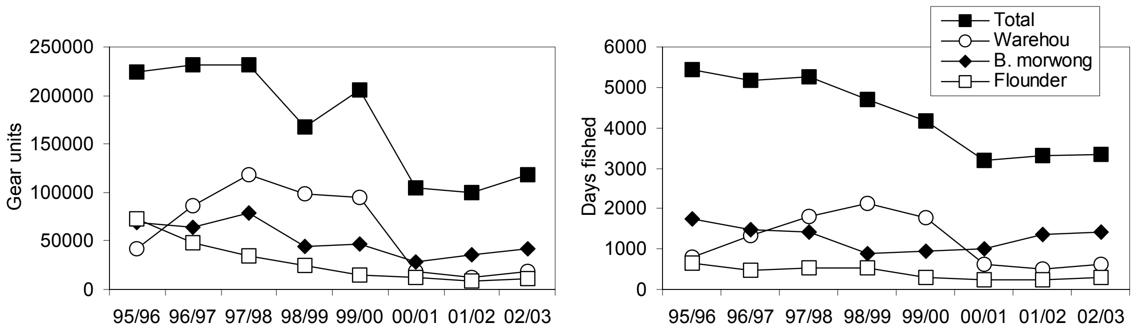
a) Beach seine



b) Purse seine



c) Graball



d) Handline

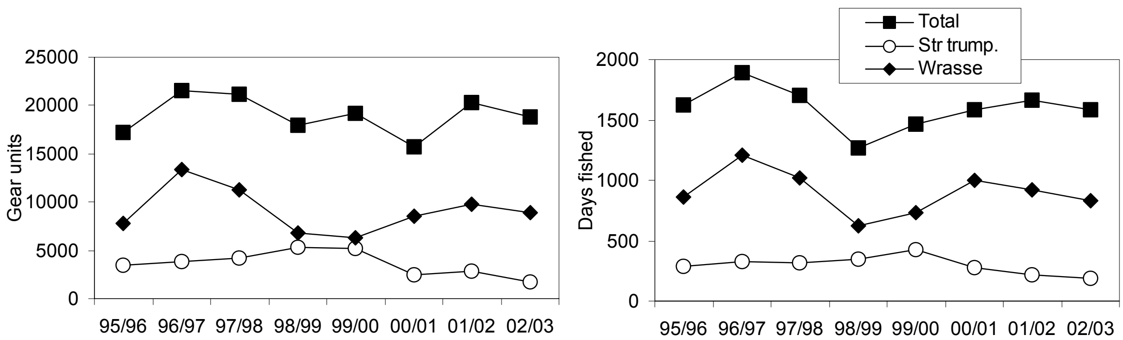


Fig 2.2. Annual effort by method for key species, expressed as gear units (refer Table 2.3) and days fished.

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 described in detail in Chapters 3-6.

2.6 Recreational fishery

2.6.1 2000/01 catches

Catch and effort information are not routinely available for the recreational fishery. However, a national survey of recreational fishing conducted between May 2000 and April 2001 (Henry and Lyle 2003) does provide the first comprehensive snapshot of the Tasmanian recreational fishery. By comparing recreational catch estimates (converted from numbers to weight) with commercial production for 2000/01, the relative importance of the two sectors may be assessed (Table 2.5).

Flathead, principally sand flathead, followed by Australian salmon dominated the recreational catch. The estimated flathead harvest of about 360 tonnes was approximately six times greater than the commercial catch from State fishing waters, whereas the recreational catch of Australian salmon (110 tonnes) was less than one quarter of the commercial take. Other species of significance included barracouta, jackass morwong, bastard and striped trumpeter, cod, mullet, flounder and calamary. In contrast to an earlier survey of recreational net fishing, the 2000/01 recreational harvest of blue warehou (16 tonnes) was substantially lower than in 1997 (116 tonnes; Lyle 2000). This was consistent with the greater than threefold drop in commercial catch from 127 tonnes in 1997 to 36 tonnes in 2000/01. The estimated harvest of bastard trumpeter in 2000/01 was almost double that for 1997 (24 tonnes) while banded morwong catches were very similar, at around one tonne, in both years.

It is evident from Table 2.5 that the recreational take represents a significant component of the total harvest for many of species, either as a proportion of the total harvest or in absolute quantities taken. For instance, the recreational sector accounted for over half of the total catch of flathead, barracouta, jackass morwong, bastard trumpeter, cod, flounder and silver trevally. 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. It is therefore important that recreational component of the fishery is also factored in stock assessments.

Table 2.5. Comparison of 2000/01 estimated recreational and commercial catches (tonnes) for key species

	Catch (tonnes)			*%*
Species/species group	*Recreational*	*Commercial*	*Combined*	*recreational*
Flathead	360.9	63.4	424.3	85.1
Australian salmon	111.2	485.0	596.2	18.7
Barracouta	54.6	15.1	69.7	78.3
Trumpeter, striped	48.4	49.6	98.0	49.4
Morwong, jackass	45.3	13.7	59.0	76.8
Trumpeter, bastard	43.2	26.2	69.4	62.2
Cod	31.3	4.0	35.3	88.7
Mullet	26.8	13.7	40.5	66.2
Calamary	22.2	76.6	98.8	22.5
Flounder	21.3	10.5	31.8	67.0
Warehou, blue	16.0	36.3	52.3	30.6
Wrasse	13.4	88.4	101.8	13.2
Leatherjacket	8.8	16.7	25.5	34.5
Trevally, silver	5.3	1.6	6.9	76.8
Arrow squid	4.7	39.7	44.4	10.6
Garfish	2.3	81.4	83.7	2.7
Whiting	1.3	42.5	43.8	3.0
Morwong, banded	1.1	39.2	40.3	2.7

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 2002/03, one mullet net and a beach seine[2]. Following the introduction of recreational net licences in 1995 the number net licences issued rose rapidly from around 8,900 to a peak of over 11,000 in 1999/00, but has subsequently declined to about 8,400 in 2002/03 (Table 2.6). However, as indicated by the number of Graball Net 1 licences issued, the actual number of gillnet licence-holders peaked in 2002/03. 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 increased towards the end of the 1990s but may have fallen in the last couple of years. With the exception of surveys conducted between 1996-98 (Lyle 2000), there has been no recent targeted assessment of recreational net catch or effort in Tasmania.

Table 2.6. 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*
Graball Net 1	5615	6290	6685	6709	7477	7401	6960	7695
Graball Net 2	2612	2678	2683	2426	2652	2515	1841	na
Mullet Net	656	684	738	739	879	845	608	754
Total licences	**8883**	**9652**	**10106**	**9874**	**11008**	**10761**	**9409**	**8449**

[2] From November 2002, the number of graball nets was reduced to one per person.

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 encompass a diverse range of fishing activities, reporting 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 effort information. There is an urgent need to educate fishers in this area. 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. Recent industry and management workshops have identified the need to improve the quality of catch reporting, including provision for catch verification. The design of the General Fishing Return is under review.

Catch and effort (at the fishing method and species levels) 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 recent national survey represents an important baseline about this sector. There is a need to consider on-going monitoring of the recreational fishery. Without such information, attempts to assess the status of those species with significant recreational catches may be flawed (Table 2.5).

2.8 Implications for Management

A major issue confronting the commercial sector at present is that of latent effort. There is general consensus that excess capacity exists in the scalefish fishery, and that options to remove this capacity need to be pursued as a matter of urgency.

As an indicator of fishery and resource status, a reasonable time series of catch and effort data is required. In the short to medium term, uncertainty will continue to be associated with this fishery because of the short time series available coupled with uncertain data quality (lack of verification). Related to this is the 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.

3 Banded Morwong (*Cheilodactylus spectabilis*)

3.1 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). Between 1994/95 and 1999/00, catches declined steadily from over 100 tonnes to just 34 tonnes, before increasing to 54 tonnes in 2002/03.

Banded morwong are targeted almost exclusively with large mesh gillnets (primarily 130-140 mm stretched mesh) for the live fish market. 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 coming from around Bicheno. Smaller catches are 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.

3.2 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 (33 and 43 cm 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; few 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 3 cm.

During 1995, 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. Spawning closures have been implemented each year since then.

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.

3.3 Stock Structure and Life-history

Banded morwong are a rocky reef species distributed from around Sydney, south to eastern Victoria and around Tasmania (Gomon *et al*. 1994). They also occur in New Zealand waters where they are found 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 (McCormick 1989a). On many southern Tasmanian reefs large changes in depth occur over short distances, suggesting depth stratification of the population may be less pronounced than that described from New Zealand. There is no information on the stock structure of banded morwong and thus the relationships of populations throughout the range are unknown.

In Tasmania, growth in female banded morwong is relatively rapid for the first 5-6 years to a size of about 35 cm, after which it slows dramatically (Murphy and Lyle 1999). By contrast, males grow relatively rapidly for the first 10-12 years to about 45 cm, before slowing. Maximum recorded ages for female and male banded morwong are 93 and 96 years, respectively. The age structure of banded morwong populations from some east coast sites provides some evidence of year class (recruitment) variability (Murphy and Lyle 1999). Such long-lived species typically have low productivity.

Banded morwong are present in a spawning condition between mid to late February and early May, with the size distribution of oocytes in the ovaries indicating they are serial spawners. Sexual maturity in females commences at about 30 cm FL, equivalent to 4-5 years of age, and length at 50% maturity is 32 cm (Murphy and Lyle 1999). Individuals have been found to be highly territorial and spawning on the same reef over several years (McCormick 1989b). Considerable numbers of *Cheilodactylus spp.* larvae have been caught some distance off the shelf break of eastern Tasmania, suggesting that banded morwong have a pelagic stage that is distributed in offshore waters (B. Bruce pers. comm.). Juveniles appear in shallow water on rocky reefs and tide-pools between September and December after a pelagic phase of around 4-6 months (Wolf 1998).

Tagging studies have indicated that movement of juvenile and adult banded morwong is limited, generally restricted to within 5 km of the release site (Murphy and Lyle 1999).

3.4 Previous Assessments

Previous assessments have been limited to the examination of trends in catch, effort and catch rates. Analyses have been conducted at State-wide as well as regional levels. Catch performance indicators were triggered in 2001/02, with the catch below the reference level despite a 30% increase in catch over 2000/01. For the first time since 1998/99, catch rate indicators were not triggered in 2001/02.

3.5 Current Assessment

Since juvenile and adult banded morwong are 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 northeast including Flinders Island (block 3F2, 3F4, 3G1, 3G2, 3G3, 3G4, 3H3, 4G2, 4G4, 4H1, 4H2, 4H3, 4H4), St. Helens (5H1), Bicheno (5H3 & 6H1), Maria (6H3 & 6G4), Tasman Peninsula (7G2 & 7H1), and south coast & Bruny (7E2, 7E4, 7F3, 7F4, 7G1, 7G3).

Similar to previous years, trends in catch and effort were examined. The assessment has been restricted to the examination of catch and effort trends by graball net, which account for around 99% of the total catch of banded morwong. Because of identified problems in the way many fishers have interpreted effort reporting requirements in logbooks, effort and catch rates have been defined as days fished and kilograms per day, respectively. In an attempt to distinguish targeted effort for banded morwong, it has been assumed that fishing on a given day was targeted if:

- the catch of banded morwong was greater than 10 kg and accounted for at least half of the total weight of all species retained; or
- the catch of banded morwong was greater than or equal to 50 kg.

In order to reduce impacts on catch rates of participants with limited involvement in the fishery, an additional analysis was undertaken using a group of experienced or ‘selected’ fishers. For this analysis, selected fishers were defined as those who had participated in the fishery for at least two of the past eight years and had caught at least 2.5 tonnes since 1995/96.

Catch rate standardisation using generalised linear modelling was also undertaken with the statistical model taking account of year, season, vessel, skipper, fishing block, depth and seal interference.

In addition to catch and effort analysis, alternative indicators for stock status have been investigated. These include trends in size and age composition, sex ratios, catch curve analysis, and yield-per recruit and spawning biomass-per-recruit analyses. Data for these analyses were derived from fishery dependent and independent sampling in the Tasman Peninsula, Bicheno and St. Helens regions from 1995/96 to 1997/98 and from 2000/01 to 2002/03.

Interviews with key industry representatives have also been conducted to provide an industry perspective on resource status and to assist with hypothesis testing.

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

3.5.1 Catch

Evaluation of 2002/03 catches against performance indicators

- The State-wide catch is outside (below) the 1994/95 to 1997/98 range and therefore triggered the performance indicator.
- The catch in the Tasman Peninsula, Maria, Bicheno and St. Helens fishing regions is outside (below) the 1994/95 to 1997/98 range and therefore triggered the performance indicator.
- The catch in the Northeast fishing region is outside (above) the 1994/95 to 1997/98 range and therefore triggered the performance indicator.
- The catch in the Bicheno region has declined by more than 30% compared to 2001/02 and therefore triggered the performance indicator.

The State-wide catch trend exhibited a sharp decline between 1995/96 and 1999/00, followed by a recovery to about 60% of the initial catch level in the most recent year (Fig. 3.1). Despite a steady increase in catches between 1999/00 to 2001/02, catch performance indicators have been triggered every year since 1998/99.

At a regional level, catches generally declined between 1995/96 and 1999/00 with the exception of St. Helens where catches expanded up until 1997/98 (Fig. 3.1). Despite having stabilised since 1999/00, catches in most main regions have been below reference levels for some years. In Bicheno, catches increased to 2001/02, but declined sharply in 2002/03.

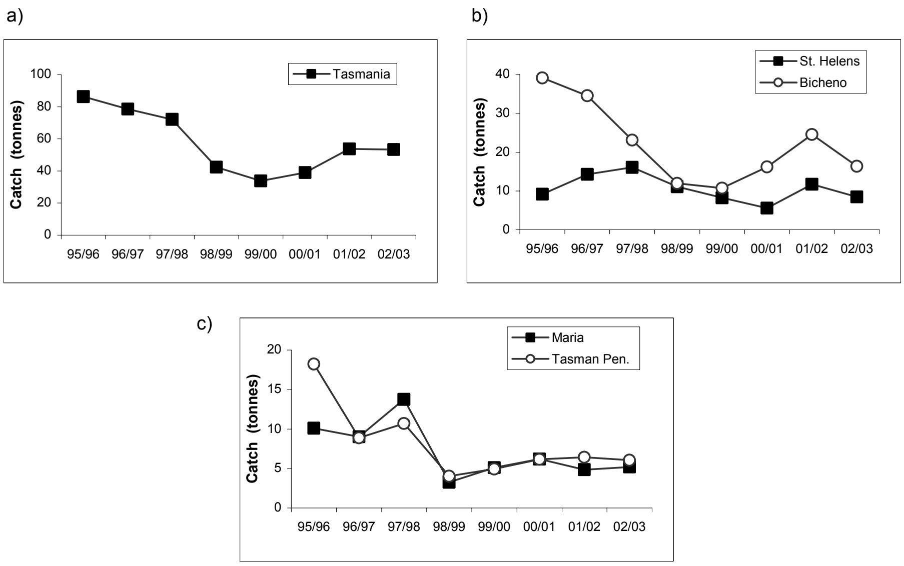


Fig 3.1. Banded morwong graball catches (tonnes) since 1995/96: a) State-wide catches; b) catches in the St. Helens and Bicheno regions; and c) catches in the Maria and Tasman Peninsula regions.

The contribution of the combined catch from the main east coast regions between Tasman Peninsula und St. Helens to the State-wide catch has dropped since 1999/00 (Fig. 3.2). While the catch taken from south coast between Low Rocky Point and Bruny Island has remained relatively stable, reported catches from the northeast coast increased significantly in 2002/03 to 11 tonnes.

Results of the National Recreational Fishing Survey indicated that the recreational catch of banded morwong in 2000/01 was low, around one tonne. This is consistent with estimated catch levels for the late 1990s and confirms that the recreational take is small.

a) b)

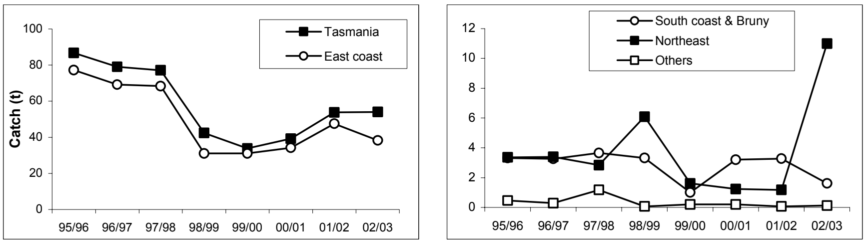


Fig. 3.2. Regional catch distribution of banded morwong: a) State-wide and east coast catches (combined St. Helens, Bicheno, Maria and Tasman Peninsula regions); and b) catches from the northeast fishing region, the south coast between Low Rocky Point and Bruny Island, and remaining areas.

3.5.2 Fishing effort

Evaluation of 2002/03 effort against performance indicators

- State-wide graball effort has not triggered the performance indicator.
- Fishing effort in the St. Helens region was greater than 10% of the highest of the 1995-97 levels and therefore triggered the performance indicator.

Between 1995/96 and 1998/99, total effort declined markedly (Fig. 3.3). Since then effort has increased slightly, driven mainly by increases of effort in the St. Helens and Bicheno regions. However, current effort levels were generally below or comparable to the reference years. The effort indicator was only triggered in the St. Helens region, where effort was at its highest level since 1995/96.

As a general rule, catch trends have reflected changes in effort, with falling catches linked to reductions in effort and recent increases in catches due to increased effort. The recent increase in catch and effort may indicate a resurgence of interest in the fishery.

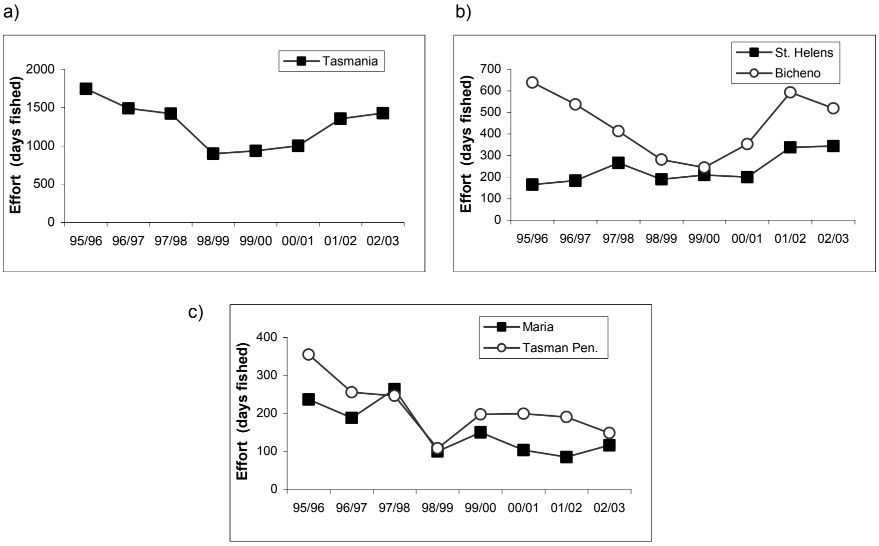


Fig. 3.3. Banded morwong effort (days fished) since 1995/96: a) State-wide effort; b) effort in the St. Helens and Bicheno regions; and c) effort in the Maria and Tasman Peninsula regions.

3.5.3 Catch rates

Evaluation of 2002/03 catch rates against performance indicators

- State-wide catch rates (standardised and unstandardised) have not triggered the performance indicator.
- Standardised and unstandardised catch rates in the Bicheno region were less than 80% of the lowest value for the 1995-97 period and therefore triggered the performance indicator.
- Unstandardised catch rates in the St. Helens region were less than 80% of the lowest value for the 1995-97 period and therefore triggered the performance indicator.

The declines in catch and effort between 1995/96 and 1999/00 were accompanied by a steady fall in the State-wide catch rates (Fig. 3.4). Catch rate performance indicators were triggered in 1999/00 giving rise to concerns about the sustainability of the fishery. Since then catch rates of total and selected effort have stabilised at about 80% of the 1995/96 levels, while those of targeted effort have continued to decline. In part, catch rate declines have been influenced by reductions in the quantities of gear fished each day, the result of regulation (specification of gear entitlement under the management plan) and the influence of seal interference on fishing operations.

The decline in catch rates up until 1999/00 was evident in all regions. However, while catch rates have stabilized or have since further declined in the St. Helens and Bicheno regions, they have recovered in the Maria and Tasman Peninsula regions. Performance indicators in both former regions were triggered in 2002/03.

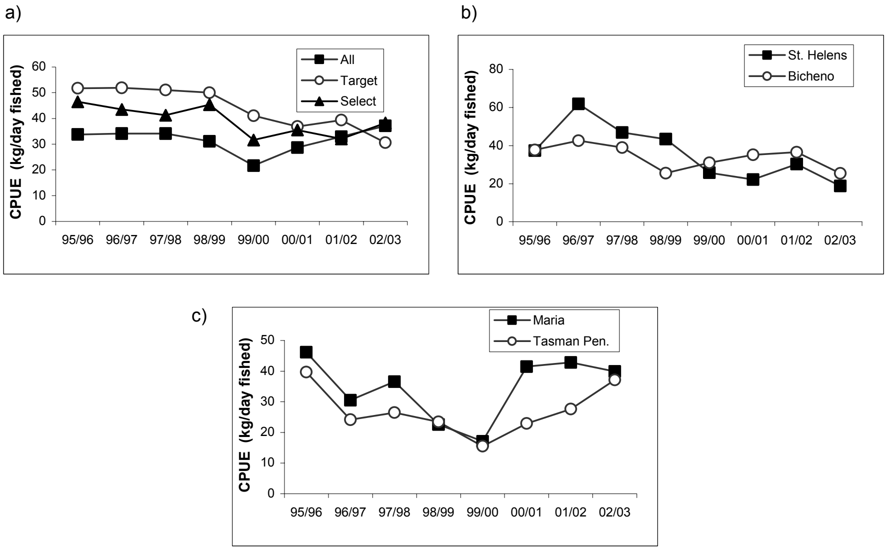


Fig. 3.4. Banded morwong catch rates (kg/day) since 1995/96: a) state-wide catch rates based on total, targeted and selected effort; b) catch rates in the St. Helens and Bicheno regions; and c) catch rates in the Maria and Tasman Peninsula regions.

As an alternative to using the geometric mean of catch rates as a stock indicator, catch rates have been standardised to reduce the impact of obscuring effects such as region, depth, season or skipper. Standardisation suggested a greater degree of stability by comparison with unstandardised catch rates, with State-wide catch rates remaining just above the trigger levels (Fig. 3.5). Similarly, standardized catch rates were more stable than the geometric mean in each of the three regions investigated. However, in the Bicheno region standardized catch rates have been below reference levels for every year since 2000/01, and in the St. Helens region trigger points were exceeded in the previous three fishing years, but not in 2002/03.

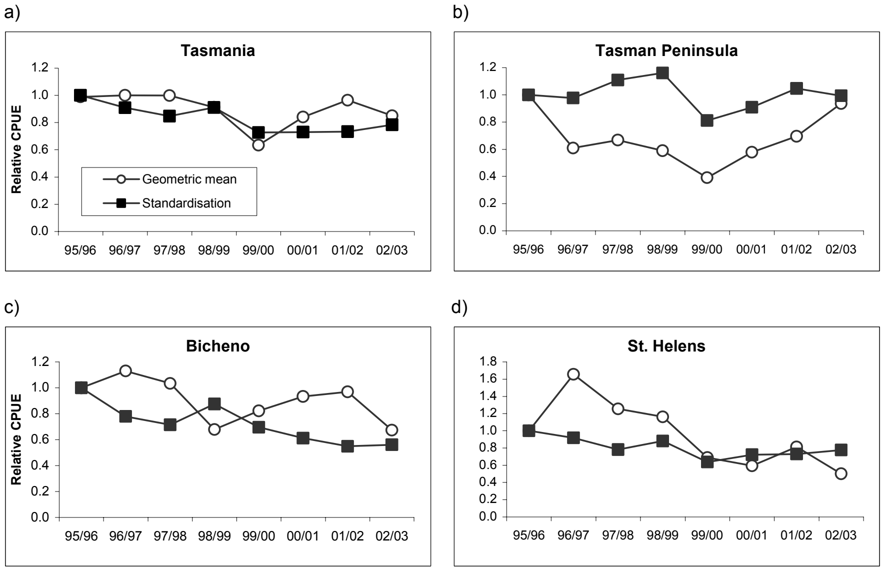


Fig. 3.5. Geometric mean and standardised catch rates for banded morwong relative to 1995/96: a) State-wide catch rates; and regional catch rates in the b) Tasman Peninsula, c) Bicheno, and d) St. Helens fishing regions.

3.5.4 Size composition

Evaluation against size composition performance indicator

- There have been substantial changes in the size structure of banded morwong catches since the mid 1990s, with changes consistent with the impacts of fishing on the stocks. However, the full implications of these changes for the stock status are uncertain.

The size structure in all regions has changed since the late 1990s with a greater representation of smaller fish in current catches (Fig. 3.6-3.8). Between 1994/95 and 2002/03, size frequency distributions for males and females in the Tasman Peninsula and Bicheno regions have exhibited declines in modal lengths. Data for St. Helens are noisy (mainly due to small sample sizes) and no clear trend is detectable over time.

Decreases in the modal sizes are obvious for both sexes. Male size compositions have been bimodal in each of the years sampled, however the relative sizes of the modes have changed. In the Tasman Peninsula and Bicheno regions, the dominant size class dropped from around 51 cm in the samples of the mid 1990s to around 37 cm in the most recent samples. Female size compositions were generally unimodal, but the position of the mode has also fallen from 41 cm to around 35 cm and distributions are now skewed towards a greater representation of smaller size classes.

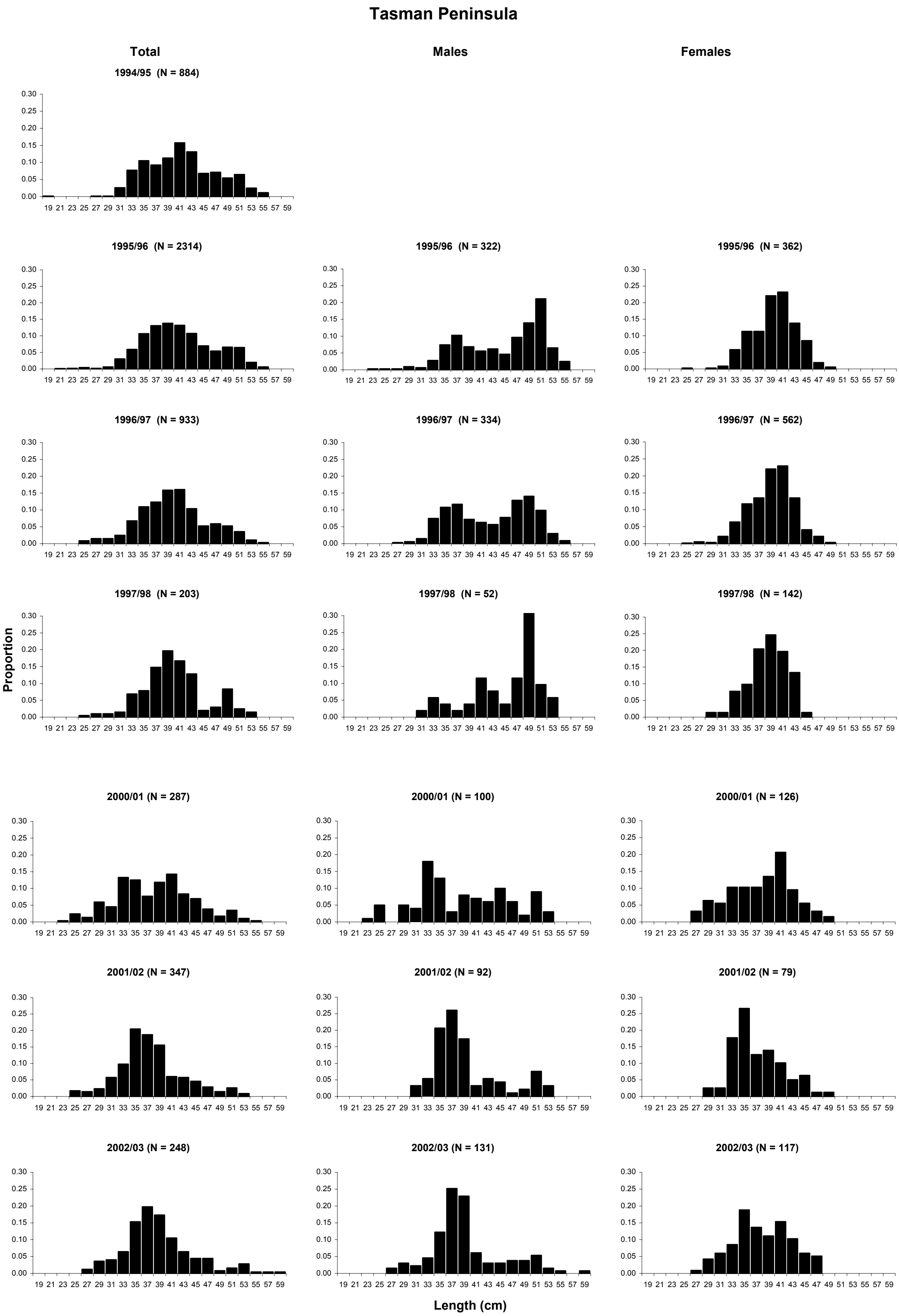


Fig. 3.6. Annual size composition of total sample, male and female banded morwong in catches of the Tasman Peninsula fishing region between 1994/95 and 2002/03. Relative frequencies in 2 cm bins (values given denote mid-point).

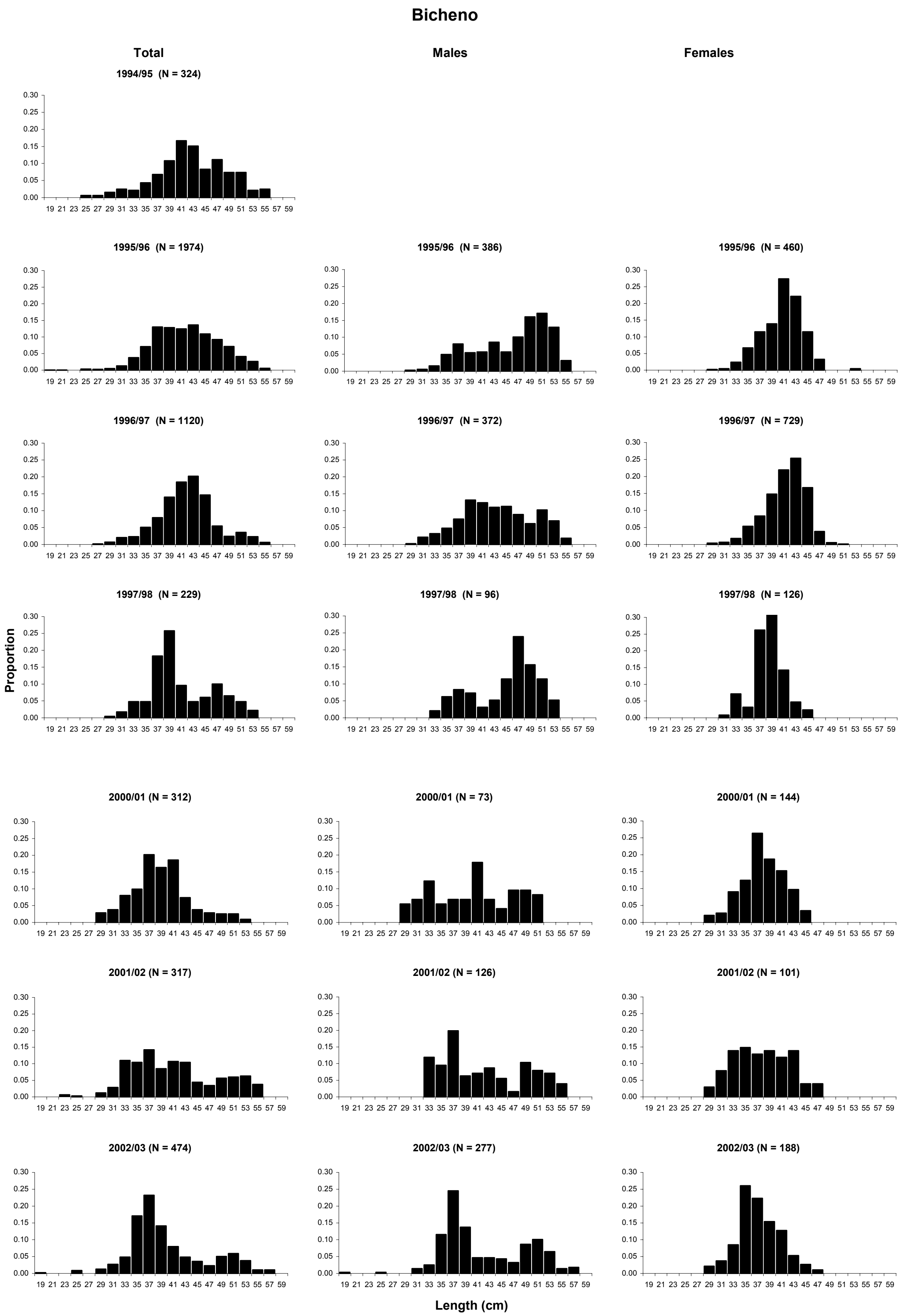


Fig. 3.7. Annual size composition of total sample, male and female banded morwong in catches of the Bicheno fishing region between 1994/95 and 2002/03. Relative frequencies in 2 cm bins (values given denote mid-point).

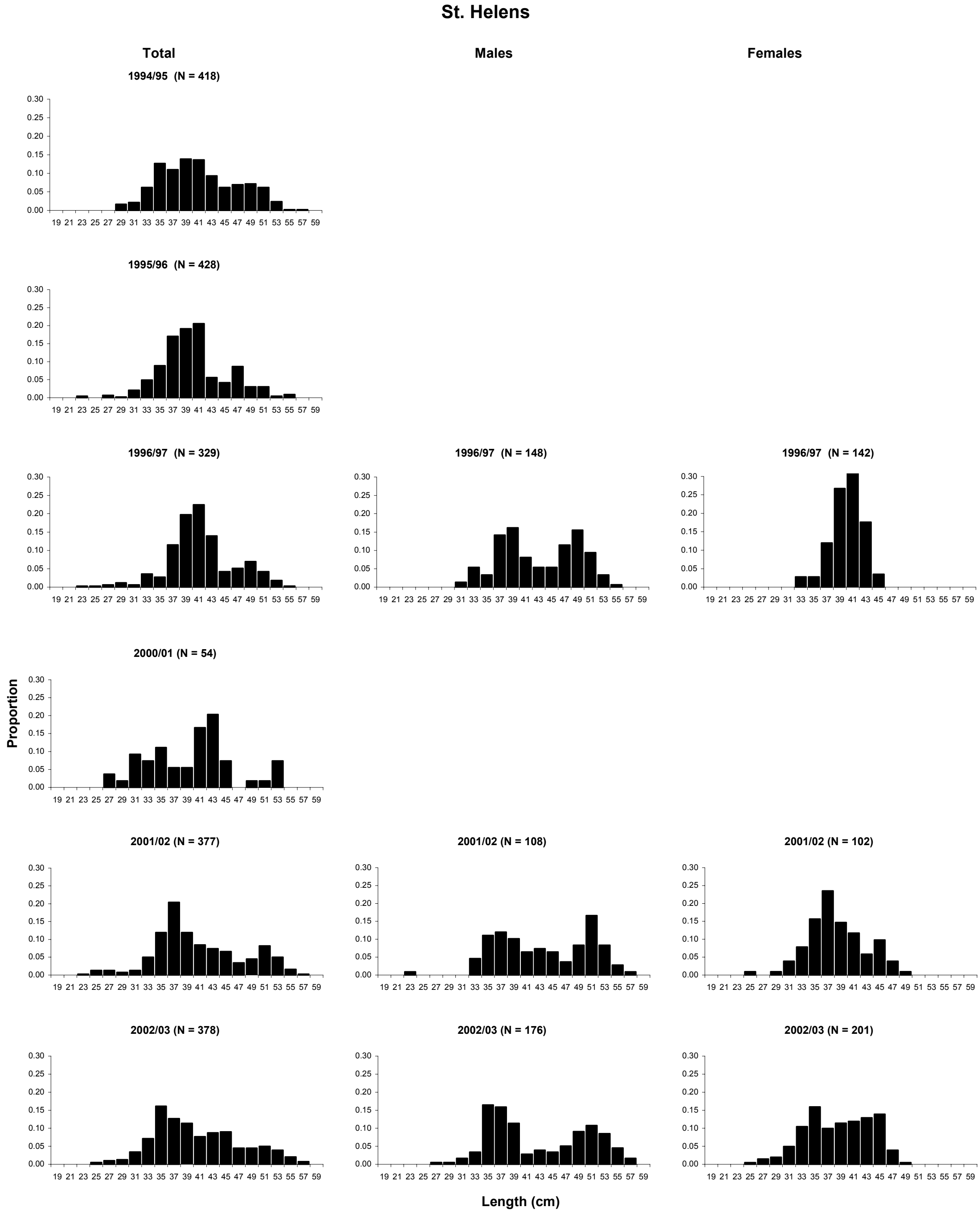


Fig. 3.8. Annual size composition of total sample, male and female banded morwong in catches of the St. Helens fishing region between 1994/95 and 2002/03. Relative frequencies in 2 cm bins (values given denote mid-point).

These changes have been reflected in changes in median size (a more appropriate measure than average size; Fig. 3.9). While median sizes varied considerable between years during the 1990s for males, they have generally dropped to around 385 mm in recent years in all regions. For females, the downward trend from around 405 to 375 mm has been more consistent over time and was most pronounced in the Bicheno region. In reality, changes in gear may have masked even stronger changes in the size composition. While gillnets with mesh size of predominantly 133mm were used in the mid 1990s, most fishers have now switched to mesh sizes of around 140mm, which are more selective for larger fish.

While decreases in fish size are consistent with expected impacts of fishing on the stocks, the biological significance of these observations is not clear. Firstly, levels of change that are considered either tolerable or significantly severe have not been defined. Secondly, relative size compositions are not useful for distinguishing between the effects of the removal of larger fish and/or increases in the numbers of smaller fish through recruitment. And thirdly, beside fishing mortality which includes handling mortality and seal-induced mortality, seasonal changes in availability of fish may have also contributed to the observed changes.

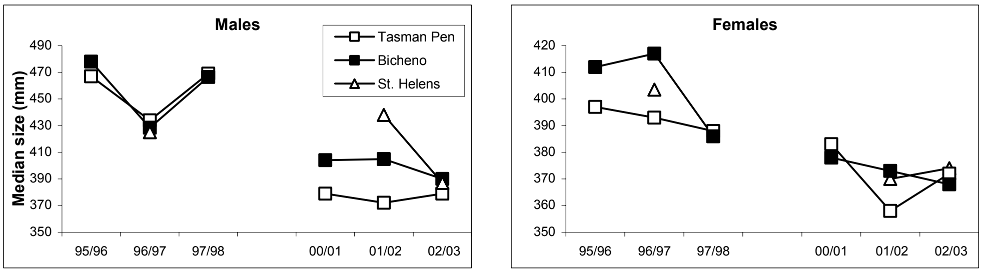


Fig. 3.9. Median size of male and female banded morwong in catches of the Tasman Peninsula, Bicheno and St. Helens regions.

3.5.5 Age composition

Evaluation against age composition performance indicator

- There has been a significant change in the age composition of commercial catches since the mid 1990s. This is consistent with a significant impact of fishing on the populations.

Banded morwong have been sampled during the spawning season in the Tasman Peninsula and Bicheno regions between 1995/96 and 2002/03 and in the St. Helens region between 2001/02 and 2002/03. Age has been determined and validated by analysis of otolith structure (Murphy and Lyle 1999). Age composition information was available from over 2500 individuals.

Fishing has impacted on the age composition of male and female banded morwong. Over time, individuals up to 5 years have become increasingly dominant in samples of males in all regions, representing 50-80% of the samples in 2002/03 (Fig. 3.10). Because males grow rapidly through the legal-size keyhole, most males are susceptible to fishing aged between 4-10 years.

Since 2000/01 in the Bicheno region, males older than 10 years have been proportionally less abundant compared to the samples taken during the mid 1990s. Reductions are particularly evident for males aged 10-20 years, age classes that would have been exposed to fishing pressure for some years. The same trend is apparent in the Tasman Peninsula region, however, males older than 10 years have been generally scarce throughout all years sampled.

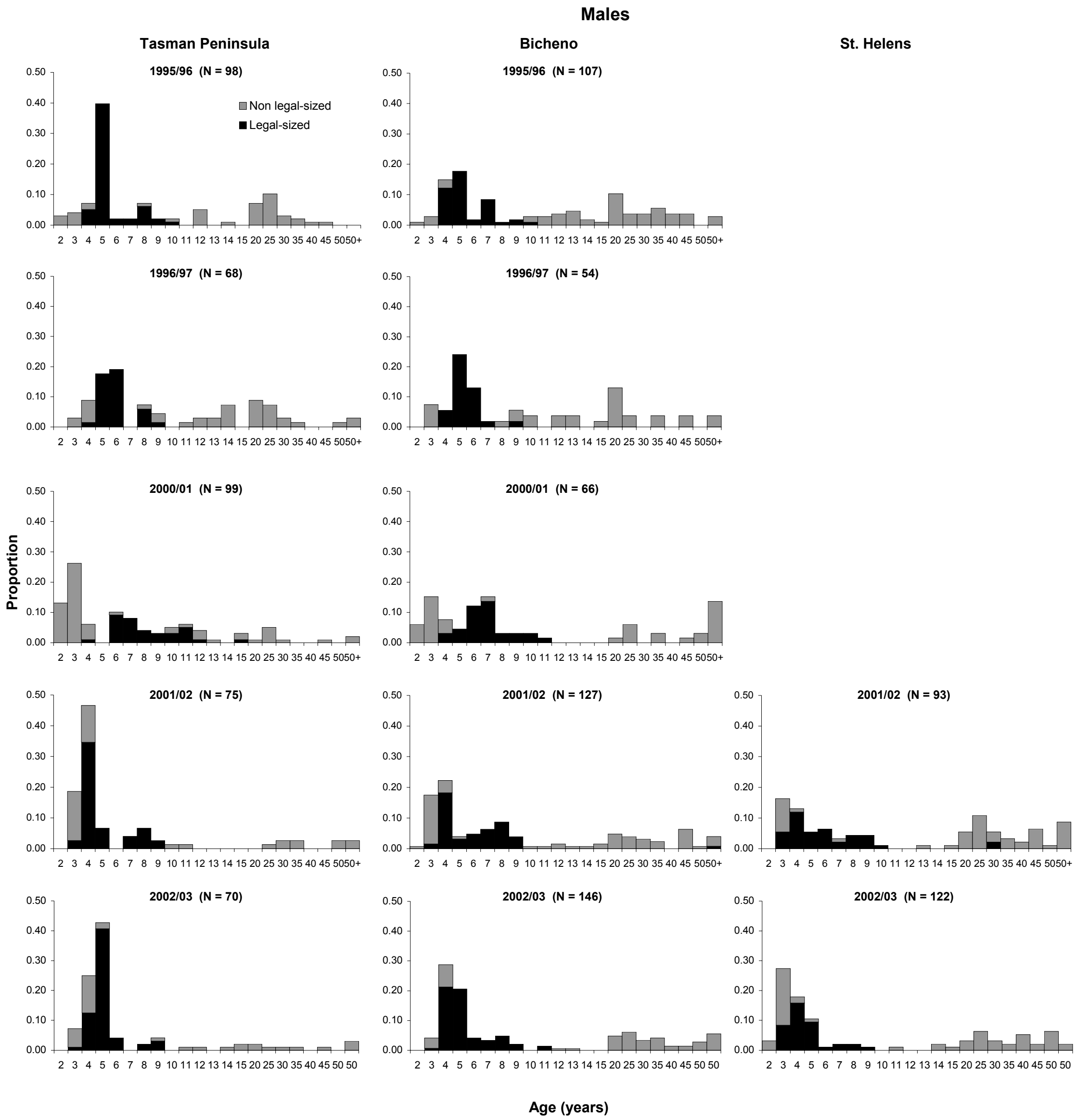


Fig. 3.10. Relative age composition of male banded morwong in catches of the Tasman Peninsula, Bicheno and St. Helens fishing regions between 1995/96 and 2002/03. Black bars refer to legal-sized fish, grey bars to non-legal-sized (undersized and oversized) fish. Relative frequencies in 5-year classes (values given denote upper limit).

In contrast to males, females recruit to the fishery at around 5-6 years of age and typically remain vulnerable for the remainder of their lives (Fig. 3.11). Fishing has had a marked impact on age structure in the Tasman Peninsula and Bicheno regions. While there are still old females available, their relative contribution has decreased significantly in recent years compared to the mid 1990s, such that females up to 5 years, mainly undersized, now dominate the catch. This suggests that the fishery has substantially reduced any accumulated biomass.

These age composition trends are reflected in the changes of median ages between 1995/96 and 2002/03 (Fig. 3.12). While the median age of males has decreased only slightly (with the exception of St. Helens), the median age of females has fallen dramatically from around 20 to 7 years over the sampling period. This trend is consistent in the Bicheno and Tasman Peninsula regions.

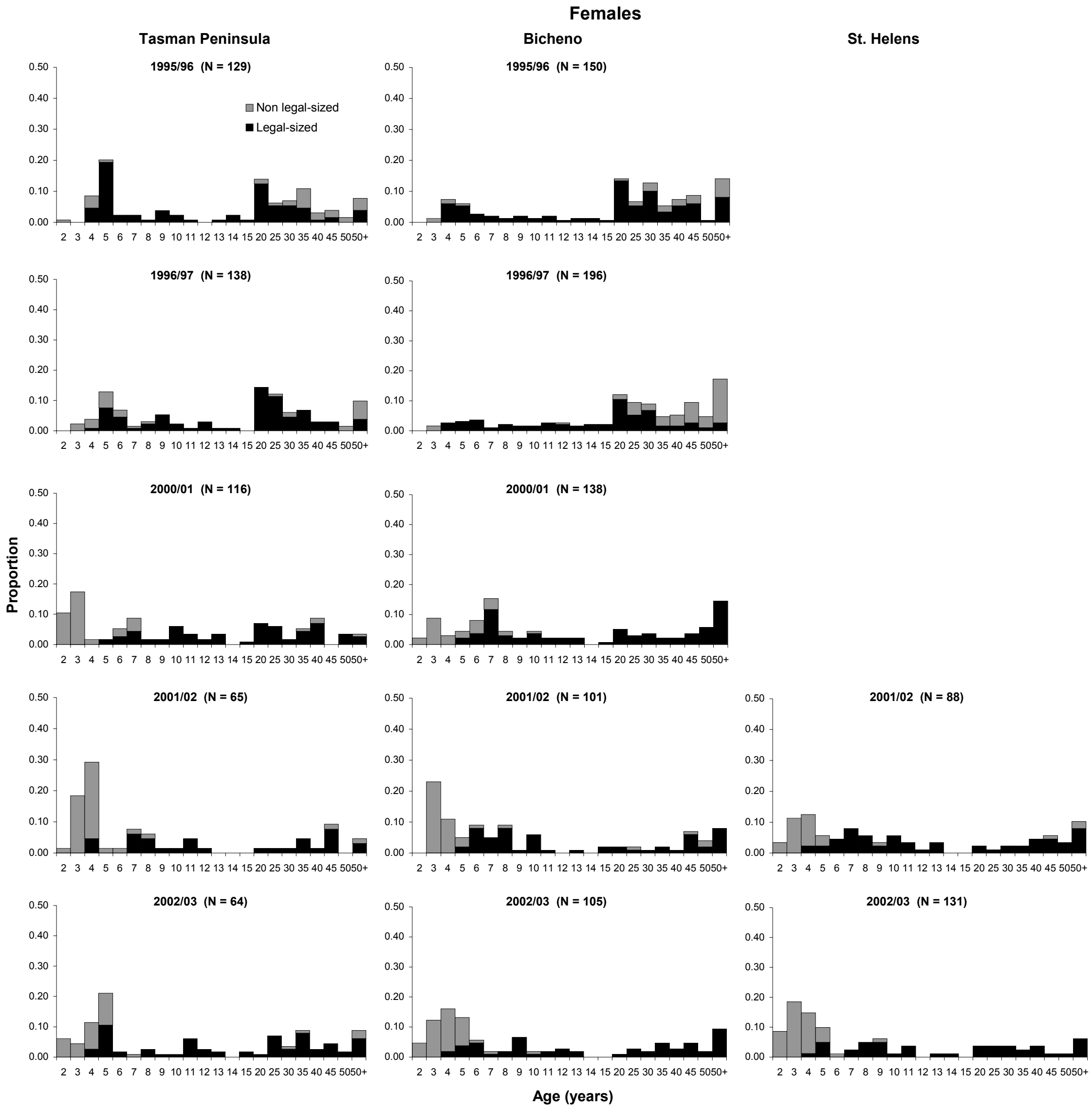


Fig. 3.11. Relative age composition of female banded morwong in catches of the Tasman Peninsula, Bicheno and St. Helens fishing regions between 1995/96 and 2002/03. Black bars refer to legal-sized fish, grey bars to non-legal-sized (undersized and oversized) fish. Relative frequencies in 5-year classes (values given denote upper limit).

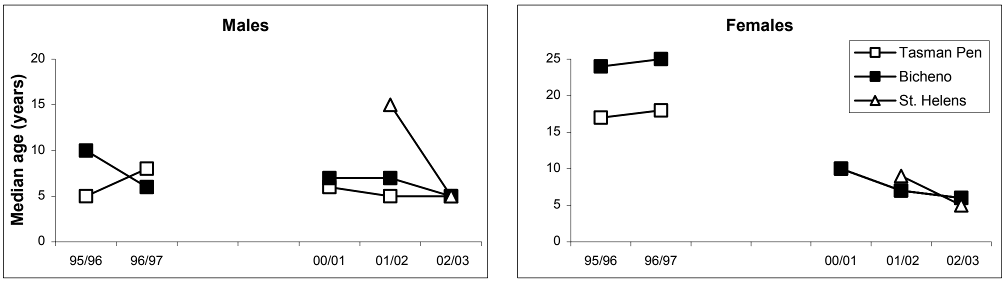


Fig. 3.12. Median age of male and female banded morwong in catches of the Tasman Peninsula, Bicheno and St. Helens regions.

3.5.6 Sex ratio

Evaluation of sex ratio performance indicator

- There is no specific performance indicator relating to sex ratios, however, they can include consideration of changes in biological characteristics. In banded morwong, the change in sex ratio is linked to differential fishing pressure on males and females (due to growth rate differences) and provides evidence of the impact of fishing on population structure.

Sex ratios based on spawning season surveys in the Bicheno and Tasman Peninsula fishing regions seem to have shifted from females dominating up until 2001 to roughly equal numbers of males and females in the more recent samples (Fig. 3.13). The proportion of females in the legal-sized catch dropped consistently in both regions, which would at least be partly caused by the greater selective fishing pressure on females. Interestingly, rather than a gradual trend, the shift seems to have happened quite suddenly between 2000/01 and 2001/02. Sex ratios in the St. Helens region appeared to be relatively constant.

The change in sex ratio was apparent to a lesser extent in the total catch, reflecting the influence of the substantial number of undersized recruits in both sexes.

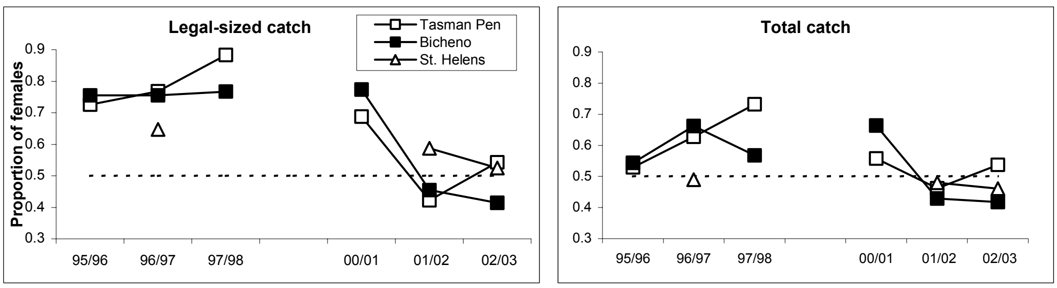


Fig. 3.13. Proportion of female banded morwong in the legal-sized and total catch in the Tasman Peninsula, Bicheno and St. Helens fishing regions. Dotted lines represent a sex ratio of 1:1.

3.5.7 Catch curve analyses

Catch curve analysis has been used to estimate total mortality *Z*. The age-frequency samples have been corrected for gillnet mesh selectivity (determined empirically and modeled using gamma distribution, after Millar and Holst 1997) to convert them into estimates of the age composition in the population. Given the longevity of banded morwong and spatial structuring of the population, the available sample sizes were comparatively low and thus may not entirely represent the populations at a regional scale. In order to increase sample sizes and reduce noise in the data, information has been pooled across sites from the Tasman Peninsula and Bicheno regions.

The analysis revealed a considerable range of estimates of *Z* based on recruited ages up to 14 years, namely 0.16 for males and 0.22 and 0.12 for females in 1995/96 and 1996/97, respectively, and a range of 0.15-0.43 for males and 0.07-0.32 for females in the 2000/01 to 2002/03 samples (Fig. 3.14). Since over half of the reported catches had already been taken by 1996, the fishery would have impacted even the earliest samples. By comparison with many other fisheries, total mortality rates are low, but given the life history characteristics of the species, natural mortality is also expected to be very low. Based on the Sparre *et al.* (1989) approximation, natural mortality *M* was estimated at 0.05, implying that fishing mortality *F* (total mortality minus natural mortality) exceeded 0.1 in the mid 1990s and 0.2 in recent years.

The population age-frequency plots also highlight the apparent dichotomy between trends for younger (to 14 years) and older age classes for both sexes and the reduction of older individuals, particularly females, in the population (Fig. 3.14).

If large males concentrate at greater depths as suggested by McCormick (1989a), they may receive further protection from fishing through a ‘depth refuge’, since fishing rarely occurs at depths over 25 m. Any females found in deeper water will also be less vulnerable to capture. Anecdotal reports suggest that fish in the deeper waters are in fact large specimens and fishers contend that there is replenishment of fishing grounds throughout the year, possibly due to movement of fish from deeper water. This gives rise to the suggestion that a portion of the population may be protected from fishing by a depth refuge. Through mixing this could account for the continued presence of very old individuals, despite the level of fishing pressure that has been exerted on the stocks. Unfortunately, we have no information about the structure or relative abundance of populations in the deeper reef areas or potential mixing rates with the shallower areas to evaluate the potential importance of depth refuges on the fish stock and the assessment.

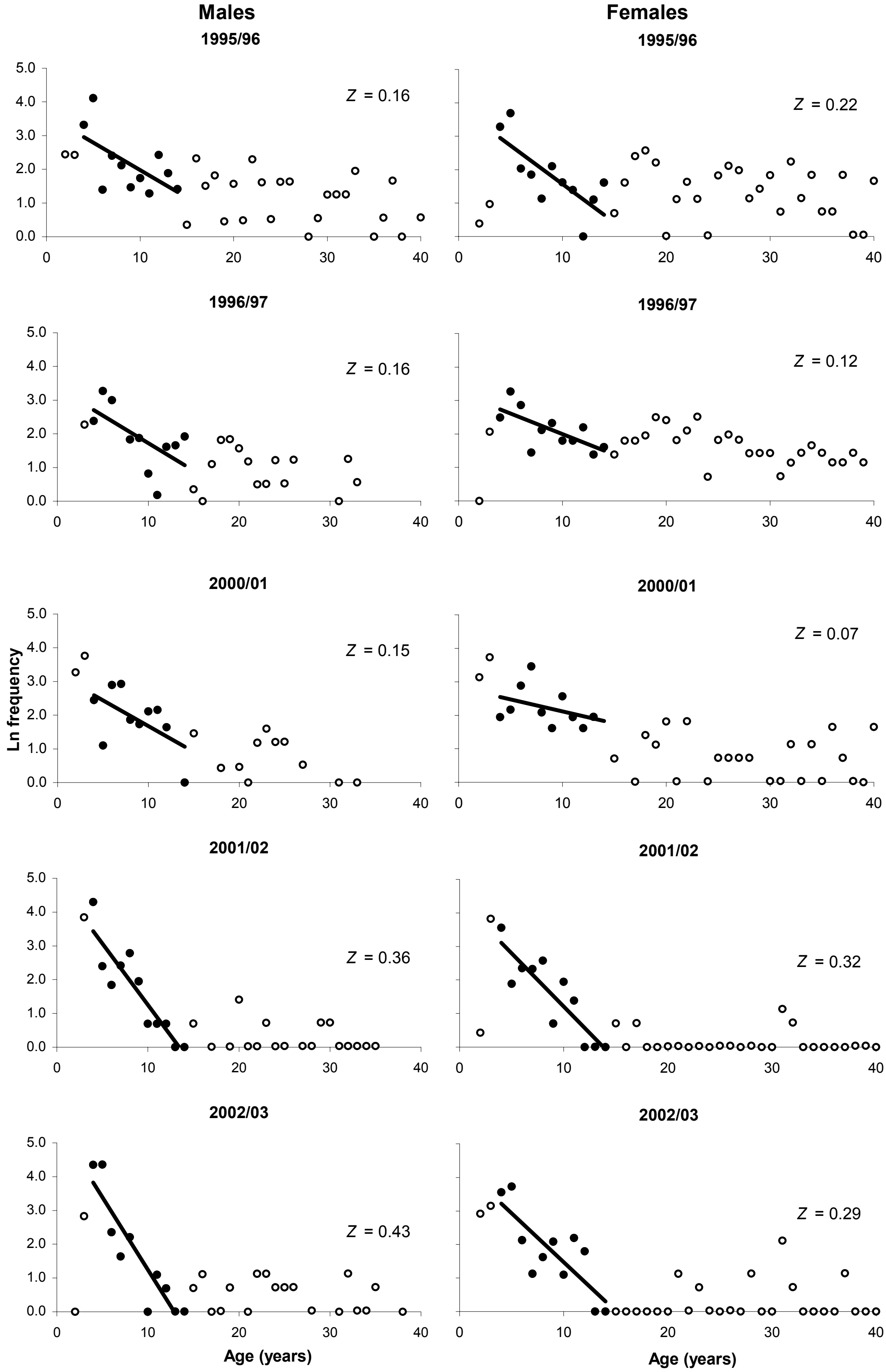


Fig. 3.14. Catch curves for male and female banded morwong in the Tasman Peninsula and Bicheno regions (pooled sites) between 1995/96 and 2002/03. The log-transformed and selectivity-corrected age-frequencies are based on direct age estimates. Data between 4 years (fish fully selected to fishing gear) and 14 years (first zero catches) has been used for mortality estimation (filled circles).

3.5.8 Yield-per-recruit and spawning biomass-recruit analyses

Yield-per-recruit and spawning biomass-per-recruit analyses have been performed using the current size limits (36-46 cm) and assumed natural mortality $M = 0.05$. These analyses highlight the dilemma faced when determining fishing reference levels for species with strong sex-based differences in growth parameters. For instance, the reference level $F_{0.1}$ (the level of fishing mortality at which the slope of the yield-per-recruit curve is 0.1 times the slope at a lightly-exploited fishery; Gulland and Boerema 1973) from the yield-per-recruit analysis was estimated as 0.25 for males but just 0.11 for females (Fig. 3.15). Because males remain vulnerable to the fishery on average only between 4 and 10 years of age, they can sustain much higher levels of fishing mortality than females.

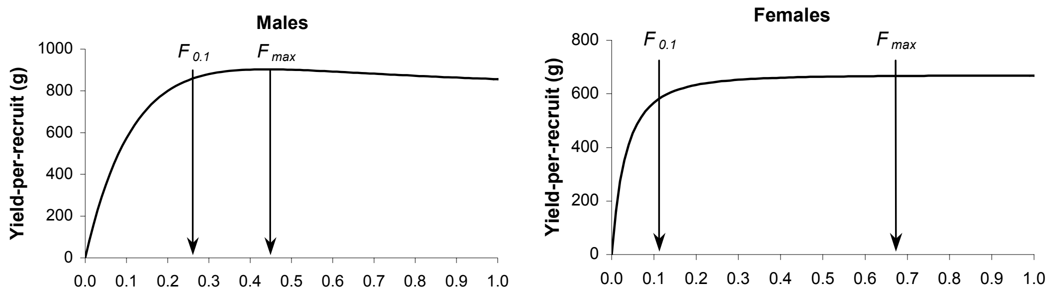


Fig. 3.15. Yield-per-recruit curves for male and female banded morwong. Results shown for size limits of 360-460 mm and natural mortality $M = 0.05$.

While $F_{0.1}$ has often been used as a target to minimize growth overfishing, it does not take recruitment into account (e.g. Clark 1991, 1993, Mace and Sissenwine 1993). To address recruitment overfishing, the fishing mortality rate $F_{30\%}$ that reduces spawning biomass-per-recruit to 30% of the unfished level, has been applied as a recruitment overfishing limit, and $F_{40\%}$ as a target level for stocks where little is known about the stock-recruitment relationships and resilience (Clark 1993, 2002, Mace and Sissenwine 1993, Mace 1994). Using ovary weight-at-size as a proxy for fecundity, the spawning biomass-per-recruit curve drops fast with increasing fishing mortality, and hence fishing mortalities are low for both reference levels, with $F_{40\%} = 0.07$ and $F_{30\%} = 0.12$ (Fig. 3.16). This analysis suggests that only low fishing mortalities, close to $F_{0.1}$ for females, are sustainable. At mortality rates $F > 0.2$, relative spawning biomass falls below 20%.

A precautionary approach would favor reference mortality rates for recruitment overfishing of females as the basis for management advice. However, since it is impractical to manage the fishery differentially based on sex, this level of fishing mortality would provide only about 50% of the theoretical maximum yield for males.

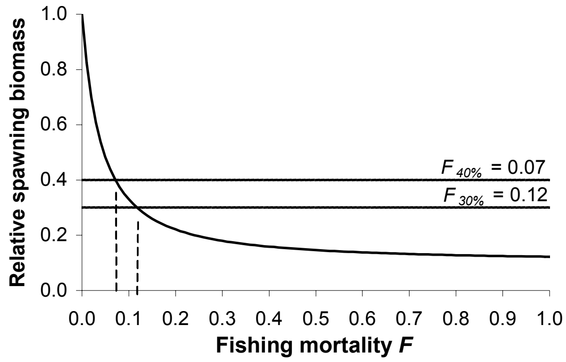


Fig. 3.16. Spawning biomass-per-recruit curve for female banded morwong. Results shown for size limits of 360-460 mm and natural mortality $M = 0.05$.

Increased minimum size limits would of course provide more effective protection to the female spawning biomass. The increase in the minimum size limit from 33 to 36 cm in 1998 represented a compromise between biological results from yield- and spawning biomass-per-recruit analyses and economic considerations (Murphy and Lyle 1999). Due to a market preference for small fish, any higher minimum size limits would have had a severe negative impact on access to the live-fish markets.

Based on estimates of F inferred by catch curve analysis (section 3.5.7), it would appear that reference points $F_{0.1}$, $F_{30\%}$ and $F_{40\%}$ derived from yield-per-recruit and spawning biomass-per-recruit analyses for females have been exceeded.

3.6 Implications for Management

Catch and catch rate indicators suggest that, initially at least, the fishery impacted on banded morwong populations. However, there has been stability in both measures in the last few years, an observation that is consistent with industry perceptions. Unfortunately, this stability does not necessarily indicate the sustainability of current levels of exploitation. There are several limitations related to the use of fishery dependent data. These include the masking effects on localised changes in abundance arising from the expansion of the fishery within and outside of original fishing grounds, the limited insights that catch rates provide into stock status for a species such as banded morwong, and issues of data quality of commercial catch returns. More specifically:

- State-wide catches have been maintained to some extent by an expansion of fishing effort from traditional fishing grounds on the east coast to new areas, with a significant increase in catches from the northeast during 2002/03. In fact over 20% of the total catch was taken from this region.
- Due to the limited movement of banded morwong, their populations are spatially structured and may even differ from one reef to the next. At the same time, fishers operate over relatively wide areas of coast to maintain catches. Because a fishing block, the spatial scale for reporting, is likely to encompass catches from many,

potentially independent, populations of banded morwong, localized or serial depletions may not be detected.

- Catches and catch rates ignore the fact that banded morwong can grow very old (over 95 years) and catches do not distinguish between production due to new recruits entering the fishery from the fish-down of accumulated biomass by successively removing the older fish.
- In a recent industry survey, industry members affirmed the view that both the frequency of seal interactions and the quantities of fish lost to seals had increased over the history of the fishery, and that seal interactions were considered to be a more significant factor influencing the downturn in catch and effort than variation in stock abundance.
- Industry representatives also noted that new participants had entered the fishery (and some experienced operators had exited the fishery) and this was likely to have had some influence on catch rates.
- Fishers emphasized that the reliability of the commercial catch and effort data was probably poor up until about 2000. In addition, a number of issues were identified in relation to catch and effort reporting, which seriously affect any interpretation of fishery-dependent information:
  (i) There is considerable confusion about how gear units should be recorded;
  (ii) Fishers tend to report only the portion of the catch that was sold live and do not include mortalities; and
  (iii) Most operators do not consistently report activity on days of heavy seal impacts.

All investigated biological measures indicate that the fishery has impacted on the stocks. Some of these changes such as the decrease of median age for females from around 20 to 7 years appear dramatic. Changes in the stock structure are to be expected with exploitation, however, at sustainable levels of exploitation it would be expected that the biological measures would attain some form of dynamic equilibrium. This has not happened. Instead, the changes have continued through time at a rate and in directions that suggest exploitation rates are too high. Currently, yield-per-recruit and spawning biomass-per-recruit analyses are the only methods to provide some measure of fishing mortality, and even these methods do not ensure sustainability. Nevertheless, both methods recommend very low fishing mortality levels at around $F = 0.1$ to obtain optimal long term yields from the fishery. The catch curve analysis suggest that these levels have been exceeded and in some areas probably considerably. Based on life history, in particular the longevity of the species, productivity of banded morwong is expected to be low. Thus, if over-fishing has occurred, stock recovery will be slow even if the fishing effort is significantly reduced.

The role of external factors such as climate change and recovery in seal numbers around Tasmania, and consequent increased predation on banded morwong, are potentially confounding factors that may have also impacted on banded morwong stocks. There is little doubt that increased incidences of seal interactions over the history of the fishery have resulted in substantial incidental mortality of banded morwong and impacted on fisher behaviour and catch rates.

Despite uncertainty in the significance of the biological changes in relation to stock status, the general downward trend in all biological indicators, set against low productivity, suggest that current fishing pressure is most likely too high and not sustainable and that management action is required to reduce fishing mortality in this fishery. Maintaining the *status quo* for the Tasmanian banded morwong fishery is therefore a high risk strategy.

3.7 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. A Fisheries Research and Development Corporation project is in progress and is intended to develop a more robust stock assessment for banded morwong and identify appropriate performance indicators.

Spawning season surveys will continue in 2004 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. An alternative may be to have the commercial catch and effort data reported at a much finer scale as with the commercial dive reporting grid.

Information about the structure 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.

Development of a logbook to provide catch and effort information on a fine spatial scale along with information regarding interactions with seals and fishing practices would greatly improve the utility of fishery dependent information.

4 Southern calamary (*Sepioteuthis australis*)

4.1 The Fishery

The fishery for calamary in Tasmania expanded markedly during the latter half of the 1990s. Accompanied by a trebling of effort, catches rose from less than about 20 tonnes p.a. prior to 1995/96 to about 90 tonnes in 1998/99. 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.

4.2 Management Background

The dramatic rise in southern calamary catches prompted a warning in August 1999 by the Minister for Primary Industries, Water and Environment that management arrangements for southern calamary 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, two 2-week-long closures of Great Oyster Bay to fishing for southern calamary were implemented during the peak spawning season between October and December 1999. 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 the commercial fishery in Great Oyster Bay and Mercury Passage was closed for a 3-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.

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. Under the reviewed management plan implemented 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.

4.3 Stock Structure and Life-history

Southern calamary are a shallow water species endemic to southern Australian and northern New Zealand waters. It is one of the most common cephalopods in the coastal waters of southern Australia and an important component of the coastal ecosystem as a primary consumer of crustaceans and fishes and as a significant food source for numerous marine animals.

The species is short-lived, probably living for less than one year, although growth is extremely variable (Pecl *et al.* 2004). Maximum recorded ages of female and male southern calamary are 263 and 275 days respectively, with males appearing to live on average slightly longer than females. Males also attain a greater size at age than females. The maximum recorded size of males and females are 3.6 kg and 538 mm dorsal mantle length (ML) and 2 kg and 398 mm ML, respectively. The rate of growth is rapid, 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. 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 (Pecl *et al.* 2004).

On the east coast of Tasmania, males account for around 60% of the commercial catch. In summer and winter, the vast majority of males taken by the fishery are mature. 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. However, immature females as old as 196 days and up 0.62 kg and 237 mm ML have been recorded. Males are mature as young as 92 days and as small as 0.06 kg and 104 mm ML.

Although spring/summer appears to be a major spawning period in Tasmania, there is evidence that low levels of spawning occur all year round (Moltschaniwskyj *et al*. 2003). The majority of summer caught squid are hatched in winter and vice versa. Southern calamary are multiple spawners although the duration of individual maturity and the frequency of batch deposition are unknown. Summer spawners appear to have the potential to lay larger batches of eggs than winter spawners (Pecl 2001). 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 and embedded directly into sand (Moltschaniwskyj *et al*. 2003). Individual egg capsules 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 (Steer *et al*. 2002).

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.

4.4 Previous Assessments

Previous assessments have been restricted to analysis of trends in catch, effort and catch rates for squid jig and purse seine methods. 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. Catch and effort (squid jig) performance indicators have been triggered each year since 1998/99.

4.5 Current Assessment

Southern calamary are taken by a variety of methods including purse seine, beach seine, squid jig, spear and dipnet. Squid jigs are the primary method and accounted for around 74% (80 tonnes) of the catch in 2002/03 (Fig.7.1). A further 10% was attributed to handline fishing, which in this instance was almost certainly squid jigging. Although some night fishing occurs, jig fishing is generally conducted during the day over shallow areas of seagrass and macro-algae to target fish concentrated on these beds. Southern calamary are taken commercially along the north and east coasts of Tasmania and off Flinders Island, with the greatest portion of the catch taken in the Mercury Passage and Great Oyster Bay regions.

A major study of calamary population dynamics and reproductive ecology was recently completed, contributing significantly to our knowledge of the species (Moltschaniwskyj *et al*. 2003). An outcome of this study involved the development of a simple assessment model that is repeated here.

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

4.5.1 Catch

Evaluation of 2002/03 catches against performance indicators

- Current State-wide catch was above the reference catch range and the highest on record, although only slightly higher from the previous year; the catch performance indicator was therefore triggered.
- Regionally, jig catches from Great Oyster Bay and Mercury Passage were higher than reference levels and thus triggered the performance indicator.

Over the past five 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 in each of the past two years (Fig. 4.1a). The expansion in the fishery was almost exclusively due to increased squid jig catches (Fig. 4.1b). The shift to jigs has occurred at the expense of purse seine catches, which have declined over time. The most recent catch of 108 tonnes represents the highest on record and is just 3% higher than the 2001/02 catch.

The fishery initially developed in Great Oyster Bay (blocks 6H1, ES13 & ES14), but has subsequently expanded into the Mercury Passage (6H3, 6G4 & ES16). The jig catch in Great Oyster Bay rose sharply to peak in 1998/99 and then declined, but since 2000/01 catches have increased steadily (Fig 4.1c). Over the past five years production in Mercury Passage has risen to levels comparable to Great Oyster Bay in the past two years. There has been little evidence of change in the size of the jig catch from the Tasman Peninsula (7G2) to date (Fig 4.1c).

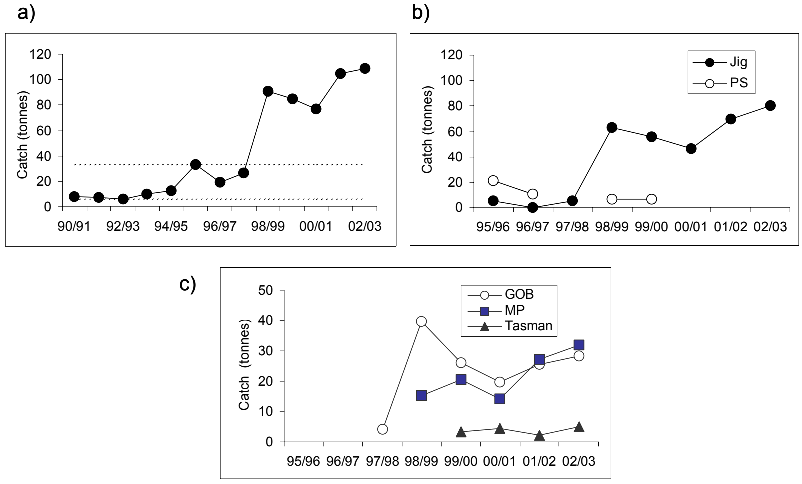


Fig. 4.1. Calamary catches (tonnes): a) State-wide catches since 1990/91 with dashed lines indicating upper and lower catch reference levels; b) catch by method where Jig is squid jig and PS is purse seine; and c) regional catches taken by squid jigs, where GOB is Great Oyster Bay, MP is Mercury Passage and Tasman is Tasman Peninsula) (note: only catches where >5 operators are represented are shown.

4.5.2 Fishing effort

Evaluation of 2002/03 effort against performance indicators

- State-wide, jig effort was at an historically high level and substantially higher than reference levels; the effort performance indicator was thus triggered.
- Regionally, jig effort in Great Oyster Bay, Mercury Passage and Tasman Peninsula increased to an extent that triggered the performance indicator.

Jig effort increased by a further 40% over 2001/02 to the highest level on record (Fig 4.2). Increases were evident in all regions. Although not shown, purse seine effort has continued to decline and was well below reference levels in 2002/03.

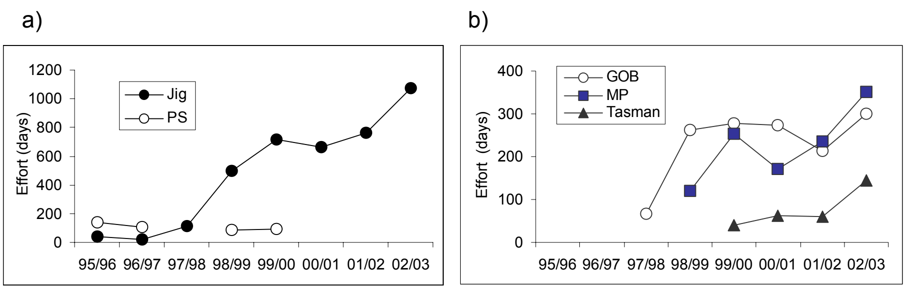


Fig. 4.2. Calamary effort (days fished): a) effort by method where Jig is squid jig and PS is purse seine; and b) regional jig effort where GOB is Great Oyster Bay, MP is Mercury Passage and Tasman is Tasman Peninsula (note: only data where >5 operators are represented are shown).

4.5.3 Catch rates

Evaluation of 2002/03 catch rate against performance indicator

- State-wide and regional jig catch rates were within reference levels, and thus have not triggered the catch rate performance indicator.

Catch rates for jigs, both State-wide and regional have fluctuated without obvious pattern (Fig 4.3). In the current year there was a slight decline overall and in the Mercury Passage and Tasman regions but an increase in Great Oyster Bay. Since purse seine effort has been very low in recent years, catch rates are not considered to be very informative of stock condition.

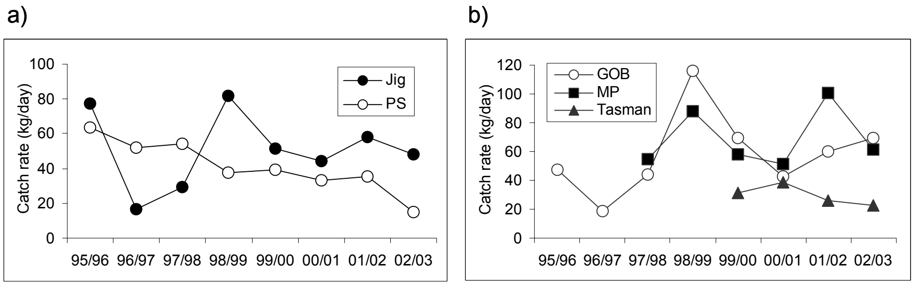


Fig. 4.3. Calamary catch rates (kg/day): a) catch rates by method where Jig is squid jig and PS is purse seine; and b) regional jig catch rates where GOB is Great Oyster Bay, MP is Mercury Passage and Tasman is the Tasman Peninsula.

4.5.4 Modelling options

Modelling strategies

Expansion of the calamary fishery has required the development of methods to assess the status of the fished stocks. In turn, the type of assessment that is possible will dictate what performance indicators can be used successfully in this fishery. Investigating performance indicators is equivalent to asking particular questions about a stock and its status. More complex stock assessment models have a greater chance of being able to answer complex questions about a fishery. Unfortunately, the data requirements for complex stock assessment models can be heavy and, obviously, it is best to limit the questions being asked of a formal assessment to those that can be answered by analysis of the available data.

In the case of southern calamary, there is a great deal of information available about a sub-set of the stock. However, many biological properties have been found to vary greatly from year to year, including growth rates, mean size of animals and the mean age of animals in the fishery. Under such rampant variability, the data requirements for a model that attempts to describe the detailed dynamics of the calamary populations would be immense. Instead, such information becomes important in emphasizing, in a qualitative way, that any answers that are produced would be highly uncertain.

Despite the limitations, there are two possible forms of assessment model that could be used with calamary. These are the classic surplus production models (Schaeffer 1954, 1957; Haddon, 2001) and various within-year depletion models (e.g. De Lury, 1947, 1951; Geaghan & Castilla, 1986; Agnew *et al.*, 1998). Both of these approaches have relatively simple data requirements and as a consequence are limited in what can be expected of them. The requirements are a listing of catches, effort, and catch rates through time. The surplus production models are generally applied to annual data while the depletion models are generally used within years.

Intra and inter-annual patterns in catch and catch rates

Commercial catch and effort data indicate that squid jigs now account for the bulk of the catch (see Fig. 4.1) which has a number of fortunate aspects, not least being that the only species targeted with jigs are calamary (or arrow squid). Furthermore, catches and the use of jigs did not increase to significant levels until the 1998/99 fishing year.

The fishery is prosecuted in a number of different geographical areas (see Fig. 4.1). At least initially, the three main areas will be considered separately and then compared.

The fisheries in Great Oyster Bay and Mercury Passage show many similarities of duration and intensity as indicated in the patterns of production within and between fishing years (Figs 4.4 & 4.5; Table 4.1). However, they differ markedly from the fishery in the South East (Tasman plus blocks 7H1, 7G1, 7G3, 7F4, ES01, ES17, ES18, ES19), both in period of maximum intensity of activity (catches) and in duration of jig fishing. The jig fishery in the South East tends to peak in activity slightly later than in the other two regions, and only lasts for a much shorter period. Furthermore, there are minor peaks of activity in the middle of the year (April through to June), which are not evident in Great Oyster Bay or Mercury Passage. The summary statistics obtained from fitting a series of normal distributions to the observed patterns of catches permit the different areas and seasons to be compared directly (Table 4.1). This analysis indicates that there has been a slight trend for the peak in fishing activity in Great Oyster Bay and Mercury Passage to occur a few weeks earlier in the calendar year and for the duration of peak fishing activity (represented by Duration in Table 4.1) to be longer.

Table 4.1. Formal descriptions of activity patterns as represented by normal distributions fitted to each year's fishing catches for each region separately

Week is the week number within the calendar year in which the peak of activity occurs; Duration is the 95% bounds of the normal curve fitted to the activity pattern in weeks; Amplitude is the relative size of the curve needed to cover each season; and BackGround is the constant level of catch that can be expected to occur outside of the main fishing season across all years. Secondary (minor) peaks of activity in the middle of calendar years 2001 and 2002 in the South East are indicated.

	98/99	99/00	00/01	2001	01/02	2002	02/03
Great Oyster Bay							
Week	44.5	43.6	41.8		43.0		41.5
Duration	24.2	19.8	24.7		25.9		18.1
Amplitude	37295.5	25779.3	22010.6		24089.3		23579.6
BackGround	128.8						
Mercury Passage							
Week	46.7	44.0	43.6		43.8		43.8
Duration	14.5	24.5	24.6		20.2		33.9
Amplitude	11531.8	20240.6	18273.5		31310.2		42974
BackGround	94.7						
South East							
Week	46.8	48.0	48.3	17.9	45.7	20.5	45.8
Duration	3.0	7.1	7.6	10.3	18.2	10.7	12.8
Amplitude	3516.8	3349.8	8136.6	1182.5	8304.6	1562.1	5798.9
BackGround	78.5						

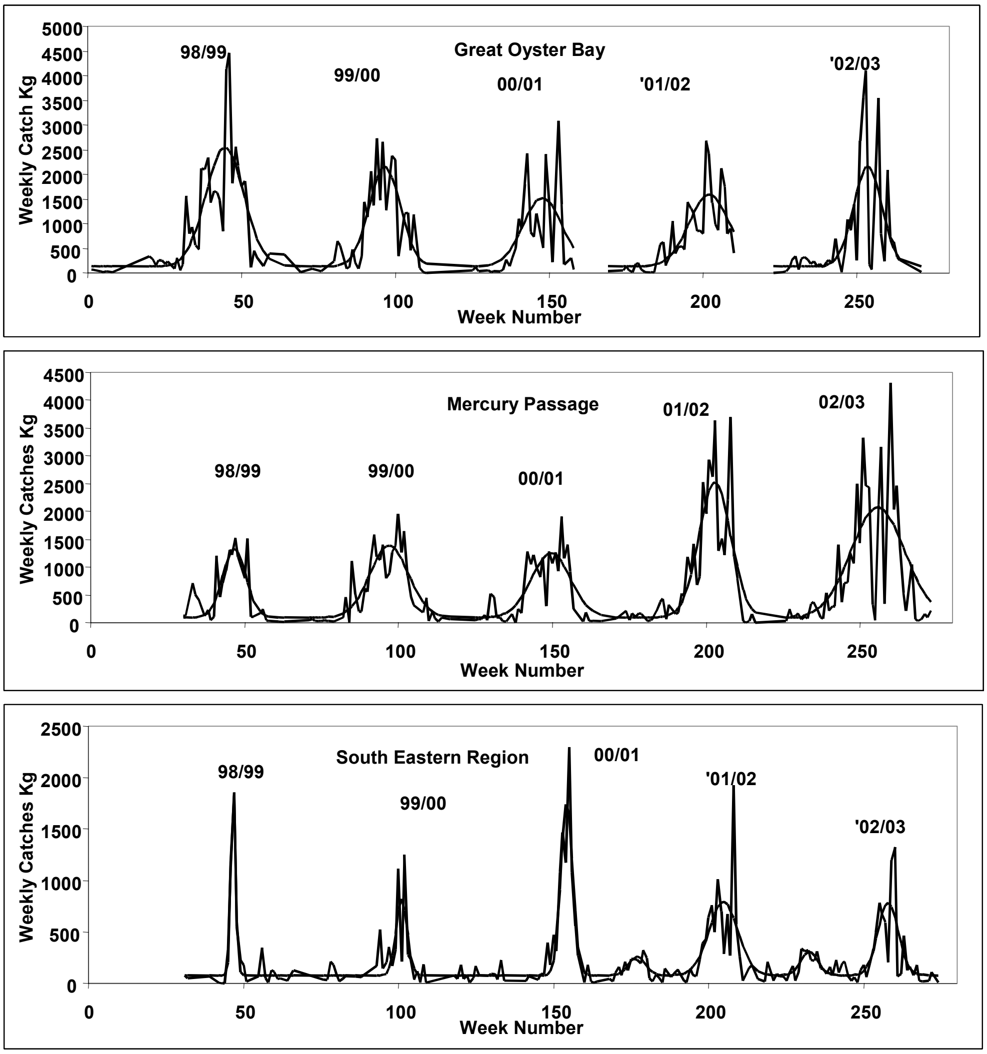


Fig. 4.4. Weekly catches (kg) by major fishing regions from the start of 1998. The smooth curve represents a set of normal distribution used to describe the background level of fishing plus the peak of activity in terms of week number and the duration of the season in weeks for each season (see Table 1). The effects of the fishing closures first introduced in the 1999/00 season are evident as the spiky pattern of catches visible each year.

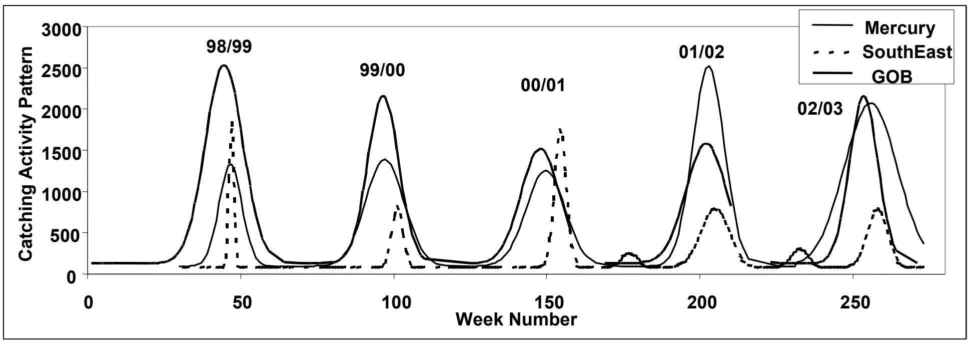


Fig. 4.5. A compilation of the normal curves representing the relative catching activity in the three areas (see Table 4.1). Note that Mercury Passage (the fine solid line) was only developing as a fishery in 1998/99, hence it only lasted for a relatively short period.

In the South East region a diversity of fishing methods is used, each with too little catch for useful modelling to be pursued beyond the present fishery description.

In the Great Oyster Bay fishery there was no clear pattern apparent in catch rates within each season apart from the obvious lowering of mean weekly catch rates across the years (Fig. 4.6). Similarly, there were no obvious within season patterns in catch rates for Mercury Passage, although in some years there was a hint of declining catch rates through the peak catching period (e.g. in 1998/99 and possibly 2000/01). Some lowering of catch rates during 2002/03 is perhaps evident in Mercury Passage.

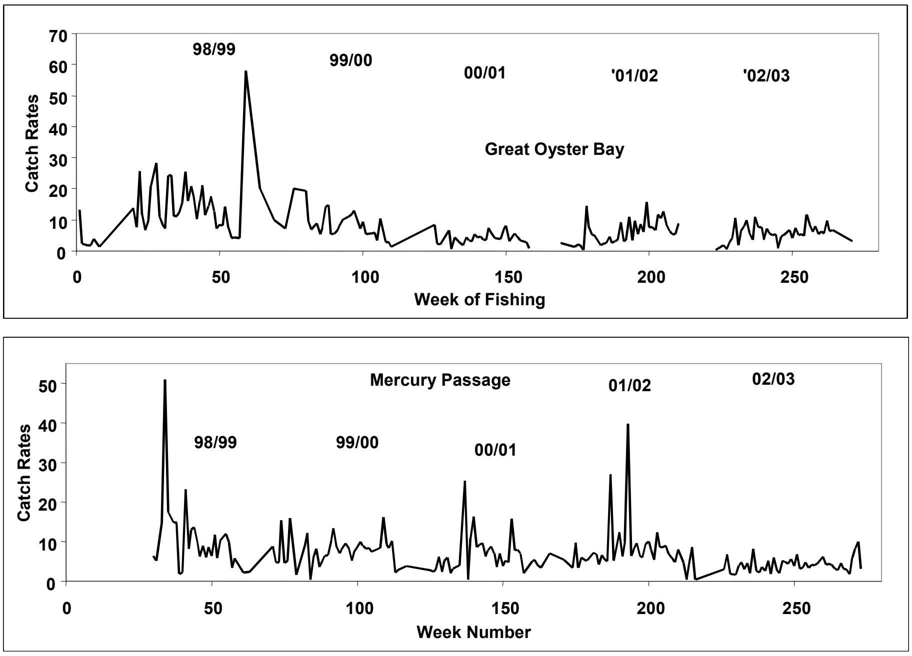


Fig. 4.6. Geometric mean catch rates by week since the start of 1998 for Great Oyster Bay and Mercury Passage.

Since the pattern of catches are so similar, the fisheries in Great Oyster Bay and Mercury Passage were assessed by combining the data from the two regions and treating them as a single fishery. The description of the fishery for the regions combined increases the number of observations available in each week (and season), which improves our confidence in the results deriving from the data (Figs 4.7 & 4.8). Visually, the general trend is one of relatively steady decline in catch rates over the history of the fishery. Unfortunately, depletion methods of estimating stock biomass within a year require the data to exhibit a general and monotonic decline in catch rates against cumulative catches. In none of the years observed has this pattern been exhibited. This is likely due to the rapid growth rates of the calamary such that at the beginning of the fishing season the biomass available continues to increase despite catches being removed.

Agnew *et al*. (1998) successfully applied a DeLury depletion assessment method to squid data from the Falkland Islands. Their analysis was modified to permit the inclusion of more than one cohort, because the data did neither exhibit clear, monotonic declines through the peak catching period. With southern calamary there may well be a wide range of different aged animals present on the fishing grounds but, unfortunately, they do not appear to be in distinct cohorts. This means that depletion methods do not provide a useful avenue to pursue with this species.

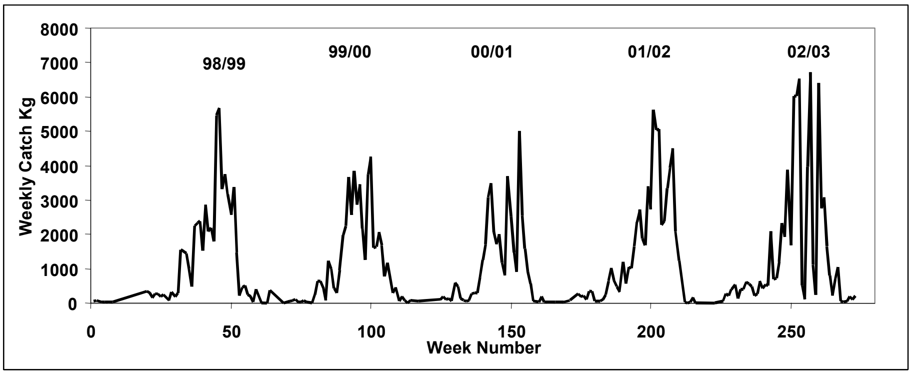


Fig. 4.7. Combined weekly catches from Great Oyster Bay and Mercury Passage starting at the beginning of 1998. The influence of the two 2-week closures are clearly visible in 2002/03, when they applied to both Great Oyster Bay and Mercury Passage.

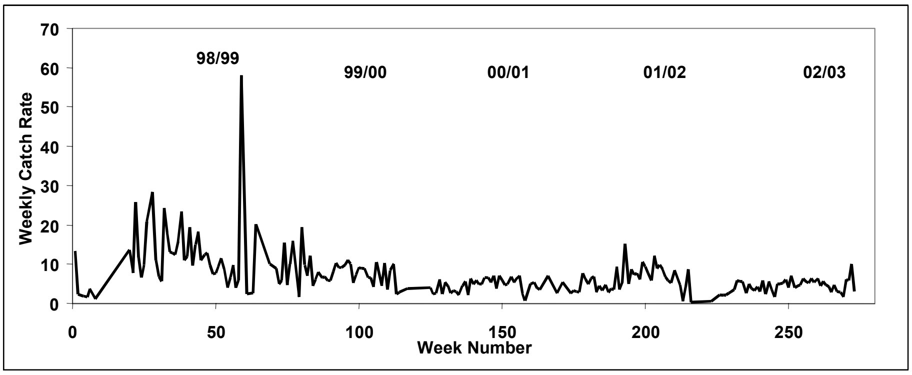


Fig. 4.8. Weekly catch rate data for data combined from Great Oyster Bay and Mercury Passage.

4.5.5 Surplus Production Model

If the system dynamics are treated at an annual time-step then the catch and catch rate patterns in the combined Great Oyster Bay and Mercury Passage fishery become clearer and the modelling is simplified (Table 4.2; Fig 4.9). A surplus production model has been applied to describe the catch through time in terms of implied spawning biomass available and catch rates.

Catch rate trend is used as the index of relative abundance needed to relate the catches to stock spawning biomass. Although catch data are available from 1995/96, the model can only be fitted to catch rate data from 1997/98. With only six years of catch rate data, it is best to use only the simplest of models with a minimum number of parameters. A non-equilibrium version of the simplest model available (Schaefer, 1954, 1957; Haddon, 2001) can be described by the following equations with only two parameters. The basic stock dynamics are described by the delay-difference version of the standard logistic production model:

$$B_0 = K$$

$$B_{t+1} = rB_t\left(1 - \frac{B_t}{K}\right) - C_t$$

where K represents the unfished equilibrium population size B_0, r is a parameter depicting population growth rate, B_t represents exploitable spawning stock biomass in year t and C_t the catch in year t. The model is fitted to the available catch rate data with the following:

$$\hat{I} = \frac{\hat{C}}{E} = qB_t$$

$$SSQ = (Ln(I) - Ln(\hat{I}))^2$$

where $\hat{I}$ is the expected catch rates (catch per effort), q is the catchability coefficient, and SSQ is the sum of squared residuals between the natural logs (Ln) of observed (I) and expected catch rates ($\hat{I}$). This implies that residual errors are log-normally distributed, which is confirmed by the relative normality of the distribution of log-transformed catch rates (Fig. 4.10).

Table 4.2 Total jig catch, geometric mean catch rate and number of jig days of effort by fishing season for Great Oyster Bay and Mercury Passage

.

Fishing Season	Catch (tonnes)	Catch rate (kg per jig hour)	Effort (jig days)
1995/96	22.5		
1996/97	11.9		
1997/98	15.8	6.6	32
1998/99	69.1	11.4	390
1999/00	60.7	7.4	563
2000/01	49.0	5.1	501
2001/02	72.1	5.9	524
2002/03	69.0	4.8	641

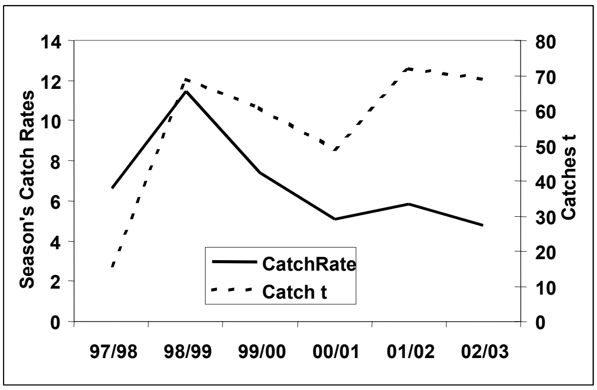


Fig. 4.9. Total catches by all methods (dotted line) and jig catch rates (solid line) from the combined Great Oyster Bay and Mercury Passage region.

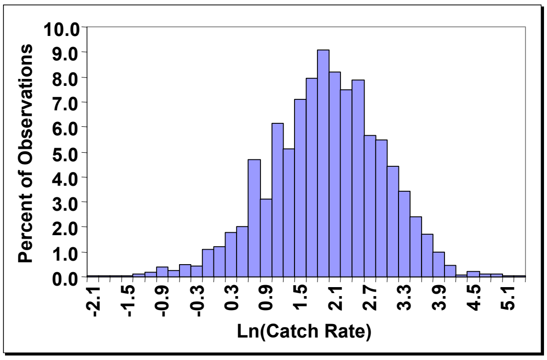


Fig. 4.10. Histogram of the relative percent frequency of observations of the natural log of catch rates for the calamary fishery in the combined Great Oyster Bay and Mercury Passage region.

An alternative model fitting criterion, the maximum likelihood approach, results in identical solutions with log-normal errors and entails minimizing the following negative log-likelihood (Haddon, 2001):

$$-LL = \frac{n}{2}\left(Ln\left(2\pi\right) + 2Ln\left(\hat{\sigma}\right) + 1\right)$$

where the standard deviation $\hat{\sigma}$ is:

$$\hat{\sigma} = \sqrt{\frac{\sum\left(Ln\left(I_t\right) - Ln\left(\hat{I}_t\right)\right)^2}{n}}$$

where I_t and $\hat{I}_t$ are again the respective observed and expected catch rates, and n is the number of years of observations. The estimation of the catchability coefficient can be made using a closed form version of the equation:

$$\hat{q} = e^{\frac{\sum Ln\left(\frac{I_t}{B_t}\right)}{n}}$$

While the model may only be fitted to the final six years of data, it is apparent from the count of records that not all estimates of seasonal catch rate are estimated with equal precision or confidence (e.g. 1997/98 has only 32 data points). One solution to this heterogeneity is to use a weighted least squares approach which applies a weight equal to the square root of the number of observations contributing to that data point:

$$SSQ = \sqrt{N}\left(Ln(I_t) - Ln(\hat{I}_t)\right)^2$$

where N is the number of observations that contribute to the estimate of I_t. With this weighting the optimum solution provides a reasonable match of observed and predicted catch rates with the exception of the earliest data point, which is not weighted greatly in the analysis (Fig. 4.11).

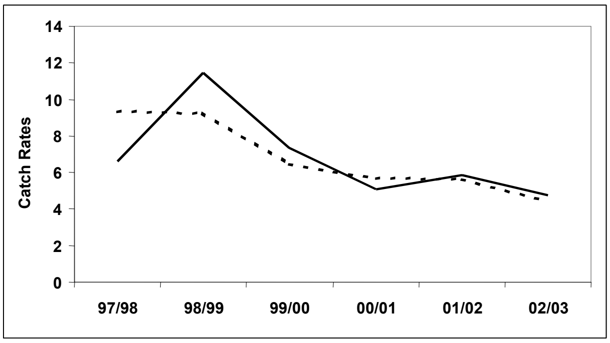


Fig. 4.11. A comparison of catch rates from the observed (solid line) and the predicted (dotted line) catch rates.

Model Fit

The surplus-production model has been fitted under three different scenarios of recreational catch, with recreational catches added as a proportion (0%, 10% and 20%) of the commercial catch. The optimum model fit implies a declining series of spawning stock biomass levels, which relate directly to a steadily increasing harvest rate in the fishery (Table 4.3; Fig. 4.12). The most recent years are showing signs of fishing mortality levels that are typically unsustainable. The optimum solution is robust in that it is not possible to force the model to accept alternative scenarios of productivity and biomass i.e. there are no false minima even close to the optimum solution.

Table 4.3. Output from the surplus production model fitted to data for combined Great Oyster Bay and Mercury Passage region

a) Model parameters under three scenarios of recreational catch contribution: productivity *r* and unfished population size *K* are parameters of the model; *q* is the catchability; *SSQ* is the sum of weighted squared residuals; σ is the standard deviation from the negative log-likelihood *–LL* function. Recreational catches are added as a proportion of the commercial catch. Note the decline in *r* and increase in *K* as recreational proportion increases. b) Model outputs assuming 0% recreational catch: Observed catch and catch rates, number of records, predicted exploitable stock biomass in the middle of the fishing season, predicted catch rate (Pred CE); and catch/exploitable biomass or harvest rate *H*.

a)	Recreational %	0.0	10.0	20.0
	r	0.99	0.97	0.96
	K	198.0	220.9	243.8
	q	0.05	0.04	0.04
	SSQ	2.44	2.48	2.51
	σ	0.64		
	-LL	7.16		

b)	Season	Catch (t)	Catch Rate	Records	Biomass	Pred CE	*H*
	1995/96	22.5			198.0		
	1996/97	11.9			175.6		
	1997/98	15.8	6.6	32	183.3	9.3	0.09
	1998/99	69.2	11.4	390	181.0	9.2	0.38
	1999/00	60.7	7.4	563	127.3	6.5	0.48
	2000/01	49.0	5.1	501	111.5	5.7	0.44
	2001/02	72.1	5.9	524	110.7	5.6	0.65
	2002/03	69.0	4.8	641	86.8	4.4	0.79

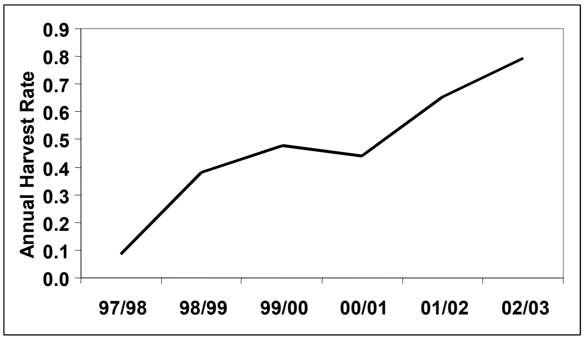


Fig. 4.12. The annual harvest rate (as Catch/Exploitable Biomass) through the six seasons of the fishery being modelled.

Uncertainty

Unfortunately, the precision of the assessment using the simplistic representation of a surplus production model is low. The uncertainty can be estimated by using a bootstrap procedure that generates a sample of the log-normal residuals which are combined with the optimal fitting line to generate new samples of catch rate time series, each of which are refitted providing new estimates of parameters and model outputs (Haddon, 2001). Bootstrap 95% confidence intervals can thus be placed around the various model outputs (Figs 4.13 & 4.14). While the predicted catch rates appear relatively precise, the predicted harvest rate has a poor precision. For instance, in 2001/02 and 2002/03 the upper 95% confidence limit on harvest rate reached 1.0 (total harvest of all available biomass – clearly false) whereas the lower limit was around 20%.

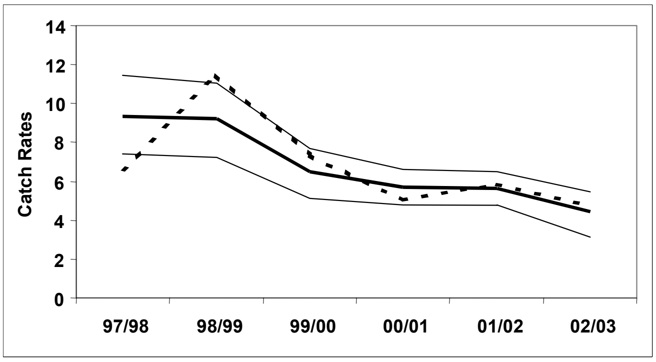


Fig. 4.13. Predicted catch rates from the optimal fit (solid line) with 95% confidence intervals (thin lines). Observed catch rates are denoted by the dotted line.

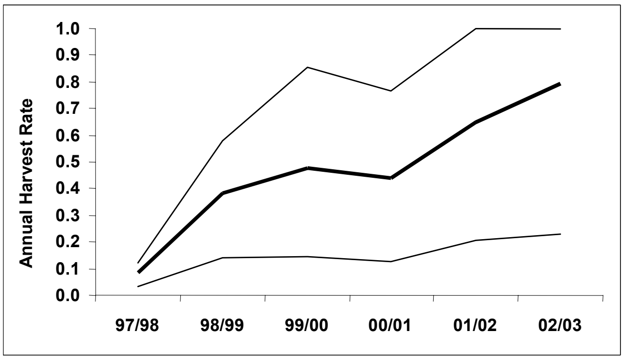


Fig. 4.14. Predicted harvest rate from the optimal fit (solid line) when recreational catches are set at 10% of commercial catches. Thin lines represent the 95% confidence intervals.

Performance Indicators

The analysis suggests that the unfished, mid-season exploitable biomass in the regions considered was in the order of 200-245 tonnes, but has been reduced to only about 90-107 t depending on recreational catch proportion. Commercial catches in the order of 70 t with zero recreational take imply that the harvest rate is very high. When recreational catches are included the predicted harvest rate reduces only minimally. If the recreational take is assumed to be 10% of the total commercial catch, the harvest rate in the final year reduces slightly from 0.79 to 0.78, and a recreational take of 20% takes the harvest rate down to 0.77[3]. Despite increasing the catches, the reducing effect on harvest rates is very small, because the increased catches imply that the stock has a higher starting biomass but is less productive than when there are no recreational catches. Irrespective of the level of recreational catch, the total harvest rate would appear to be too high to be sustainable. In particular the marked increase in harvest rate over the past two years is cause for concern.

The current performance indicator relating to catch rates is not as sensitive as one based on harvest rate. Harvest rate provides an indication of the escapement (the proportion of the available biomass not harvested) and could be used as an effective performance indicator, although a target level of escapement would need to be agreed upon. Typical escapement values used are approximately 40%, which is an arbitrary figure derived from experience with other squid fisheries (Agnew *et al*. 1998). It should be noted, however, that while this was the target in the Falkland squid fishery, that fishery still collapsed. This implies that harvest rates probably should not exceed about 60%.

High levels of uncertainty about this analysis mean that care must be taken if the results of this assessment are to be used in the management of the Tasmanian stock. However, the increasing trend in the implied harvest rate is consistent with declining observed catch rates, declining levels of estimated egg-production (Moltschaniwskyj *et al*. 2003), and increasing effort being imposed on this species.

[3] Note, recreational catch estimates for 2001/02 for Great Oyster Bay and Mercury Passage are equivalent to about 8% of the commercial catch.

4.6 Management Implications

Evaluation of performance indicators based on catch and effort for calamary is compromised, because the fishery effectively developed after the management plan was introduced. As such, comparisons are based between a fishery in under-developed (pre-1998/99) and in developed states and thus will always result in catch and effort indicators being triggered. In fact, at this stage it would be of greater concern if catches fell to within historic levels than remained above reference levels.

The sustainability of current catch levels is uncertain, but preliminary modelling suggests that within the main area of the fishery harvest rates are very high. This implies that the fishery has impacted significantly on stocks and is set against the fact that there continues to be growing interest in the fishery. There is substantial capacity within the Tasmanian scalefish industry to increase effort levels.

Currently limited information is available on the stock structure of southern calamary in Tasmania. Such information is required to assess the validity of current spatial management and regional analyses reported here. In particular, the relationships between calamary populations fished in Great Oyster Bay and Mercury Passage and other regions need to be investigated.

Calamary have a life span of generally less than one year, with no accumulation of recruitment across a number of years. This suggests considerable potential for inter-annual variability in abundance coupled with vulnerability to recruitment over-fishing, especially since the species can be targeted whilst aggregating to spawn. Given such vulnerability, the impact of fishing activities on the spawning behaviour of the aggregations needs to be addressed. Furthermore, since growth and reproductive characteristics of 'micro-cohorts' differ substantially depending upon the timing of hatching and subsequent environmental conditions, environmental factors may prove as important as fishing mortality in driving the population dynamics and determining spatial patterns of abundance.

Although there is a high degree of uncertainty with the present assessment, key indicators do suggest that maintaining the *status quo* for the Tasmanian southern calamary fishery is a high risk strategy. For the fishery to remain sustainable, a more precautionary approach is required including consideration of options that will effectively reduce harvest rates.

4.7 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.

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 analyse statoliths for age in order to determine spawning times and growth rates of seasonal cohorts. Our understanding of the variability and plasticity in the life cycle and the subsequent application of population modelling techniques would 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. The relationship between reproductive output and age and size of females, in terms of batch size and frequency of batch deposition, needs to be quantified. The significance of seagrass and macro-algal habitats for spawning and feeding of southern calamary will require further sampling in areas along the east coast.

5 Striped Trumpeter (*Latris lineata*)

5.1 The Fishery

Striped trumpeter has had a long history of commercial exploitation in Tasmania, being highly esteemed for its eating qualities. There is also a high level of interest in the species from recreational fishers and charter boat operators.

The species is taken by a variety of fishing methods, with hooks and gillnets being the primary methods. Juvenile striped trumpeter are taken predominantly by graball net in inshore waters (within 3 nautical miles) and usually in depths <20 m, whereas adult fish are taken in deeper offshore waters by hook methods (dropline, handline, bottom longline, trotline) and by 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.

5.2 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 target 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 in effort directed at these species. A bag and possession limit of five striped trumpeter was also introduced for recreational fishers.

A legal minimum size limit of 35 cm total length (TL) applies for striped trumpeter. This size is substantially below the size at maturity, which is around 44 cm for females and 53 cm for males.

5.3 Stock Structure and Life-history

Striped trumpeter are 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. During

2001 a striped trumpeter tagged off the Tasman Peninsula in 1996 was recaptured off St. Paul Island. Such large-scale movements suggest the potential for mixing between widely separated populations (Lyle and Murphy 2001).

Striped trumpeter occur mainly on the continental shelf over rocky bottom to depths of about 300 m, with juveniles found mainly over shallow inshore reefs. Since nothing is known of the stock structure in Australian waters, a common stock throughout its range is assumed for management purposes.

Striped trumpeter are reported to grow to 1.2 m in length and 25 kg in weight (Gomon *et al*. 1994). Growth in juveniles is rapid, 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 (Murphy and Lyle 1999). Older fish grow significantly more slowly, with a large range in size-at-age for fish over about 50 cm. Maximum age is currently estimated to be 43 years. While this has yet to be fully validated, the incremental structure in sectioned otoliths is clear and unambiguous.

There is limited knowledge about the life history of striped trumpeter. Spawning occurs from July to early October, depending on geographical location (Ruwald *et al.* 1991), with spawning commencing and finishing earlier at lower latitudes. Females reach maturity at a smaller size and age (44 cm and 5 years) than males (53 cm and 8 years) (Hutchinson 1994). Striped trumpeter are 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). 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 (Murphy and Lyle 1999). 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 (Lyle and Jordan 1999).

Recruitment is highly variable, with evidence of a particularly strong year class spawned in 1993 (Murphy and Lyle 1998) 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).

5.4 Previous Assessments

Previous assessments have been limited to the examination of catch, effort and catch rate trends, and reporting against performance indicators (trigger points). Catch performance indicators were triggered in 2001/02, where catches were below reference levels. While effort indicators were not triggered, dropline catch rates were below reference levels in 2001/02.

5.5 Current Assessment

The current assessment examines trends in catch, effort and catch rate for the primary fishing methods, namely dropline, handline and graball net. In an attempt to distinguish fishing effort targeted at striped trumpeter, fishing on a given day using these methods has been assigned as targeted if:

- the catch of striped trumpeter was greater than 10 kg and accounted for at least half of the total weight of all species retained; or
- the catch of striped trumpeter was greater than or equal to 50 kg.

A review of existing biological data, including re-examination of age composition data and yield-per-recruit and catch curve analyses have also been undertaken and are reported in this assessment.

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

5.5.1 Catch

Evaluation of 2002/03 catches against performance indicator

- State-wide catch was slightly lower than in 2001/02 and well below the reference catch range; the catch performance indicator was therefore triggered.

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 for this sector have been unavailable, although it is assumed that subsequent catches have been reported in Commonwealth logbooks. Apart from 1999/00 when over 14 tonnes was taken, Commonwealth catches have been relatively low. Data for Commonwealth vessels has been unavailable since 2001/02, though dual endorsed operators are required to report trumpeter catches in the Tasmanian logbook.

The overall catch and catches by the primary fishing methods are presented in Fig. 5.1. The most conspicuous trend was the initial increase in production for all methods up until 1999/00. Catches in 1998/99 and 1999/00 were higher than during the reference period and therefore exceeded the catch trigger in both years. There was a sharp downturn in catch in 2000/01 that resulted in catch triggers being exceeded because of the rate of change and the fact catches fell to below reference levels. The 2002/03 catch of just 36 tonnes represented a decline of about 10% compared to 2001/02 and was the lowest catch reported since the late 1980s (Lyle and Jordan 1999).

Strong 1993 and 1994 year-classes entered the fishery between 1995/96 and 1997/98 and influenced subsequent catches (and catch rates). There is circumstantial evidence to suggest that the 1996 year-class was also relatively strong and would have recruited to the inshore gillnet fishery in 1998/99. The subsequent decline in graball catches since 1998/99 presumably reflects the movement of the strong year-classes offshore but also suggests that there has been limited recruitment in recent years. The 250 kg trip limit for commercial operators is likely to have contributed to the fall in dropline and handline catches since 2000/01. Industry representatives suggest that the trip limit represents a strong disincentive to fish for the species.

A recent 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 represents a significant contribution to the overall fishery. The introduction of a voluntary logbook for the charter boat sector during 2003 should provide on-going catch information and may have some potential as an indicator of trends in the broader recreational fishery.

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

	Catch (tonnes)			
Year	*Tasmanian*	*Victoria*	*Commonwealth*	*Combined*
1990/91	74.5	37.1		111.6
1991/92	58.2	36.8		95.0
1992/93	52.7	19.8		72.5
1993/94	56.5	16.0		72.5
1994/95	72.4	14.6		87.0
1995/96	60.3			60.3
1996/97	79.7		0.7	80.4
1997/98	75.4		5.7	81.1
1998/99	98.4		8.9	107.4
1999/00	86.3		14.5	101.8
2000/01	41.2		7.5	49.6
2001/02	40.0			40.0
2002/03	35.9			35.9

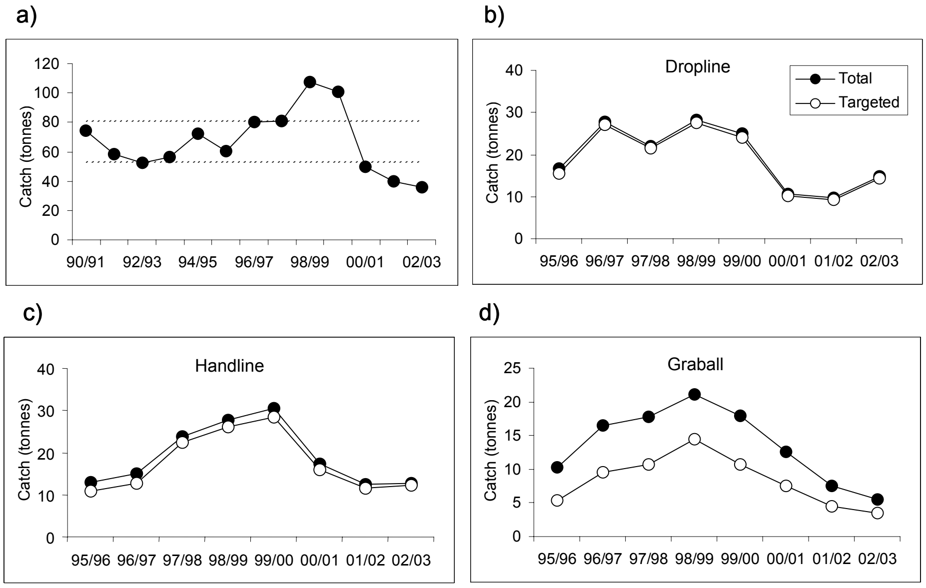


Fig.5.1. Striped trumpeter catches (tonnes): a) State-wide catches (State and Commonwealth waters) since 1990/91 with dashed lines indicating upper and lower catch reference levels; b) total and targeted dropline catches; c) total and targeted handline catches; and d) total and target graball catches.

5.5.2 Fishing effort

Evaluation of 2002/03 effort against performance indicator

- Handline and graball effort targeted at striped trumpeter were within or below reference levels. Dropline effort was, however, more than 10% greater than the highest level during the reference period, and therefore the effort performance measure was triggered.

During the latter part of the 1990s, effort for the major fishing methods increased, presumably linked to the increased availability of striped trumpeter (Fig. 5.2). However, effort has fallen since for all methods apart from dropline in the most recent year when effort increased by 36% compared to 2001/02. Although not presented, 2002/03 dropline effort based on gear units (hook lifts) remained well below reference levels (refer also Table 2.2) implying that either gear units were not consistently reported correctly or that, on average, there were fewer hook lifts each fishing day in 2002/03 compared with previous years. An examination of catch records suggests an inconsistency in reporting, and further justifies the use of days fished as the effort measure.

It is apparent that the bulk of the dropline and handline effort in which striped trumpeter was taken was classified as targeted effort, whereas only a small proportion of the graball effort met this criterion (Fig 5.2). Not surprisingly, targeted effort for both hook methods tracked the trends for total effort.

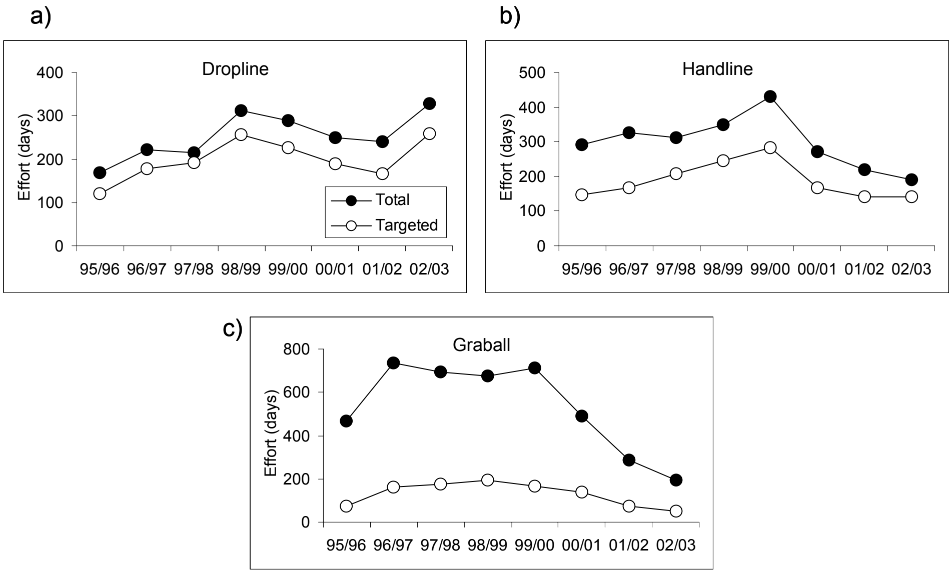


Fig. 5.2. Striped trumpeter effort (days fished): a) total and targeted dropline effort; b) total and targeted handline effort; and c) total and targeted graball effort.

5.5.3 Catch rates

Evaluation of 2002/03 catch rate against performance indicator

- Catch rates based on total handline and graball net effort were within reference values. By contrast, total and targeted catch rates for dropline and targeted catch rates for handline and graball nets were below 80% of the lowest reference level. Catch rate performance indicators were therefore triggered for droplines.

Catch rates for the hook methods have declined since the late 1990s whereas graball catch rates have remained stable over time (Fig 5.3). Compared to 2001/02, dropline and handline catch rates improved very slightly although the former remained low, at less than 50% of reference levels. Based on targeted catch rates, those for handlines have remained within reference levels whereas dropline catch rates were below reference levels (Fig. 5.3).

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).

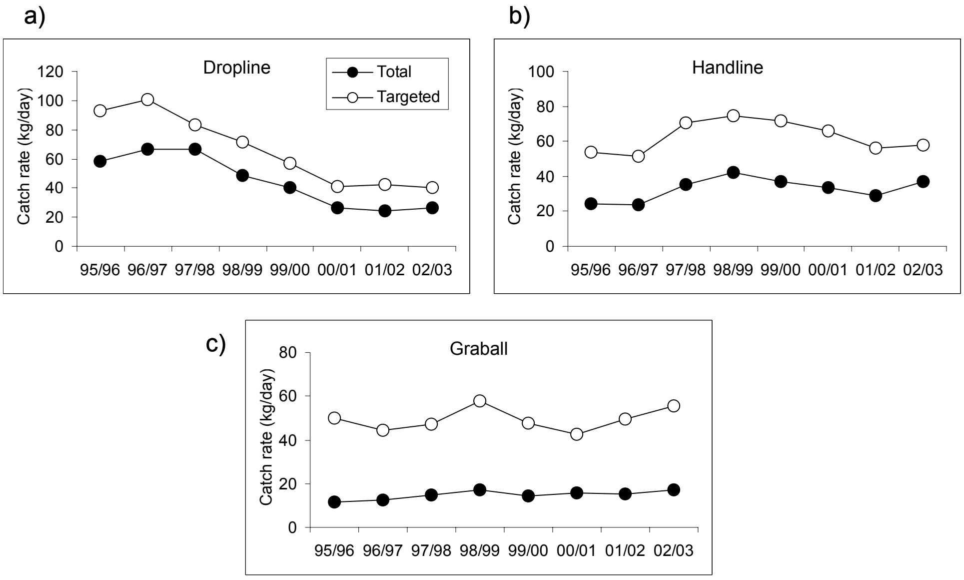


Fig. 5.3. Striped trumpeter catch rates (kg/day): a) total and targeted dropline catch rates; b) total and targeted handline catch rates; and c) total and targeted graball catch rates.

5.5.4 Size composition

Size composition information obtained from research fishing and commercial catch sampling since 1990 are summarised in Fig. 5.4. These data support the observation that fish move from shallow inshore reefs to deeper offshore reefs as they approach about 45 cm in length. There is little evidence of size structuring at depths beyond about 50 m. The offshore migration has implications for management of striped trumpeter in that the inshore graball fishery effectively targets different life history stages, namely juvenile and sub-adult fish, to the offshore hook fishery, which is predominantly based on adult fish.

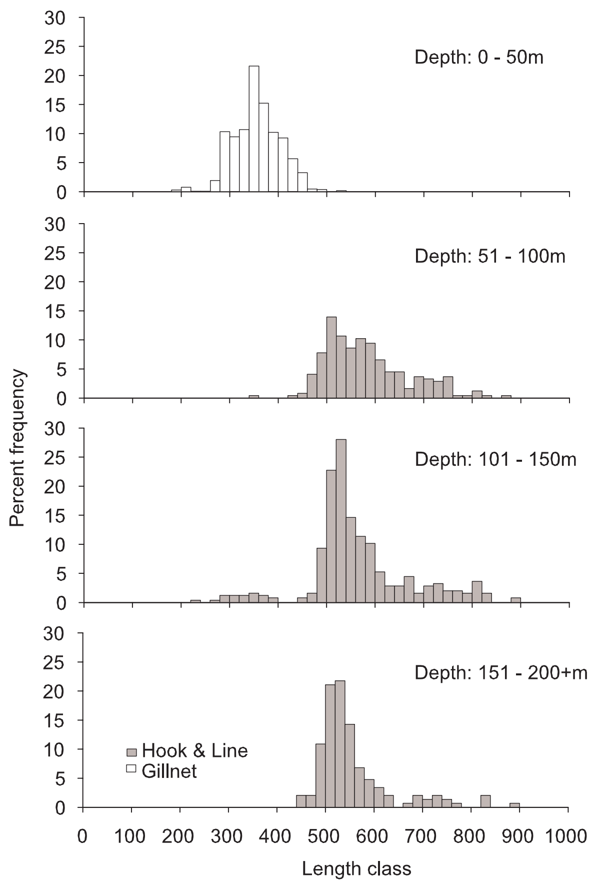


Fig. 5.4. Length frequency (mm FL) distribution by 50 m depth strata for striped trumpeter collected between 1990–2002.

5.5.5 Catch curve analysis

Catch curve analysis has been used to estimate total mortality *Z*. The analysis was based on hook caught fish taken during 1998/99 and involved the conversion of length frequency data to ages, using an age-length key developed for that year. A regression line was fitted to the resultant age frequency data between ages 6 and 12 years (ages 13-16 appeared to be over represented, either an artefact of sampling or indicative of recruitment variability). The slope of this regression indicated $Z = 0.24$. Based on natural mortality $M = 0.09$, this implied a fishing mortality *F* of about 0.15. For this purpose, *M* was estimated through comparisons with fish of similar age, size, habitat and environment.

The reliability of this analysis is, however, uncertain, partly because catch curves assume limited recruitment variability between years, an assumption that was clearly violated for striped trumpeter, and the sample used to develop the age length key was small. The 1993-year class (5 year olds) was excluded from the analysis to partly address the concern regarding recruitment variability.

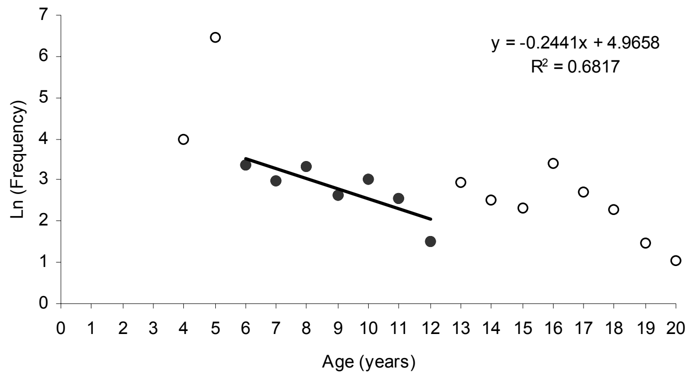


Fig. 5.5. Catch curve analysis for hook caught striped trumpeter sampled between November 1998-October 1999. The regression line has been fitted to ages 6-12 years (filled circles).

5.5.6 Yield-per-recruit analysis

Yield-per-recruit (YPR) analysis has been performed to investigate potential yield under a range of minimum size limits and fishing mortality levels. By necessity this analysis is relatively simple and involves a number of simplifying assumptions. They include constant growth rates between year classes and regions, and constant natural mortality rates for the recruited age classes. The input parameters of the YPR are listed in Table 5.2.

Table 5.2. Input parameters of the yield-per-recruit analysis.

L_∞, k and t_o are parameters of the von Bertalanffy growth function; M is natural mortality; a and b are parameters of the length-weight relationship.

Parameter	Value
L_∞	773.3
k	0.15
t_o	-1.46
M	0.096
a	0.00002
b	3.00

The YPR indicates that maximum yield is not achieved at the current size limit of 350 mm TL (about 320 mm FL; Fig. 5.6). Rather, the model suggests that at levels of F greater than 0.15, maximum yield is achieved at minimum size limits above about 450 mm FL.

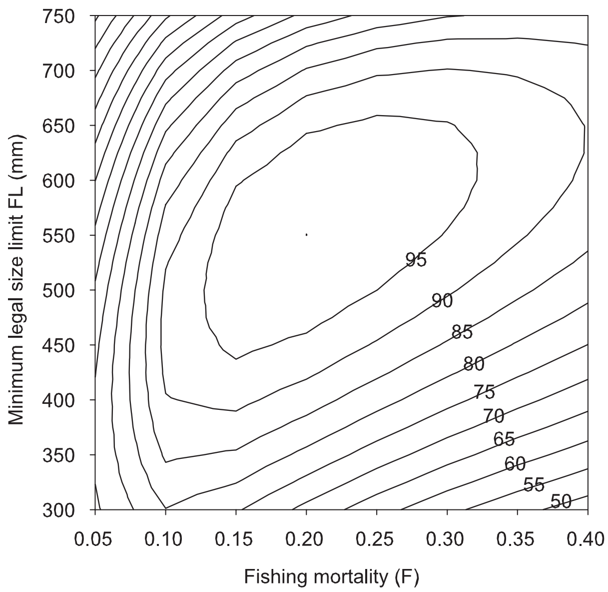


Fig. 5.6. Yield-per-recruit isopleths for striped trumpeter (numbers indicate percentage of maximum yield).

5.6 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 variations in population size, especially if there is a prolonged period of poor recruitment, when the fishery becomes dependent upon relatively few year classes. If there has been poor recruitment as implied by the most recent catch data, and the abundance of the mature stock has declined significantly, then catches are likely to remain depressed until there is a period of sustained good recruitment. Furthermore, if the decline in catches does represent a decline in abundance, then it is likely that fishing mortality is too high and may lead to recruitment over-fishing.

The impact of recent management changes, however, 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 handline effort over the past three years, but the recent increase in dropline effort goes against this trend. There is also concern that the decline in commercial catches may be, in part at least, due to changes in reporting requirements for Commonwealth operators. Although these operators have been requested to provide catch information in Tasmanian catch returns for species under Tasmanian jurisdiction (including striped trumpeter) and for fishing within state waters, this may not have routinely occurred. In fact, industry reports suggest that some Commonwealth operators may not even be reporting catches in their Commonwealth catch returns. There is an urgent need to resolve this matter with the Commonwealth and ensure that catch and effort information are comprehensive.

As commercial catches decline, it is likely that interest by the recreational sector will grow and there is evidence that this sector may already account for a significant component of the total mortality. There are anecdotal reports to support this trend, and in any case the National Survey has demonstrated that the recreational take is at least comparable to the commercial catch.

Based on yield-per-recruit, the current minimum size limit would appear to be sub-optimal and consideration should be given to increasing the size limit substantially to increase yield and reduce the likelihood of growth over-fishing. Furthermore, under the current size limit many fish are taken before reaching maturity, which is likely to impact on future egg production and recruitment. However, because of structuring within the population, any such increases would result in few if any of the inshore gillnet catch being of legal size. Not only would this effectively close the inshore fishery, it could potentially give rise to problems relating to incidental mortality of fish taken as by-catch in gillnets, especially during periods of strong recruitment pulses. Such unaccounted mortality could still have a detrimental impact on the stocks.

Although a more rigorous assessment is required to assess the sustainability of the fishery, the expectation is that this fishery is declining and will continue to do so without action. It would be prudent to act to reduce fishing mortality, both commercial and recreational, in some significant manner and review the minimum size limit.

5.7 Research Needs

The Scalefish Fishery Research Advisory Group has identified the need for research into stock assessment, recruitment variability and gear interactions as areas of high research priority for striped trumpeter.

There is an urgent need to characterize the commercial and recreational fisheries for this species in terms of size composition and age-structure. There is a need to refine life history and population parameters for striped trumpeter (including growth and mortality, reproductive biology, movements, etc) and 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

Evaluation of 2002/03 catches against performance indicators

- Current State-wide catch is only marginally higher from the previous year and within the reference catch range, indicating that the catch performance indicators were not triggered.

Apart from 1995/96, State-wide catches have remained relatively constant since the early 1990s, and the 2002/03 catch of 92 tonnes was only slightly higher than that for the previous year (Fig 6.1a). Regionally, catches from the north east including Flinders Island (blocks 3G4, 4G2, 4G4, 4H1, 4H3) dominate, although catches have steadily expanded in the southeast (blocks 7G1, 7G2, ES17, ES18, ES19) and decreased recently on the east coast (blocks 6G4, 6H1, ES13, ES14, ES15, ES16) (Fig. 6.1b).

Beach seine is the primary capture method and catch levels have varied only slightly since the mid 1990s (Fig. 6.1c). Following an initial expansion in dipnet catches to 1998/99 (34 tonnes), catches have declined steadily to just 13 tonnes in the current year. Purse seines account for the bulk of the catch taken by the ‘other’ fishing methods.

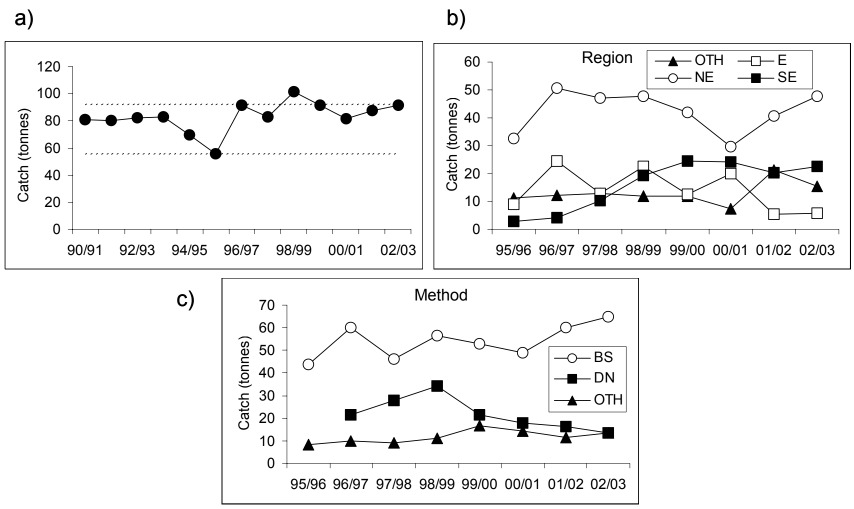


Fig. 6.1. Garfish catches (tonnes): a) State-wide catches since 1990/91 with dashed lines indicating upper and lower catch reference levels; b) regional catches where SE is southeast Tasmania, E is east Tasmania, NE is northeast Tasmania and OTH is all other areas; and c) catch by method where BS is beach seine, DN is dipnet and OTH is all other methods.

6.1.2 Fishing effort

Evaluation of 2002/03 effort against performance indicators

- Beach seine and dipnet effort were within the range for the reference period, indicating that effort performance indicators were not triggered for either method.

Beach seine effort has tended to increase since 1998/99, whereas over the same period dipnet effort levels have declined following the sharp increase in dipnet fishing activity (Fig. 6.2). The increase in beach seine effort has, however, only returned effort to levels reported in 1997/98 and dipnet effort is now comparable to that experienced in 1996/97.

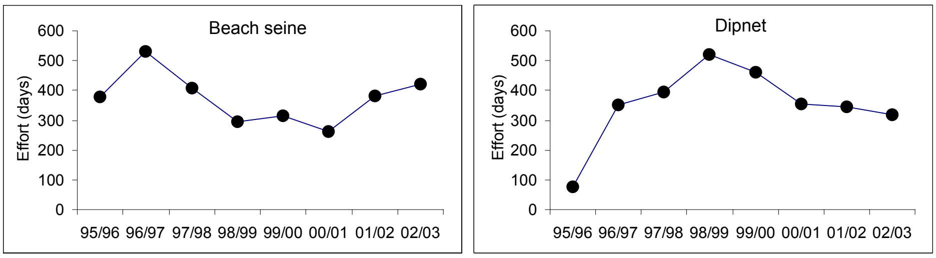


Fig. 6.2. Beach seine and dipnet fishing effort (days fished) for garfish.

6.1.3 Catch rates

Evaluation of 2002/03 catch rates against performance indicator

- Beach seine and dipnet catch rates have not triggered performance indicators.

Beach seine and dipnet catch rates have been stable over the past 4-5 years (Fig. 6.3). However, it is recognised that catch rates are likely to be relatively insensitive to changes in abundance for schooling species such as garfish.

Some industry members have expressed concerns 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, which could reduce opportunities to use beach seines to target the species and even impact on beach seine catch rates. In regard to the latter, there was no evidence of a decline in beach seine catch rates as dipnet effort increased, though such impacts may have been localised and masked in this State-wide analysis.

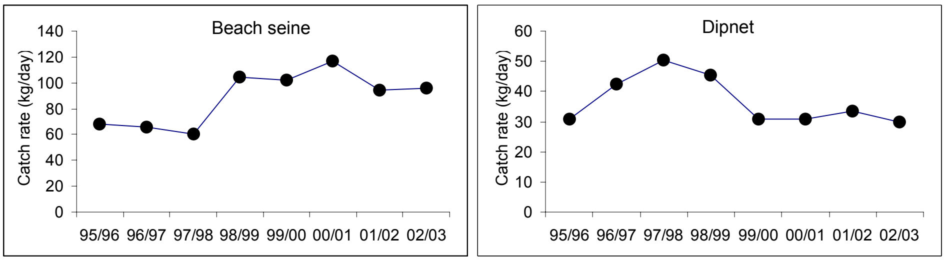


Fig. 6.3. Beach seine and dipnet catch rates (kg/day) for garfish.

6.1.4 Implications for management

There is no evidence for concern over garfish stock status based on the examination of fishery dependent indicators. There is, however, potential for effort to expand, particularly 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.

6.2 Wrasse (Family Labridae)

6.2.1 Catch

Evaluation of 2002/03 catches against performance indicators

- Current State-wide catch was reduced by 22% compared to the previous year and outside (below) the reference catch range; therefore the catch performance indicator was triggered for the first time since the introduction of the management plan.

Several species of wrasse occur in Tasmanian waters with purple wrasse (*Notolabrus fucicola*) and blue-throat wrasse (*N. tetricus*) the main commercial species. 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, but it is uncertain whether the data are comprehensive. Over the past three years 'live' wrasse accounted for between 66-76% of the total catch, and thus trends in the live fish fishery will ultimately be reflected in overall production levels. Species of wrasse are not routinely distinguished in catch returns.

From 1997/98 to 2001/02, State-wide catches were relatively constant. The 2002/03 catch of 72 tonnes represented a decline of 22% compared with the previous year and was below the lower reference value (Fig. 6.4a). Industry reported that the SARS epidemic has had an influence on the live fish markets, with about half of the 20 tonne drop in catches due to falls in the live wrasse catch.

Since the mid 1990s the focus of the fishery has shifted from the southeast (blocks 7F3, 7F4, 7G1, 7G2, 7G3, 7H1) to the east coast (blocks 5H1, 5H3, 6G4, 6H1, 6H3, ES13, ES14, ES15, ES16) (Fig. 6.4b). Catches from the northeast including Flinders Island (blocks 3F1, 3F2, 3G1, 3G2, 3G3, 3G4, 3H3, 4G2, 4G4, 4H1, 4H3) have increased recently, while production elsewhere has remained relatively stable (Fig. 6.4b). 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. While there is an apparent market preference for blue-throat wrasse, purple wrasse are more robust for live handling.

Handline and fish trap represent the primary capture methods used in the live fishery (Fig. 6.4c), with blue-throat wrasse more susceptible to line methods and purple wrasse to trap capture. On this basis, it would appear that purple and blue throat wrasse are taken in roughly equal quantities in the live fishery, since catches by trap and handline are generally comparable in most years. Gillnets account for the bulk of the remaining catch, but because survival in nets is poor, graball caught wrasse are rarely marketed live. Trap and handline catches fell in 2002/03, but there was little variation in the catch by the other methods.

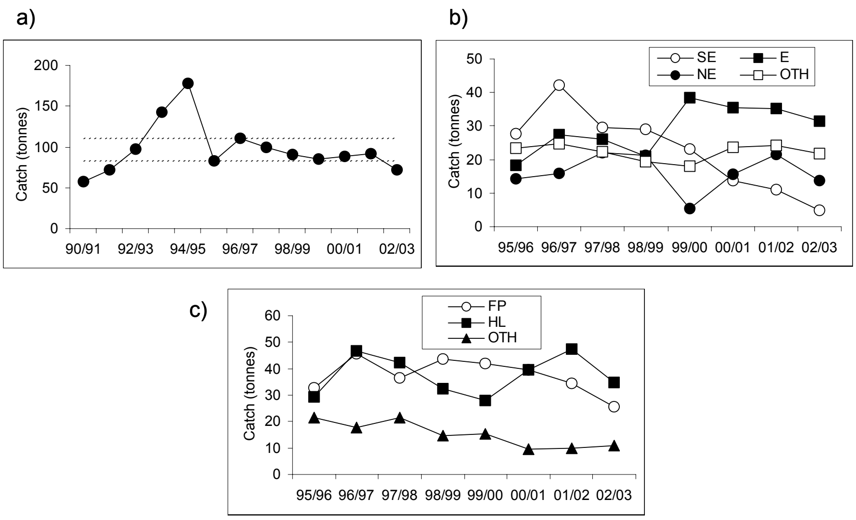


Fig. 6.4. Wrasse catches (tonnes): a) State-wide catches since 1990/91 with dashed lines indicating upper and lower catch reference levels; b) regional catches where SE is southeast Tasmania, E is east Tasmania, NE is northeast Tasmania and OTH is all other areas; and c) catch by method where FP is fish trap, HL is handline and OTH is all other methods.

6.2.2 Fishing effort

Evaluation of 2002/03 effort against performance indicator

- Fish trap and handline effort were either within or slightly below reference levels, and therefore did not trigger performance indicators.

Fish trap and handline effort increased in the late 1990s, then declined and stabilised. Current effort levels are very similar to those in 2001/02 (Fig 6.5).

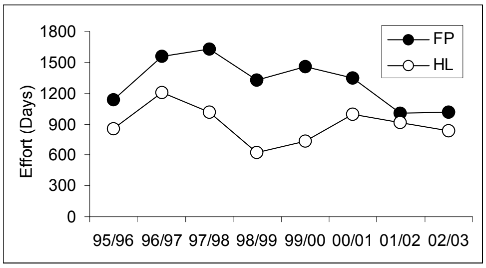


Fig. 6.5. Fish trap (FP) and handline (HL) fishing effort (days fished) for wrasse.

5.2.3 Catch rates

Evaluation of 2002/03 catch rates against performance indicator

- Fish trap and handline catch rates have not triggered performance indicators.

Since the mid 1990s, trap and handline catch rates have followed an increasing trend, although in the current year there were slight falls for both methods compared to 2001/02 (Fig. 6.6). Catch rate trends imply that stocks of both wrasse species have not been impacted significantly by the fishery. However, broad-scale analyses may be relatively insensitive to changes in abundance at the level of individual reefs at which the fishery impacts on the fish populations. In fact, there is evidence on some east coast reefs that exploitation rates of legal sized purple wrasse are extremely high (Ewing 2003). 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.

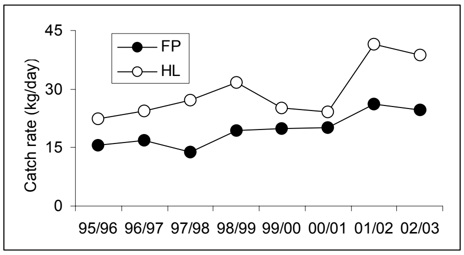


Fig. 6.6. Fish trap (FP) and handline (HL) catch rates (kg/day) for wrasse.

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, especially if effort becomes concentrated in particular regions. There is already evidence for a concentration of catch and effort off the east coast.

The minimum size limit provides good protection (several years post size at maturity) for breeding stock of purple wrasse and for female blue-throat wrasse. The limit does not, however, provide the same level of protection for male blue-throat wrasse because males are derived from mature females, typically after they have entered the fishery. This coupled with the fact that they 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 results 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 has exacerbated this situation.

6.3 Blue warehou (*Seriolella brama*)

6.3.1 Catch

Evaluation of 2002/03 catches against performance indicator

- Current State-wide catch was reduced by 26% compared to the previous year and outside (below) the reference catch range; therefore the catch performance indicators was triggered for the third year running.

Recent studies have indicated that there are two stocks of blue warehou in Australian waters, east and west of Bass Strait. The fishery for blue warehou in Tasmanian State Fishing waters is centred off the southeast coast and thus probably targets the eastern stock. 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 influenced by prevailing oceanographic conditions and availability of prey species. These factors combine to produce marked inter-annual variability in abundance and hence in catches taken from state waters, as demonstrated in Fig. 6.7. The current catch of 49 tonnes represented a 26% reduction compared to the previous year and less than the minimum level for the reference period. The species is taken primarily in graball nets, with a range of other capture methods used, including other gillnet categories (small mesh and shark net) and seine nets (Fig. 6.7). Significantly, in 2001/02 about half the total catch was taken by beach seine off the northeast coast. In many respects this was unusual, with fishers reporting the presence of large schools of fish off some beaches.

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 and Henry 2003), substantially lower than recreational catches taken in 1997 and 1998 (Lyle 2000) but consistent with the depressed state of the commercial catches.

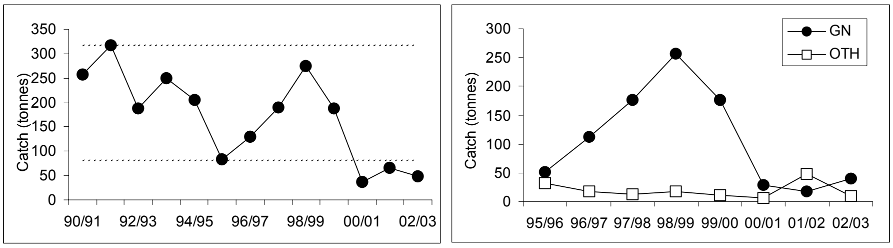


Fig. 6.7. Blue warehou catches (tonnes) since 1990/91 with dashed lines indicating upper and lower catch reference levels; and catch by method, where GN is graball net and OTH is all other methods.

6.3.2 Fishing effort

Evaluation of 2002/03 effort against performance indicator

- Graball effort exhibited a modest increase in the current year but remained at a low level, indicating that the effort performance indicator was not triggered.

In an attempt to distinguish targeted fishing for blue warehou, the following assumptions have been made. Fishing on a given day using graball nets has been assigned as targeted if:

- the catch of blue warehou was greater than 10 kg and accounted for at least half of the total weight of all species retained; or
- the catch of blue warehou was greater than or equal to 50 kg.

Blue warehou are primarily taken with targeted fishing effort. Following the sharp increase in graball effort in the late 1990s, effort fell dramatically, with current effort levels similar to those reported prior to the expansion of the fishery (Fig. 6.8).

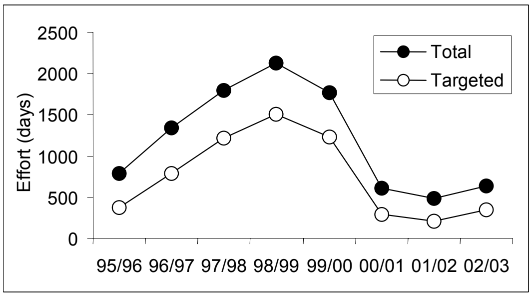


Fig. 6.8. Total and targeted graball fishing effort (days fished) for blue warehou.

6.3.3 Catch rates

Evaluation of 2002/03 catch rates against performance indicators

- Catch rate performance indicators were not triggered.

Consistent with reduced availability, total graball catch rates declined after 1998/99, but since 2000/01 have stabilised and were within reference levels in 2002/03 (Fig. 6.9). Targeted catch rates have followed a similar pattern although in recent years were just above the catch rate performance indicator.

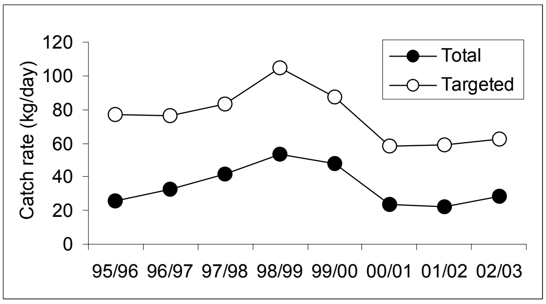


Fig. 6.9. Total and targeted graball catch rates (kg/day) for blue warehou.

6.3.4 Implications for management

Blue warehou are 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 2002 South East Fishery stock assessment for blue warehou concluded that the blue warehou stocks have experienced a serious decline since the early 1990s and that a stock rebuilding strategy is required (Smith and Wayte 2002). In the absence of significant rebuilding through recruitment, catches of blue warehou are expected to be poor for the foreseeable future. The total allowable catch (TAC) for the

Commonwealth fishery was reduced to just 300 tonnes in 2003 down from over 2,000 tonnes in 1998, reflecting concerns over stock status.

A range of environmental factors, as well as stock size, influences the availability of blue warehou in Tasmanian inshore 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.

6.4 Bastard trumpeter (*Latridopsis forsteri*)

6.4.1 Catch

Evaluation of 2002/03 catches against performance indicators

- Current State-wide catch represented a slight reduction compared to the previous year and was outside (below) the reference catch range; therefore the catch performance indicators was triggered for the third year running.

Catches of bastard trumpeter have declined steadily since the mid 1990s (Fig. 6.10a) and the current catch of 20 tonnes is the lowest since the late 1980s (Lyle and Jordan 1999). Bastard trumpeter are taken almost exclusively by graball (Fig. 6.10b).

The species has significance to recreational fishers, with an estimated 43 tonnes taken in 2000/01. This is almost double the size of the corresponding commercial catch. Industry representatives have expressed concerns about the scarcity of the species in recent years.

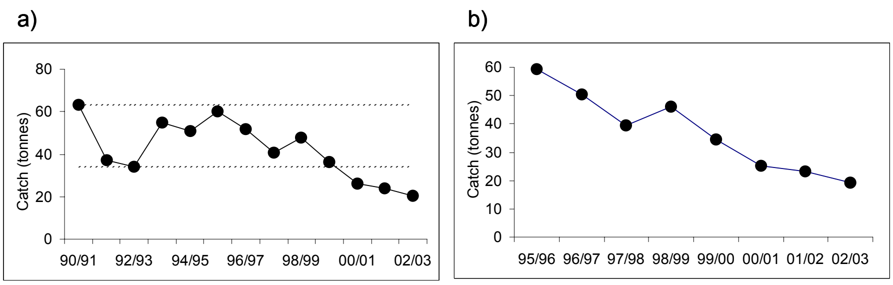


Fig. 6.10. Bastard trumpeter catches (tonnes): a) State-wide catches since 1990/91 with dashed lines indicating upper and lower catch reference levels; and b) graball catches since 1995/96.

6.4.2 Fishing effort

Evaluation of 2002/03 effort against performance indicators

- Graball effort was at its lowest level since 1995/96 and did not trigger the effort performance indicator.

Graball effort for bastard trumpeter has generally declined since the mid 1990s and in 2002/03 was slightly lower than for the previous year (Fig 6.11).

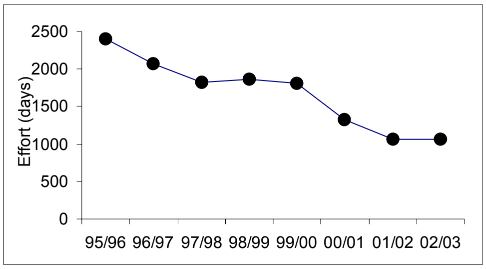


Fig. 6.11. Graball fishing effort (days fished) for bastard trumpeter.

6.4.3 Catch rates

Evaluation of 2002/03 catch rates against performance indicator

- Graball catch rate was the lowest since 1995/96 but not less than 80% of the lowest level during the reference period; thus the catch rate performance indicator was not triggered.

Despite decreased catches, catch rates for bastard trumpeter have varied very little over time (Fig. 6.12), possibly reflecting the fact that the species is generally taken as a by-product rather that a target species.

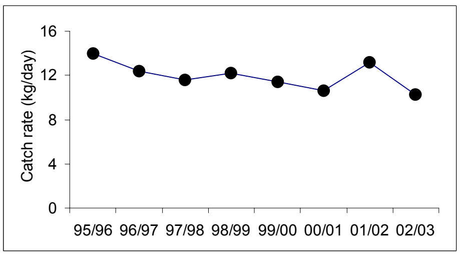


Fig. 6.12. Graball catch rates (kg/day) for bastard trumpeter.

6.4.4 Implications for management

Catch rates are probably a poor indicator of stock status for bastard trumpeter, since he species is largely taken as by-product and total catch may be a better indicator of abundance/availability. As such, trends in commercial production suggest that current inshore populations are at low levels, and continuing to decline.

Two aspects of bastard trumpeter life history have bearing on 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 variability in recruitment 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 suggest that recruitment levels have not been high in recent years. Whilst juvenile biomass may vary widely due to recruitment variability and fishing pressure, we have no information regarding adult biomass, because fish that evade the inshore fishery are subject to very low levels of fishing pressure. However, the fact that the commercial and recreational fishery is based on juveniles gives rise to the possibility of recruitment overfishing as well as growth overfishing. Consideration of increasing minimum size limit to above the size at maturity[4] would be beneficial to the stock, but have the effect of effectively closing down both commercial and recreational fisheries for the species.

6.5 Australian salmon (*Arripis* spp.)

6.5.1 Catch

Evaluation of 2002/03 catches against performance indicator

- Current State-wide catch was only slightly lower than in 2001/02 and within the reference catch range; the catch performance indicator was therefore not triggered.

The total catch of Australian salmon in 2002/03 of 407 tonnes was about 10% lower than in the previous year but within reference levels (Fig. 6.13a). Beach seines account for the bulk of the catch and recent production has fluctuated between 300-400 tonnes per annum (Fig. 6.13b).

Australian salmon represent the second most commonly caught species in the recreational fishery, with an estimated harvest of 111 tonnes in 2000/01 (Henry and Lyle 2003).

[4] On the basis of very limited information, size at maturity appears to be greater than 50 cm FL.

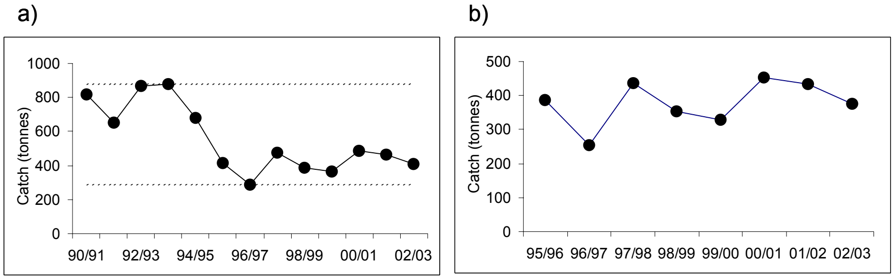


Fig. 6.13. Australian salmon catches (tonnes): a) State-wide catches since 1990/91 with dashed lines indicating upper and lower catch reference levels; and b) beach seine catches since 1995/96.

6.5.2 Fishing effort

Evaluation of 2002/03 effort against performance indicator

- Beach seine effort was within the reference range, and the effort performance indicator was therefore not triggered.

With the exception of 1997/98 and 1998/99, beach seine effort has remained remarkably stable over time (Fig. 6.14).

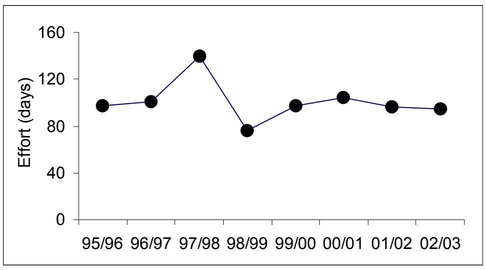


Fig. 6.14. Beach seine fishing effort (days fished) for Australian salmon.

6.5.3 Catch rates

Evaluation of 2002/03 catch rates against performance indicator

- Beach seine catch rates have generally declined over time and in the current year were less than 80% of the lowest level during the reference period; the catch rate performance indicator was therefore triggered.

Beach seine catch rates for 2002/03 were about 54% of the minimum level during the reference period and the lowest since 1995/96 (Fig. 6.15). 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 a very small number of extremely large catches. In this respect, the geometric mean approach to calculating catch rates may provide biased estimates and, in any case catch rates are not a particularly sensitive indicator for a schooling species such as Australian salmon.

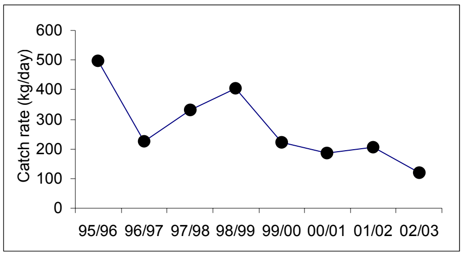


Fig. 6.15. Beach seine catch rates (kg/day) Australian salmon.

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 within 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 moderating such expansion.

Australian salmon 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.

6.6 Flounder (Fam. Pleuronectidae)

6.6.1 Catch

Evaluation of 2002/03 catches against performance indicator

- Current State-wide catch represented a slight reduction compared to 2001/02 and was outside (below) the reference catch range; the catch performance indicator was therefore triggered for the fifth year running.

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

Flounder catches have declined steadily since the mid 1990s and, at just 10 tonnes, are currently below the minimum reference level (Fig. 6.16a). The current catch represents the lowest reported since 1986/87 (Lyle and Jordan 1999). Graball ('flounder' nets) and spears represent the primary fishing methods for flounder and the decline in catches has been evident in both methods (Fig. 6.16b).

The estimated recreational catch of flounder in 2000/01 of 21 tonnes was double the size of commercial catch, indicating the importance of the recreational component of this fishery (Henry and Lyle 2003).

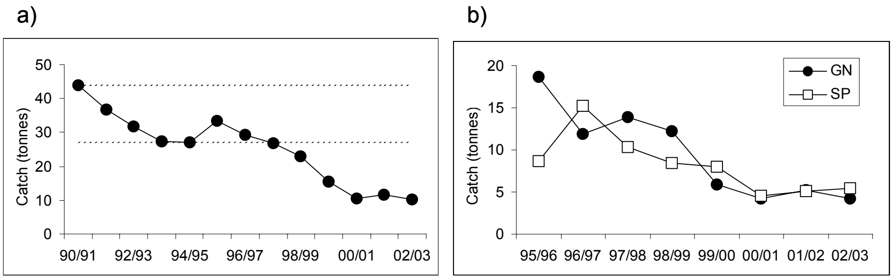


Fig. 6.16. Flounder catches (tonnes): a) State-wide catches since 1990/91 with dashed lines indicating upper and lower catch reference levels; and b) catches for graball (GN) and spear (SP) since 1995/96.

6.6.2 Fishing effort

Evaluation of 2002/03 effort against performance indicator

- Graball and spear effort remained at low levels and did not trigger the effort performance indicator.

Following an initial decline in graball and spear effort for flounder, effort has generally stabilised for both methods at lower levels than during the reference period (Fig. 6.17).

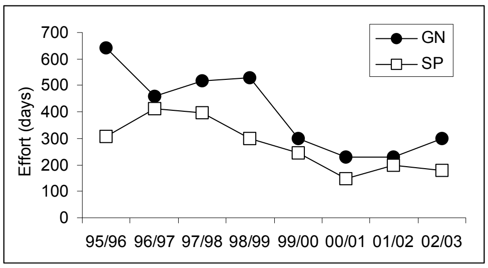


Fig. 6.17. Graball (GN) and spear (SP) fishing effort (days fished) flounder.

6.6.3 Catch rates

Evaluation of 2002/03 catch rates against performance indicator

- While spear catch rates were within the reference range, graball catch rates were less than 80% of the lowest level during the reference period; the catch rate performance indicator was therefore triggered for graball nets.

Graball catch rates have declined steadily since the mid 1990s and in 2002/03 were just 66% of the lowest level during the reference period (Fig. 6.18). By contrast, spear catch rates have varied very little over time.

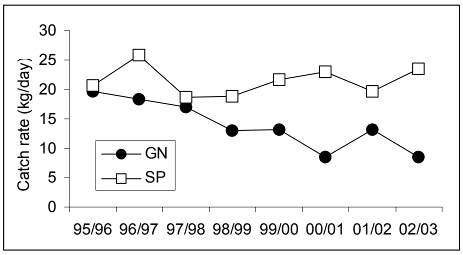


Fig. 6.18. Graball (GN) and spear (SP) catch rates (kg/day) for flounder.

6.6.4 Implications for management

Industry members have commented that while there have been declines in flounder stocks, there have also been changes in the markets for the species that have impacted on the amount of effort directed at flounder.

The current status of the flounder stocks is unknown, but it appears that they have declined in recent years.

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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*	Red bait	*Emmelichthys nitidus*
Australian salmon	*Arripis* spp.	Red fish	Fam. Berycidae
Barracouta	*Thyrsites atun*	Red mullet	*Upeneichthys* sp.
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 saltator*
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* sp.	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 noveazelandiae*
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	Mugilidae	Shark, spurdog	Fam. Squalidae
Nannygai	*Centroberyx affinis*	**Cephalopod**	
Perch, magpie	*Cheilodactylus nigripes*	Calamary	*Sepioteuthis autralis*
Perch, ocean	*Helicolenus* spp	Cuttlefish	*Sepis* 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*[5].

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

ii) Effort Problems

Records where effort (based on gear units, refer to Table 2.3) was zero or null, or appeared to be recorded incorrectly (that is 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.

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

Commonwealth logbook data:

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.

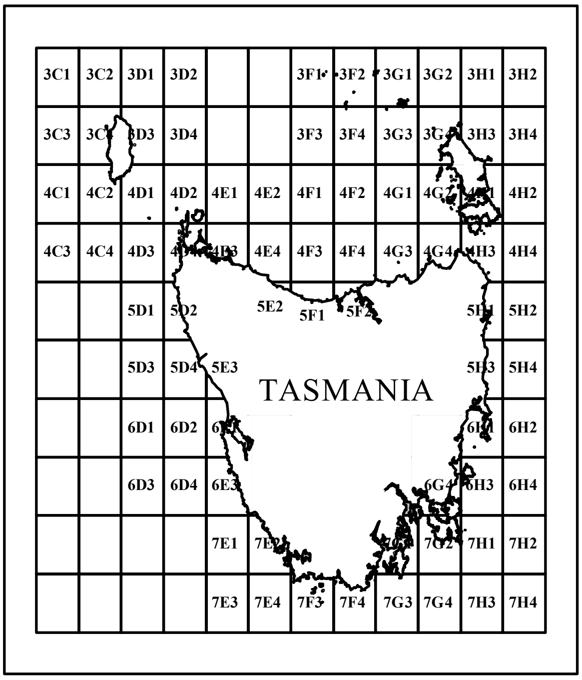

Fig. A1 Numbers for fishing blocks used in calculation of catch figures.

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.