FISHERY ASSESSMENT REPORT

TASMANIAN SCALEFISH FISHERY – 2002

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July 2003

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This assessment of the scalefish resource is the fourth 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 5 March 2003 to consider background documents and provide input into the assessments. The Working Group participants were:

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Scalefish Fishery Assessment - 2002

Summary

The Tasmanian scalefish fishery is a multi-species fishery operating in State Fishing Waters and encompassing a wide variety of capture methods. The Scalefish Management Plan, introduced in 1998 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 which have two primary functions:

- to monitor performance of the management plan 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 – 2001/02 is presented, with more detailed analyses of catch and effort by method for the period 1995/96 – 2001/02. 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. Recreational fishery catch estimates for 2000/01 are available for a number of key species.

Commercial catch and effort information is available for a seven year period, the first three years being used to define reference effort and catch rate levels against which subsequent performance is evaluated. In this regard there are only four 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 dip net, dropline and squid jig effort to historically high levels. However, apart from squid jigs, effort levels for these methods had fallen to within or below reference levels by 2001/02 (Table 1). The dramatic increase in squid jig effort has occurred in response to the expansion of fisheries for southern calamary and arrow squid. These developments have resulted in the effort trigger being exceeded again in 2001/02.

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

Table 1 Effort trigger point assessment by major fishing methods for 2001/02
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	N
Handline	N	N
Troll	N	N
Fish trap	N	N
Spear	N	N
Dip net	N	N
Squid jig	Y	Y

Species assessments

Detailed assessments are provided for striped trumpeter, banded morwong, sea garfish, wrasse and southern calamary, while other key species are considered in brief. Descriptions of the 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.

Striped trumpeter

Further falls in the catch of striped trumpeter across all methods occurred in 2001/02 and resulted in the catch trigger being exceeded, with the catch being the lowest recorded since the late 1980s.

The 2001/02 catch of striped trumpeter of 40 tonnes was the lowest recorded since the late 1980s. The estimated recreational catch of striped trumpeter of 48 tonnes in 2000/01 was equivalent to the commercial catch taken in the same year.

Falls in catches were apparent across each of the three main fishing methods, namely dropline, handline and graball net, and generally reflected lower effort levels in 2001/02 compared to the previous year. Catch rates for all 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.

Resource status is uncertain, however, falling graball net catches (primarily juvenile fish) over the past three years and reductions in offshore hook catches (mainly adult fish) over the past two 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 provide no evidence to support strong recruitment over the past few years.

The impact of recent management changes, namely the introduction of a 250 kg trip limit cannot be discounted as a contributing factor to the down-turn in catches. There was evidence of reductions in the quantities of gear fished each day, and fishers noted that some operators were not bothering to target the species because of the low catch limit.

Although a more rigorous assessment than is possible through examination of commercial catch data is required to assess the sustainability of the fishery, catch and effort need to be monitored closely over the coming years. Furthermore, the recreational component of the fishery is clearly significant and may become even more so if commercial effort (and catch) continue to decline. In this regard catch and effort information from the recreational sector will become increasingly important in monitoring stock status. Even without a robust assessment, the expectation is that this fishery is declining and may continue to do so.

There is an urgent need to characterise the fishery for this species in terms of size composition and age-structure across fishing methods. Life history and population parameters (including growth and mortality, reproductive biology, movements, etc) need to be refined and yield per recruit analyses undertaken to determine the appropriate legal minimum size.

Banded morwong

Catch triggers were exceeded for banded morwong in 2001/02, with the current catch below the reference level despite a 30% increase in the catch over 2000/01.

Catch rate triggers were not exceeded for the first time.

The fishery for banded morwong expanded in the early 1990's 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. Recent increases in effort and slight increases in catch rates in most regions have contributed an apparent recovery in catches in the past two years.

The 2001/02 catch of 51 tonnes was just over 30% higher than in 2000/01 but was still lower than reference levels, indicating that both catch triggers were exceeded. This represented the first time that there had been a significant positive trend in the catch.

State-wide and regional catch rates (based on gear units) had generally increased in 2001/02 to levels comparable (Bicheno) or above (Schouten, Maria and Tasman) those that applied in the reference years. Catch rates for St Helens were, however, below the minimum for the reference period but within 80% of the trigger level. For the first time since catch rate triggers were introduced in 1998, they were not exceeded for banded morwong.

Overall, catch and catch rate indicators suggest that the fishery has impacted on banded morwong stocks. The apparent 'recovery' in catch and catch rates should be interpreted with caution and not be taken to indicate the sustainability of current levels of exploitation. These fishery dependent indicators may be influenced by factors other than fish abundance, for instance management changes (licensing and size limits), shifts in the dynamics of the fishery (including expansion into new areas and changed/more efficient fishing practices) and impacts of seals.

There is considerable uncertainty surrounding the resource status and since banded morwong are sedentary and long-lived (implying low productivity), a precautionary approach to the management of the species is advised. There is an urgent need to investigate fishery independent indicators of stock condition.

Sea garfish

No triggers were reached for sea garfish in 2001/02.

The 2001/02 sea garfish catch of 81 tonnes was virtually unchanged compared to 2000/01 and was within the reference range for the species. Dip net catch rates were within 80% of the lowest previous value (1995/96) whereas beach seine catch rates were within reference values. Sea garfish are a schooling species and thus catch rate trends may not be reliable nor sensitive indicators of abundance.

There is 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 dip net sector. While it is not known whether present catch levels are sustainable it would be prudent to consider management options that limit further expansion in this fishery.

Wrasse

No triggers were exceeded for wrasse in 2001/02.

The development of live fish markets for wrasse resulted in increased catches since the early 1990's. Two main species are involved, purple wrasse and blue-throat wrasse, though catches of these species are not generally distinguished in catch returns. Wrasse catches have remained stable over the past four years, at around 90 tonnes p.a. In 2001/02 catch rates for handline and trap methods were higher than reference levels.

Purple and blue-throat wrasse account 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 have been used as proxies for the relevant species, thus overcoming some of the uncertainties caused by grouping the species. General stability or even increasing catch rate trends for both of the major fishing methods implies that stocks of the two 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 at which the fishery impacts on the fish populations, that is at the level of individual reefs. 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 even though key fishery indicators do not indicate significant fishery impacts.

There are concerns that blue throat males may not be adequately protected by the current minimum size limit. This is because blue throat wrasse change sex, with males derived from mature females generally after they have entered the fishery and this, coupled with the fact that they are strongly site attached, suggests that they are vulnerable to depletion.

Southern calamary

Catch and jig effort triggers for southern calamary were exceeded for the fourth year.

The fishery for southern calamary expanded markedly in 1998/99 and, reflecting the development of this as a target fishery, catches since have exceeded those for the reference period every year since. The 2001/02 catch of 103 tonnes was the highest on record and was over 30% greater than for 2000/01. Jig effort continued to escalate, up a further 25% over the 2000/01 peak level. State-wide and regionally, jig catch rates were higher in 2001/02 than for the previous year but remained within reference levels.

The resource status of southern calamary is unknown and the sustainability of current catch levels is uncertain. Declining jig catch rates in the major fishing regions prior to the current year are of concern and may indicate that the fishery has impacted significantly on stocks. The observation that calamary have a life span of generally less than one year, with no accumulation of recruitment across a number of years, 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.

Other key species

Catch, effort and catch rates were also examined for bastard trumpeter, blue warehou, arrow squid, Australian salmon, flathead, flounder and jackass morwong.

Bastard trumpeter

Bastard trumpeter catches have declined steadily since the mid-1990s and the current catch of 23 tonnes is the lowest reported since 1987/88. The species has significance to recreational fishers, with an estimated 43 tonnes taken in 2000/01, almost double the size of the corresponding commercial catch.

Graball catch rates have remained relatively stable but are probably a poor indicator of stock status in this instance, since bastard trumpeter are largely taken as a by-catch of gillnetting. Bastard trumpeter, like the related striped trumpeter, exhibit strong recruitment variability that can result in short-term variability in catches.

Assessment against performance indicators indicate that the current catch is below reference levels and therefore the catch trigger has been exceeded for the second year. Effort and catch rate triggers were not exceeded.

Blue warehou

Recent studies have indicated that there are two stocks of blue warehou in Australian waters, one to the west of Bass Strait and one to the east. The fishery for blue warehou in Tasmanian State Fishing waters is centred off the south-east coast and thus probably targets the eastern stock. Catches are also taken off the north-east and north-west coasts, the latter potentially involving the western stock.

Although the commercial catch of 66 tonnes in 2001/02 was almost double that for 2000/01 it was still less than the minimum level for the reference period, triggering both catch indicators. The estimated recreational harvest in 2000/01 was just 16 tonnes, substantially lower than in the late 1990's but consistent with the depressed state of the commercial fishery.

The 2002 South East Fishery stock assessment for blue warehou (incorporating Tasmanian data) concluded that the blue warehou stocks have experienced a serious decline since the early 1990s and that a stock rebuilding strategy is required.

Arrow squid

There was a dramatic expansion in arrow squid catches in State Fishing Waters in 1999/00, with catches peaking at about 480 tonnes. Since then catches have fallen dramatically and in the current year just 2 tonnes was caught, the lowest catch since 1989/90. The catch in 2001/02 was just 5% of that for 2000/01.

Marked inter-annual variability in availability of arrow squid in coastal waters is a feature of the species and thus recent poor catches do not necessarily require or suggest different management action.

Australian salmon

The total catch of Australian salmon in 2001/02 of 458 tonnes, 5% lower than in the previous year and within reference levels. Australian salmon represent the second most commonly caught species in the recreational fishery, with an estimated harvest of 111 tonnes in 2000/01.

Beach seine catch rates were slightly lower than the minimum for the reference period but catch rate estimation is influenced by the extremely skewed nature of the data, i.e. the majority of catches are small but the total catch is influenced by a very small number of extremely large catches. In this respect catch rates are probably not a particularly sensitive indicator for a schooling species such as Australian salmon.

Flathead

Flathead catches have remained relatively stable, between 50-60 tonnes since 1995/96, though the 2001/02 catch of 47 tonnes represented a 25% decline compared to the previous year. The catch was just outside the reference range and thus the catch trigger was exceeded.

Flathead are the most commonly caught species by recreational fishers and in 2000/01 the estimated recreational harvest of about 360 tonnes was substantially higher than the commercial catch.

As the majority of the commercial catch is comprised of tiger flathead whereas sand flathead account for the vast majority of the recreational catch, interactions between the two sectors in relation to flathead would appear to be low.

Flounder

Flounder catches have declined steadily since 1995/96 and, at just 10 tonnes, are currently below the minimum reference level. 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.

Jackass morwong

The performance indicator for catch was triggered for jackass morwong, with the 2001/02 catch of about 15 tonnes only slightly higher than in the previous year but lower than the minimum for the reference period. The recreational catch in 2000/01 was 45 tonnes, some three times larger than the commercial catch from State waters. However, as for blue warehou, jackass morwong are taken by trawl methods in Commonwealth waters, where catches are significantly greater (820 tonnes in 2001) than those from State waters.

2001/02 trigger point summary

Catch, effort and CPUE trigger point analysis for key species is summarised in Table 2.

Table 2 Summary trigger point assessment for key species –2001/02.

Y triggered; N not triggered; arrows indicate direction of change; # applies only to particular methods, * catch history period for comparison is 1994/95 to 1997/98; ** catch history period for comparison is 1995/96 to 1997/98.

	Catch		*Effort*	*CPUE*
Species	*Outside 90-97 range*	*Decline/ increase by >30%*	*Increase by >10% from highest 95-97 level*	*< 80% min. 95-97 range*
Striped trumpeter	Y ↓	N	N	N
Banded morwong*	Y ↓	Y ↑	N	N
Sea garfish	N	N	N	N
Wrasse**	N	N	N	N
Southern calamary	Y ↑	Y ↑	Y	N
Bastard trumpeter	Y ↓	N	N	N
Blue warehou	Y ↓	Y ↑	N	N
Arrow squid	Y ↓	Y ↓	N	N
Australian salmon	N	N	N	N
Flathead	Y ↓	N	N	N
Flounder	Y ↓	N	N	Y #
Jackass morwong	Y ↓	N	N	N

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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;
- CPUE of 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, the management of which is complicated by jurisdictional issues, 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 fifth in a series of annual assessments of the scalefish fishery and incorporates catch and effort information available up to and including June 2002. Copies of previous assessment reports (Lyle and Jordan 1999, Jordan and Lyle 2000, Lyle and Hodgson 2001, 2002) 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.

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 limitations of these catch returns in some detail and, in summary, noted that they provided only basic information about production levels and are 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 in late 1997 of the Commonwealth non-trawl logbook (GN01 and subsequent versions), 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 2002 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. Catches of striped and bastard trumpeter, however, represent the exception since Tasmania has management responsibility for these species through Offshore Constitutional Settlement (OCS) arrangements with the Commonwealth. All catch and effort data relevant to these species, including catches from Commonwealth waters, have been incorporated into the analyses.

2.2.3 Data analysis

For the purposes of this assessment, effort and catch rate analyses are restricted to data provided for the period July 1995 to June 2002. All catch returns available as at October 2002 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 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 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 geometric mean of all valid individual daily catch records has been calculated. Since catch rate data are typically log-normally distributed the arithmetic mean does not accurately describe the data. The geometric mean is calculated as the *n*th root of the product of the scores (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 (Lyle *et al*. 2003) and a state-wide survey of licensed fishing activity for the period December 1996 – 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 2001/02 catch of 1,151 tonnes represented an increase of about 100 tonnes compared to the previous year. Increased catches of barracouta (up by 115 tonnes compared with 2000/01) was the primary contributor to the overall increase in scalefish catch.

Although cephalopod production, at around 170 tonnes, was similar to 2000/01 there was an increase in calamary catches offset by a sharp drop in the arrow squid catch. In fact the 2001/02 calamary catch represented a historic high whereas arrow squid production was the lowest reported since the late 1980s.

In assessing trends within the scalefish fishery it is important to recognise that some species, such as blue warehou 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, trumpeters and calamary tend to occur more consistently in inshore waters, with catch variability reflecting a combination of factors including market influences, management intervention and stock size.

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 2001/02 catch of 458 tonnes represented a decline of just 5% compared with 2001/01 and was within the catch range for the reference period (1990/91 – 1997/98). Industry reports suggest that the generally lower landings since the mid-1990's 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 132 tonnes was almost eight times higher than for 2000/01 and, according to industry reports, reflected increased availability rather than changes in market preference (product is used for bait and for human consumption). Although representing a sharp increase in catch, the current catch level is within reference catch levels.

Flathead catches declined from over 100 tonnes p.a. in the early 1990's, due largely to reductions in inshore trawl (otter trawl and Danish seine) activity (Lyle and Jordan 1999). Since 1995/96, flathead catches have remained relatively stable at between 50-60 tonnes, though the 2001/02 catch of 47 tonnes represented a 25% decline compared to the previous year. As such the most recent catch was just below the lower reference catch level.

Catches of flounder have typically ranged between 30 – 40 tonnes but over the past three years have fallen to below 20 tonnes, with just 10 tonnes reported in 2001/02. 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-1990's, sea garfish production has remained relatively stable at between 80 – 100 tonnes p.a. Current landings of 81 tonnes were virtually unchanged compared to 2000/01.

The development of live fish markets for banded morwong during the early 1990's resulted in a marked increase in landings to 145 tonnes (1993/94), though it is generally accepted that this figure is unreliable and represents a significant overstatement of the catch. Catches subsequent to 1995/96 have generally declined, from almost 90 tonnes to less than 35 tonnes in 1999/00. Production has increased slightly over the past two years, to 51 tonnes in 2001/02. As such, however, current catches remain below reference levels.

Corresponding to the reduction in inshore trawl activity in the early 1990's jackass morwong landings declined from over 100 tonnes p.a. to between about 15-30 tonnes in more recent years. Current catch levels are just below reference levels.

Landings of mullet declined gradually up until the mid-1990s, from 30-10 tonnes p.a. and since that time have fluctuated between 10-20 tonnes, the most recent catch (12 tonnes) representing a very slight fall compared to 2000/01.

Up until the mid-1990's bastard trumpeter catches fluctuated between 35 – 65 tonnes p.a., but then declined steadily to just 23 tonnes in 2001/02, the lowest level reported since the late 1980s. By contrast, striped trumpeter production expanded from the early 1990's to over 100 tonnes by 1999/00 before dropping sharply to just 40 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 1990's. The most recent catch of 66 tonnes represented an 80% increase compared to the previous year but was still well below the minimum reference catch level.

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

The marked increase in wrasse landings in the early 1990's was due to the expansion of live fish markets. Subsequent to 1995/96, however, wrasse production stabilised at around 85 - 100 tonnes p.a. with the most recent catch of 88 tonnes, almost identical to that for the previous year.

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 2001/02. During the latter half of the 1990's 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 fluctuated between about 75 tonnes and a peak of 103 tonnes in 2001/02. Octopus production increased gradually from around 30 to 75 tonnes p.a. by the mid-1990's and despite some variability since appears to have stabilised at around 60 tonnes p.a.

Table 2.1 Annual 'Tasmanian' scalefish and cephalopod production (whole weight) by species for the period 1990/91 to 2001/02.

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**
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	458.1
Barracouta	351.5	268.3	205.4	59.6	25.2	19.9	53.8	65.2	27.6	25.0	15.1	131.6
Boarfish	7.2	9.4	7.6	10.1	9.1	7.3	10.4	9.4	7.0	7.3	7.9	5.4
Bream	5.7	3.5	1.4	7.4	7.2	2.5	9.9	1.0	0.0	0.1	0.0	0.1
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
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
Eel	0.2	0.5	0.9	2.2	3.1	2.1	1.4	1.7	2.0	1.2	0.8	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	47.5
Flounder	44.0	36.8	31.8	27.3	27.1	33.3	29.3	26.7	22.8	15.4	10.5	10.1
Garfish	80.9	80.1	82.3	82.9	69.3	56.0	91.6	83.0	101.7	91.2	81.4	80.6
Gurnard	20.5	19.0	19.3	19.3	14.0	14.2	12.4	9.9	7.1	9.9	7.8	5.3
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
Leatherjacket	12.2	14.0	13.1	23.3	27.7	14.5	12.6	13.3	12.9	16.5	16.7	15.8
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
Mackeral, 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
Mackeral, jack	6.1	11.1	32.8	48.4	39.7	26.2	19.3	19.7	59.8	13.7	8.6	18.1
Marblefish	0.2	0.9	0.3	1.0	1.8	3.5	5.6	3.0	2.6	4.2	4.0	4.4
Morwong, banded	7.0	6.9	39.2	145.5	105.8	86.7	79.0	72.6	43.1	33.8	39.2	51.3
Morwong, jackass	136.9	111.9	83.2	117.6	63.1	27.2	19.2	34.1	18.2	16.7	13.7	14.5
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
Mullet	31.2	22.2	26.2	19.5	23.8	10.4	11.2	16.0	14.5	21.0	13.7	11.9
Other	106.8	92.1	77.6	60.0	25.2	21.1	23.8	21.2	19.4	10.6	9.7	10.5
Pike, long-finned	0.1	0.0	0.1	0.3	0.2	0.3	3.1	3.9	9.5	10.0	6.6	10.5
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
Pilchard/anchovy	0.1	0.0	3.8	14.6	12.1	6.2	4.3	15.4	2.8	1.7	3.2	0.7
Stargazer	10.7	3.0	1.2	4.3	1.5	0.2	0.0	0.3	0.1	0.2	0.1	0.1
Trevally, silver	15.0	12.2	2.5	5.9	15.5	5.9	4.5	7.8	8.0	3.2	1.6	3.9
Trevally, unspec.	5.6	1.4	9.5	2.4	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trumpeter, bastard	63.3	37.2	34.0	54.8	50.8	60.1	51.8	40.7	47.7	36.4	26.2	23.2
Trumpeter, striped	74.5	58.2	52.7	56.5	72.4	60.3	80.4	81.1	107.4	100.9	49.6	39.7
Trumpeter, unspec.	0.7	0.0	0.0	0.4	0.1	0.2	0.1	0.6	3.5	0.0	0.0	0.0
Warehou, blue	257.6	317.6	187.7	250.1	205.4	82.2	128.9	189.5	274.3	187.6	36.3	66.2
Warehou, spotted	0.7	0.4	4.2	8.8	3.4	14.6	15.6	4.8	0.0	0.0	0.0	0.0
Whiting	124.2	152.3	84.3	97.9	81.4	25.3	39.3	48.1	30.4	31.4	42.5	39.6
Wrasse	57.2	71.7	97.3	142.4	178.0	83.4	110.1	100.0	90.7	85.4	88.4	88.7
Total scalefish	**2450.3**	**2154.1**	**2134.8**	**2367.1**	**1933.4**	**1206.0**	**1224.3**	**1459.3**	**1374.5**	**1168.7**	**1049.6**	**1151.2**
Cephalopod												
Calamary	8.2	7.5	5.8	9.7	12.6	33.0	19.0	26.6	90.6	84.6	76.6	102.7
Cuttlefish	0.5	0.7	0.0	1.1	0.8	0.2	0.3	0.2	0.0	0.0	0.0	0.7
Octopus	32.2	35.2	47.4	58.2	55.3	76.9	40.8	43.4	85.5	61.5	62.0	62.9
Squid, arrow	35.1	7.2	7.0	7.7	8.6	5.7	7.8	12.9	79.7	480.5	39.7	2.0
Total cephalopod	**76.0**	**50.6**	**60.2**	**76.7**	**77.3**	**115.8**	**67.9**	**83.0**	**255.8**	**626.7**	**178.3**	**168.2**

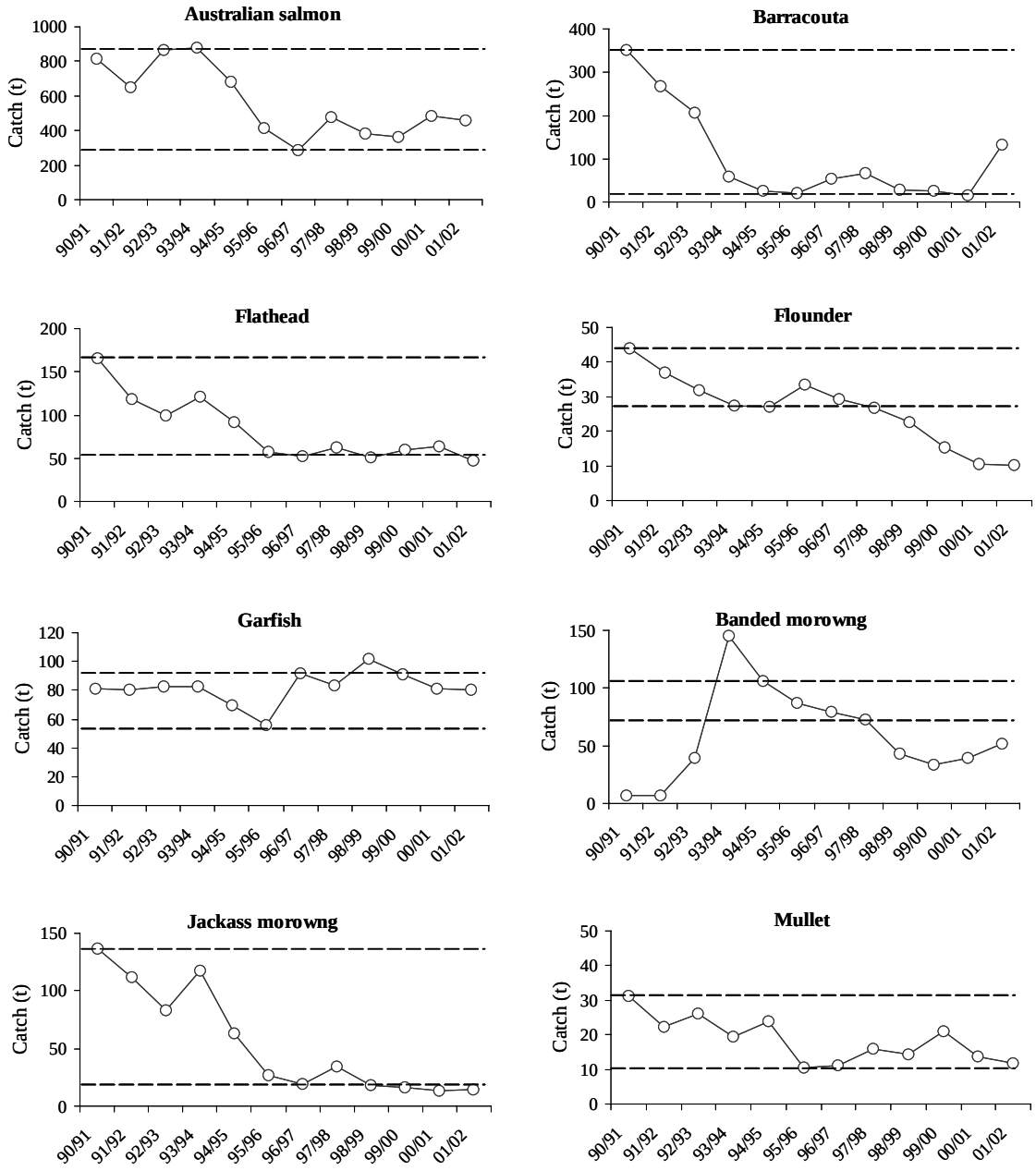


Fig. 2.1 Annual catches for key scalefish species 1990/91 to 2001/02. Dotted lines indicate upper and lower catch levels for the catch reference period (1990/91-1997/98 for all species except banded morwong [1994/95-1997/98] and wrasse [1995/96-1997/98]).

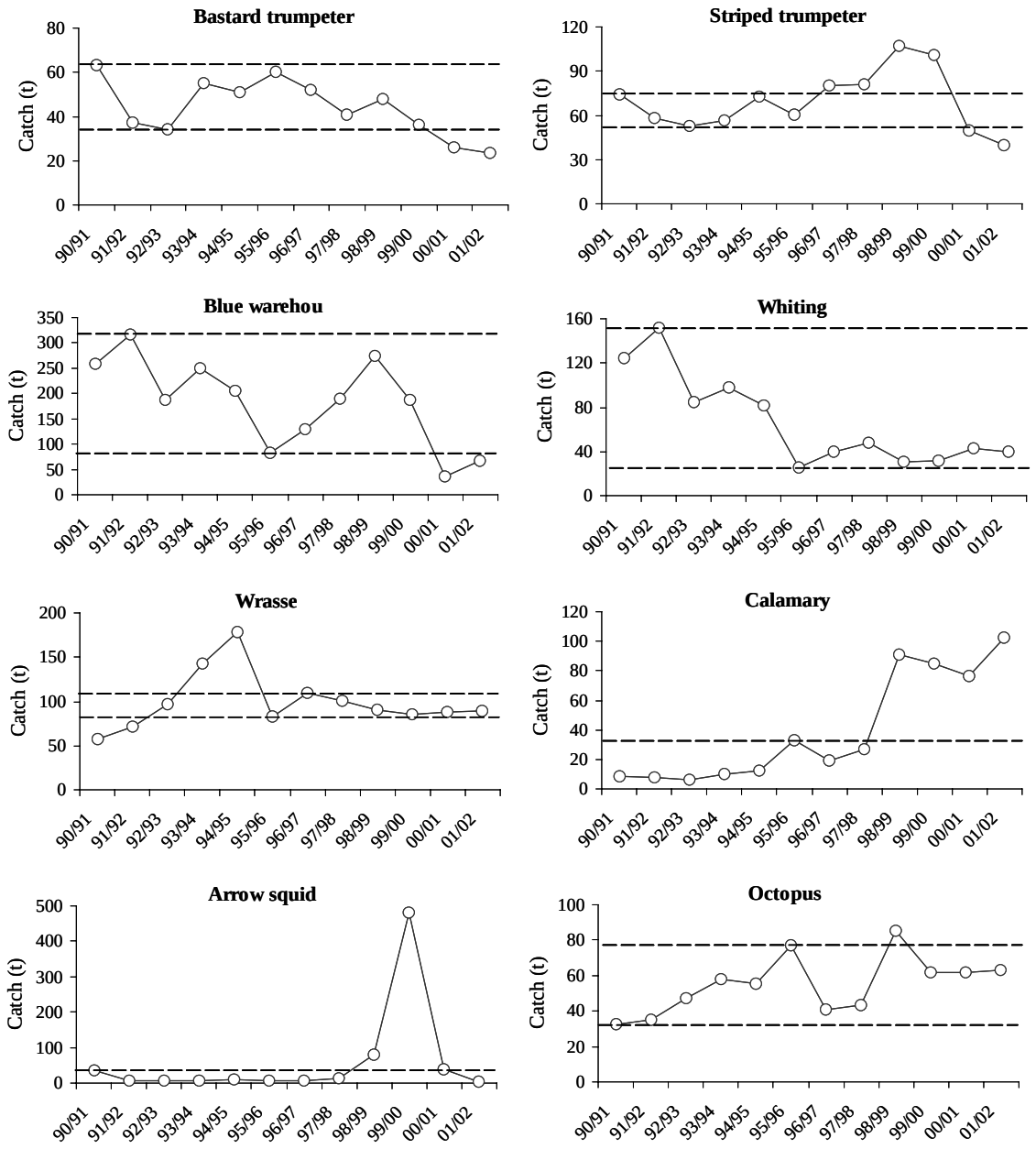


Fig. 2.1 Continued.

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 (1995/96–1997/98), effort levels in 2001/02 for most gear types were within range (handline and dip net 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 than during the reference period but effort units were higher (though less than 10% higher), indicating greater fishing effort for each day fished. Conversely, for droplines although the amount of gear used was lower, the number of days fished was higher than during the reference period. The recent introduction (late 2000) of trip limits 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 2000/01, effort levels in 2001/02 were generally similar or lower for all gear types apart from beach seine, handline and squid jig, which had experienced increases in effort.

Since 1995/96, effort trends for the major gear types have ranged from decline (purse seine, graball and spear), to relative stability (small mesh net and fish trap) and to sharp increases (squid jig) (Table 2.2 and Fig. 2.2). Following the introduction of the new management arrangements (November 1998), beach seine, purse seine, graball and handline effort fell whereas dropline, squid jig and dip net 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 there was also a direct impact of the management change 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 dip nets).

Considering effort by gear type alone, however, can mask important dynamics within the fishery itself, such as shifts in species targeting. This is particularly pertinent where individual species may be targeted using a variety of gear types and where a given gear type can be used to target a number of different species (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 year 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.

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

Lyle (1998) concluded that there are effectively three main components or discrete targeted fisheries within the graball fishery, i.e. for blue warehou, for banded morwong and for 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 over the past two years. 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 most recent year.

The two main handline sub-fisheries, for striped trumpeter and for wrasse, demonstrate different trends in effort. There was a minor increase in handline effort for striped trumpeter up until 1999/00 following which effort fell slightly. This 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. Interestingly, there was a general increase in spear effort for calamary up until 1999/00 but subsequent effort has also fallen.

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, including the activity of automatic jig vessels (not represented in Fig 2.2). 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, in the absence of a fishery in 2001/02, arrow squid effort levels had fallen to within reference levels.

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. dip nets for garfish, droplines for striped trumpeter and fish traps for wrasse. Species based effort is also considered in more detail in Chapters 3-8.

In terms of the effort based performance criterion, only squid jig effort was at least 10% higher than the peak for the reference period (see Table 2.2). Effort triggers 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, dip nets and jigs.

Table 2.2 Total annual catch and effort by major fishing methods for the period 1995/96-2001/02.
Gear units of effort are defined in Table 2.3. ## does not include automatic jigs * Five or fewer vessels involved, catch data not shown.

				Effort	
Method		*Year*	*Catch (tonnes)*	*Gear units#*	*Days fished*
Seine	Beach seine	95/96	467.3	1024	524
		96/97	364.1	1351	681
		97/98	520.7	1184	573
		98/99	440.4	869	397
		99/00	422.7	970	428
		00/01	528.1	1130	372
		01/02	561.0	1414	466
	Purse seine	95/96	35.2	418	185
		96/97	30.4	337	153
		97/98	41.8	319	154
		98/99	73.0	228	142
		99/00	33.7	268	123
		00/01	*	275	104
		01/02	*	259	91
Gillnet	Graball	95/96	347.9	223679	5439
		96/97	378.7	231305	5182
		97/98	446.3	232088	5249
		98/99	494.9	167664	4706
		99/00	360.1	205131	4174
		00/01	173.6	104511	3192
		01/02	182.5	92082	3198
	Small mesh net	95/96	38.7	11019	286
		96/97	27.0	7964	260
		97/98	21.8	7875	246
		98/99	31.0	7767	272
		99/00	22.4	6840	202
		00/01	20.3	10406	238
		01/02	24.2	11933	230
Hook	Dropline	95/96	19.9	438	158
	(< 200 m)	96/97	30.0	433	203
		97/98	24.7	540	222
		98/99	31.8	669	309
		99/00	30.5	424	288
		00/01	15.8	604	248
		01/02	12.6	310	256
	Handline	95/96	76.0	17188	1627
		96/97	94.5	21583	1895
		97/98	97.7	21131	1703
		98/99	87.9	17884	1271
		99/00	90.9	19197	1464
		00/01	81.7	15657	1588
		01/02	94.8	18848	1649
Trap	Fish trap	95/96	41.8	8265	1401
		96/97	57.2	10710	1796
		97/98	49.9	9880	1875
		98/99	53.7	10893	1558
		99/00	56.1	11292	1637
		00/01	54.3	10581	1548
		01/02	48.5	6445	1275

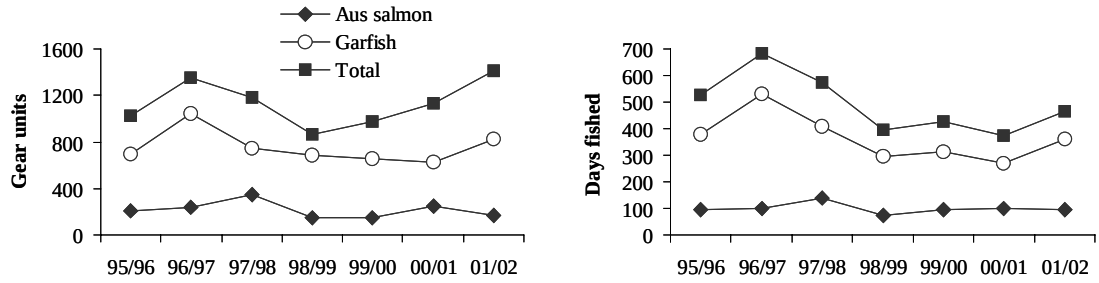
Table 2.2 Continued

Method		*Year*	*Catch (tonnes)*	*Effort*	
				Gear units#	*Days fished*
Other	Squid jig	95/96	8.7	8022	94
		96/97	6.5	10491	71
		97/98	15.0	4133	186
		98/99	89.6	10014	591
		99/00	173.7	173309	1000
		00/01	59.2	16120	730
		01/02	73.0	21296	806
	Dip net	95/96	*	317	78
		96/97	24.1	1511	361
		97/98	33.4	1711	409
		98/99	42.4	2708	557
		99/00	29.3	2390	500
		00/01	22.8	1822	371
		01/02	23.8	1862	371
	Spear	95/96	14.0	1383	361
		96/97	19.2	1845	462
		97/98	13.8	1554	437
		98/99	17.2	1377	390
		99/00	16.0	1500	375
		00/01	12.6	1192	289
		01/02	9.8	976	223

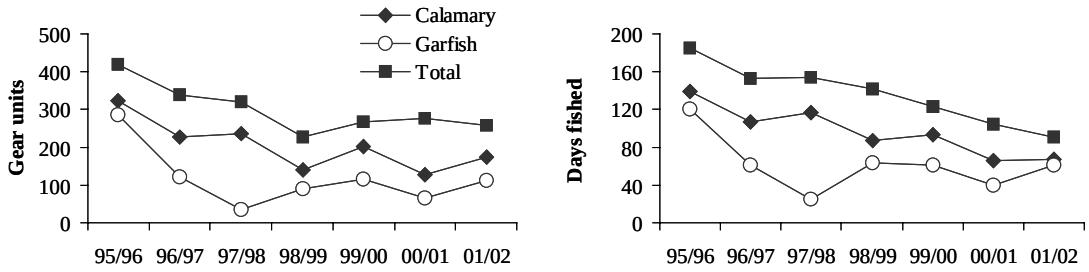
Table 2.3 Table of effort gear units by fishing method

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

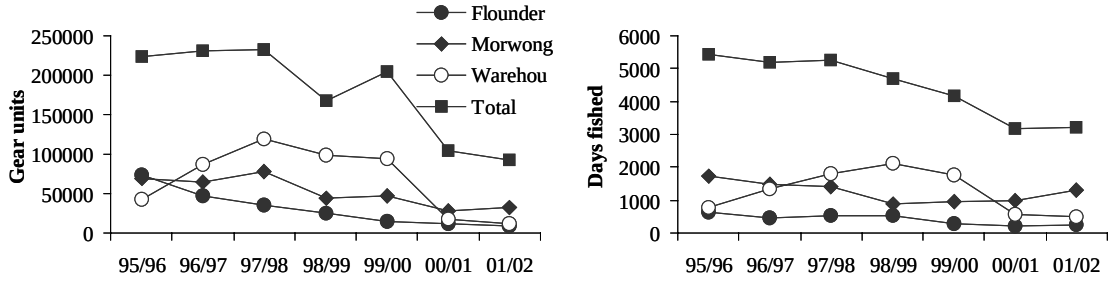
a) Beach seine



b) Purse seine



c) Graball



d) Handline

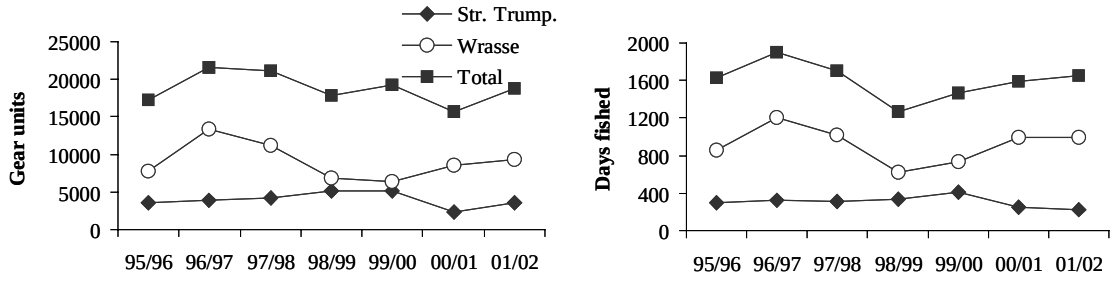
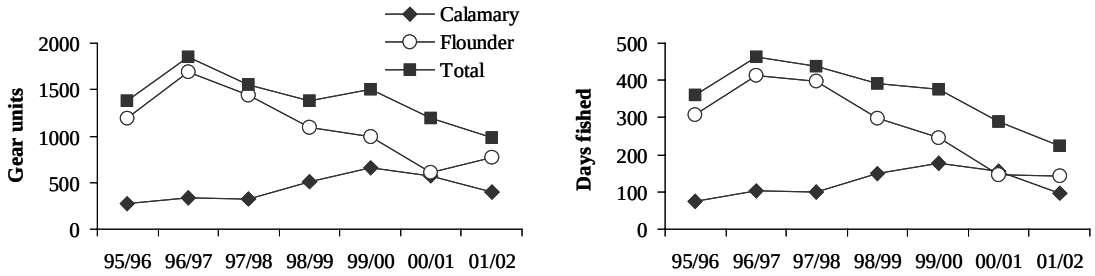


Fig 2.2 Annual effort by method for key species, expressed as gear units (refer Table 2.3) and days fished.

e) Spear



f) Squid jig

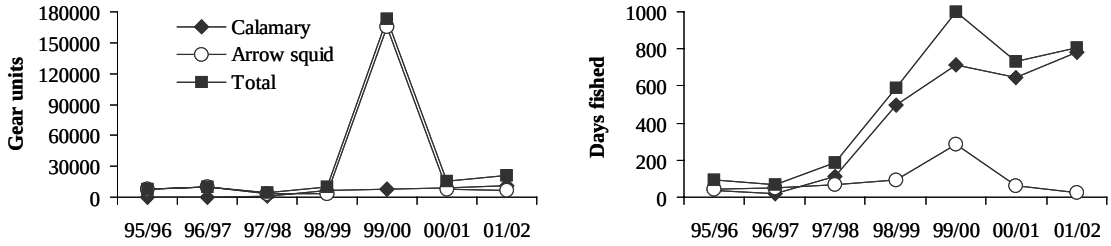


Fig 2.2 Continued.

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 trigger is exceeded when catch rates fall below 80% of the lowest value for the reference period (i.e. 1995/96 to 1997/98 unless otherwise specified). CPUE trends for key species/species groups are considered in detail in Chapters 3-8.

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 (Lyle *et al*. 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 (Lyle 2000), the 2000/01 recreational harvest of blue warehou (16 tonnes) was substantially lower than in 1997 (116 tonnes), an observation that

was consistent with the greater than threefold drop in commercial catch between 1997 (127 tonnes) and 2000/01 (36 tonnes). 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 apparent from Table 2.5 that the recreational take represents a significant component of the total harvest for many of species. 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 evident from this analysis that the recreational component of the fishery is significant, either as a proportion of the total harvest or in absolute quantities taken, and it is therefore important that this sector 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 graballs, one mullet net and a beach seine[2]. Following the introduction of recreational net licences in 1995 the number issued rose rapidly from around 8,900 to a peak of over 11,000 in 1999/00 but has subsequently declined to about 9,400 in 2001/02 (Table 2.6). Although not a direct index of recreational net fishing effort (not all

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

licence holders fish each year and in any case the level of individual fishing effort is highly variable), the overall increase in net licences since the mid-1990's suggests that there has been an increase in recreational netting effort over the period.

Table 2.6 Number of recreational gillnet licences issued by licensing year since 1995/96.

Licence type	*1995/96*	*1996/97*	*1997/98*	*1998/99*	*1999/00*	*2000/01*	*2001/02*
Graball Net 1	5615	6290	6685	6709	7477	7401	6960
Graball Net 2	2612	2678	2683	2426	2652	2515	1841
Mullet Net	656	684	738	739	879	845	608
Total licences	**8883**	**9652**	**10106**	**9874**	**11008**	**10761**	**9409**

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. Within the context of the time series, seven years is barely sufficient to infer meaningful trends in the status of either the fishery or fish stocks. 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. The lack of information about targeting also complicates interpretation of catch per unit effort.

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, and there is an urgent need to educate fishers in this area. Further, the lack of catch verification remains an issue in relation to data quality. Anecdotal reports from some industry members suggest that some catch and effort data may be unreliable, particularly that 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 some provision for catch verification. The catch reporting system is currently 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 add further uncertainty regarding the underlying causes of any observed trends in catch and effort. There is, therefore, a clear need to take account of such factors by incorporating industry perceptions and information, when interpreting fishery dependent information.

Limited information about the recreational fishery remains a major uncertainty, although the recent national survey provides important baseline information about this fishery. There is a need to consider on-going monitoring of the recreational fishery, without such information attempts to assess the status of species with significant recreational catches may be flawed.

2.8 Implications for Management

In many respects the commercial fishery is in a state of flux, not only in response to changing marketing requirements and/or resource availability but also to management changes. The introduction of the Scalefish Management Plan defined access and gear entitlements but recent changes in other fisheries, such as the Tasmanian rock lobster fishery (move to a ITQ management system) and Commonwealth fisheries including shark, are also likely to have an impact on fisher's behaviour. For example, there is already evidence of effort shift into the less regulated activities, for instance in the increased use of squid jigs and dip nets. 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 Striped Trumpeter (*Latris lineata*)

3.1 Management Background

Striped trumpeter has had a long history of exploitation in Tasmania, being highly esteemed for it's eating qualities. 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).

Responsibility for the management of striped trumpeter in both inshore and offshore (from 3 – 200 nautical miles) waters was passed to Tasmania in 1996 through an OCS arrangement with the Commonwealth. A MOU 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 both a Tasmanian scalefish 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 and 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 trip limit of 250 kg of striped trumpeter, yellowtail kingfish and red snapper for all fishers (Commonwealth and State), in all inshore and offshore waters relevant to Tasmania. This measure was introduced because it was recognised that the striped trumpeter fishery was not a year round fishery able to sustain continuous targeting, but had developed a niche as part of a diversified fishery, and required some protection against over-fishing. Further, introduction of quotas for key SENT species and for rock lobster, plus introduction of output control management of the southern shark fishery, meant that striped trumpeter may have been vulnerable to additional targeting by operators participating in those fisheries. 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 for both males and females.

3.2 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.

Striped trumpeter are reported to grow to 1.2 m in length and 25 kg in weight (Gomon *et al*. 1994). They occur mainly on the continental shelf over rocky bottom to depths of about 300 m, although juveniles are known to occur on shallow reefs throughout Tasmania. As

nothing is known of the stock structure of striped trumpeter in Australian waters a common stock throughout its range is assumed for management purposes.

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).

There is some 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 metamorphosis from the post-larval 'paperfish' stage probably occurring up to nine months after hatching. The distribution of larvae and recruitment processes are unknown.

While no information is available on the size and timing of settlement, small juveniles at around 18 cm fork length (FL) have been caught on shallow reefs off southeastern Tasmania in January (Murphy and Lyle 1999). Tagging studies suggest that juveniles tend to remain in around shallow reefs for several years, with only limited movement. There are also indications of movement of larger juveniles into deeper offshore reefs which is supported by data from the commercial fishery which shows fish around 45 cm recruiting to the offshore hook fishery (Lyle and Jordan 1999).

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 in fish over approximately 50 cm. Maximum age is currently estimated to be 43 years and, while this has yet to be fully validated, the incremental structure in sectioned otoliths is clear and unambiguous (Tracey *et al*. in prep). The age composition, mortality rates and productivity have not been estimated for any stock.

There is evidence of marked recruitment variability in striped trumpeter, with a very strong cohort spawned in 1993 (Murphy and Lyle 1998). The 1994 cohort also appeared to be relatively strong, though its size relative to the 1993 cohort is unknown.

3.3 Previous Assessments

Previous assessments have been restricted to analyses of commercial catch, effort and catch rate data and reporting on performance indicators (trigger points).

Catches in 1998/99 and 1999/00 were higher than during the reference period and therefore exceeded the catch trigger in both years. The effort trigger for handline fishing was also exceeded in both years but CPUE remained within previous levels. There is evidence, based on limited ageing of catch samples, that the strong 1993 cohort, in particular, contributed significantly to the increased catches over this period.

In 2000/01 there was a sharp down-turn in catch that resulted in catch triggers being exceeded, in terms of the rate of change and the catch being below the reference level. The impact of the 250 kg trip limit for commercial operators is likely to have contributed to the

fall in catches. Industry representatives reported that many operators were simply not bothering to fish for the species because of the low trip limit.

3.4 Current Assessment

3.4.1 The Fishery

Striped trumpeter catches are concentrated along the east coast, including Flinders Island, as well as off the south and southwest coasts of Tasmania. Limited catches are also taken off the west coast. The species is primarily caught using hooks and gillnets, with droplines, handlines and graball nets the dominant gear types (Fig. 3.1). There is also a minor by-catch of striped trumpeter in rock lobster pots.

Hook fishing methods accounted for around 70% of the total 2001/02 catch of 40 tonnes. Hook fishing occurs over hard bottom, with droplines generally fished in depths of 60-140 m and handlines between 40-80 m and 120-160 m. Reflecting their more inshore distribution, juvenile striped trumpeter are generally taken in graball nets from inshore reef areas in depths of less than 20 m, often in association with other reef species. During 2001/02 less than 20% of the catch was taken by graball net.

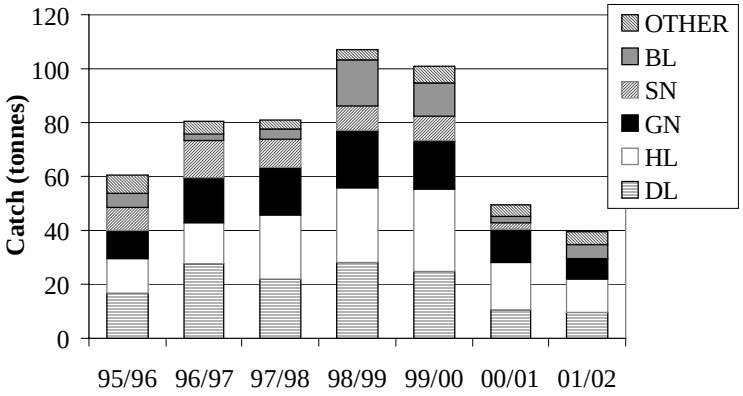


Fig. 3.1. Annual catch of striped trumpeter by method. DL is dropline; HL is handline; GN is graball; SN is shark mesh net; BL is bottom longline.

3.4.2 Recent developments

Fishers again noted that the 250 kg trip limit had impacted on fishing operations, with less incentive for fishers to target striped trumpeter. This impact appears to have been reflected in reductions in average daily catches and reduced effort over the past two years for the main target fishing methods (*viz*. drop line and hand line) (Figs 3.2-3.3). Reduced abundance/availability of striped trumpeter, however, cannot be discounted as factor in producing the observed decline in effort and catches.

A review of existing biological data, including re-analysis of growth and age composition data is being undertaken and will be available for the 2003 assessment.

3.4.3 2002 Assessment

The recent catch history, including catches reported in Victorian and Commonwealth logbooks, but taken in waters south of latitude 39° 12’S (i.e. waters incorporated in the OCS

agreement for striped trumpeter) is presented in Table 3.1. The 2001/02 commercial catch of just 40 tonnes was equivalent to 80% of that taken in the previous year and was the lowest reported since the late 1980s (Lyle and Jordan 1999).

The current assessment has been restricted to an examination of catch, effort and catch rate trends for the primary fishing methods, namely dropline, handline and graball net. In an attempt to distinguish targeted fishing for striped trumpeter the following assumptions have been made. 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.

Annual catch, effort and CPUE by method are represented graphically in Figs 3.2-3.4. Based on the above definition of targeted fishing, it is apparent that handline and dropline effort is, for the most part, targeted whereas only a minor proportion of the graball effort met the targeting criteria.

The most conspicuous trend in catches for these methods was the initial increase in production up until 1998/99 or 1999/00, followed by sharp falls such that catches in 2001/02 were equivalent or below 1995/96 levels. Catch rates (based on gear units) on the other hand, have been relatively stable over the period. By contrast, daily catches (based on targeted and total effort) have declined steadily over the past 3-5 years for the hook methods. While it is likely that the 250 kg trip limit may have impacted from 2000/01, it is significant that the declining trend was already evident prior to the introduction of the trip limit. This apparent mis-match between stable CPUE and declining daily catches implies that fishers have used less gear or fished for shorter periods, on average, for each day fished for striped trumpeter in recent years.

Striped trumpeter are only occasionally taken in gillnets and are, by the above definition, rarely targeted. The strong 1993 and 1994 cohorts entering the fishery between 1995/96 and 1997/98 influenced graball catches and catch rates and there is circumstantial evidence to suggest that the 1996 year class was also relatively strong and should have recruited to the 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 recent estimate of the recreational take of striped trumpeter (48 tonnes in 2000/01) indicates that the recreational catch is comparable to the commercial catch and, therefore, a significant component of the overall fishery. The introduction of a voluntary logbook for the charter boat sector in 2003 should provide on-going catch information and may have some potential as an indicator of trends in the broader recreational fishery.

In the absence of a more robust assessment, including fishery independent information, the status of striped trumpeter resource remains uncertain. On one hand, recent management changes appear to have resulted in changed fishing practices, specifically a reduction in the amount of targeted fishing for the species, and thereby catches have fallen. On the other hand, recent falls in catches across all methods may reflect reduced biomass of both new recruits and adults. If biomass has in fact declined sharply, this can be attributed to a combination of factors, including the effects of exploitation and variable recruitment. The impacts of the present harvest strategy that in effect selects for juveniles using graballs and adults using hook methods on yield per recruit needs to be investigated.

Table 3.1. Annual catches of striped trumpeter (tonnes) south of latitude 39° 12'S.
Based on Tasmanian (General Fishing Return), Victorian and Commonwealth logbook 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	39.7			39.7

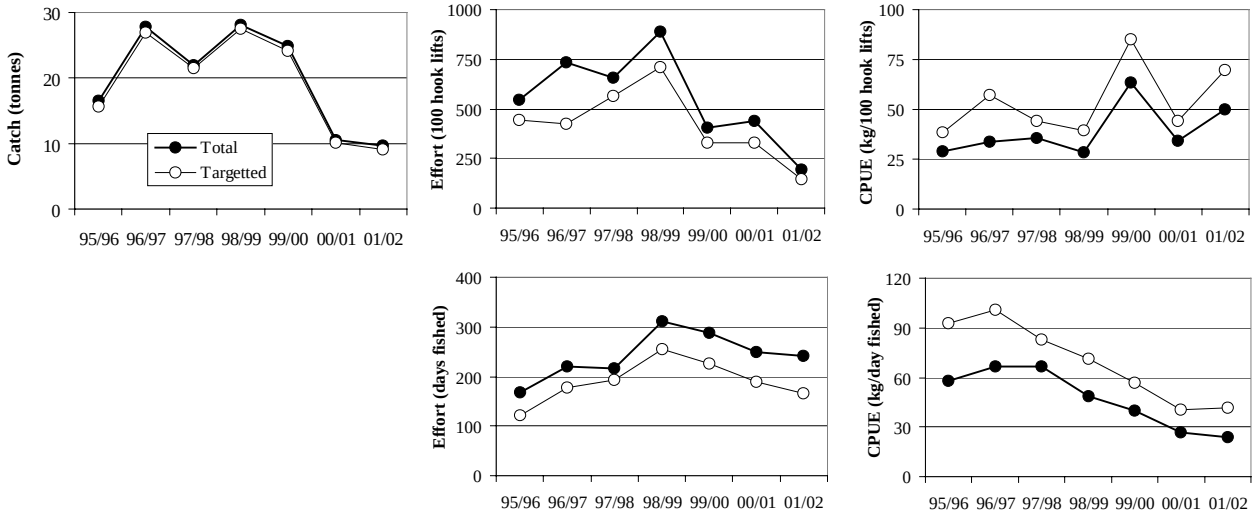


Fig. 3.2. Annual dropline catch, effort (hook lifts and days fished) and CPUE (targeted and total) for striped trumpeter.

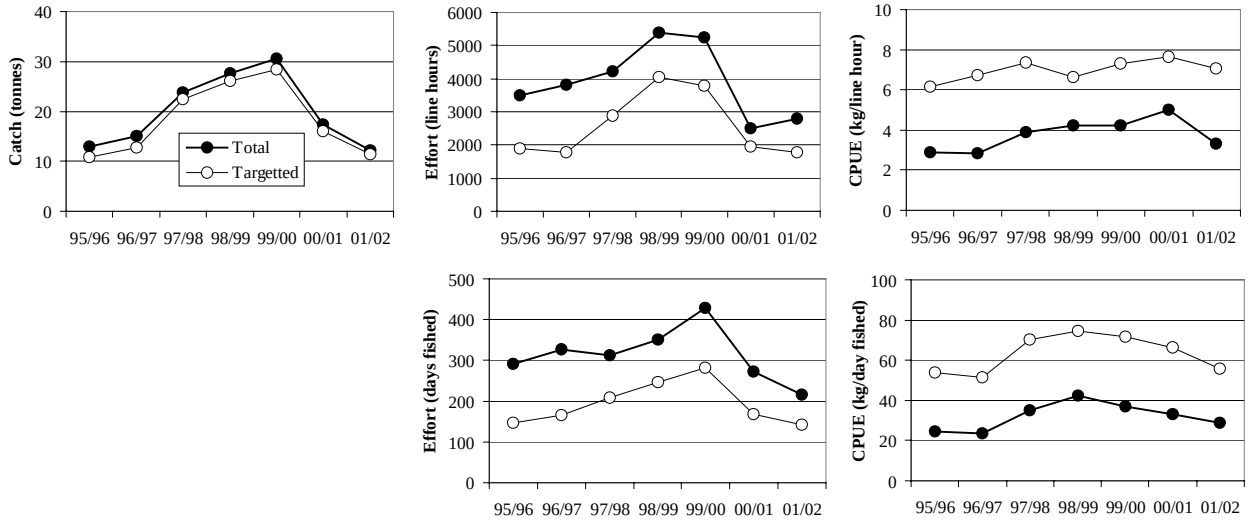


Fig. 3.3. Annual handline catch, effort (line hours and days fished) and CPUE (targeted and total) for striped trumpeter**.**

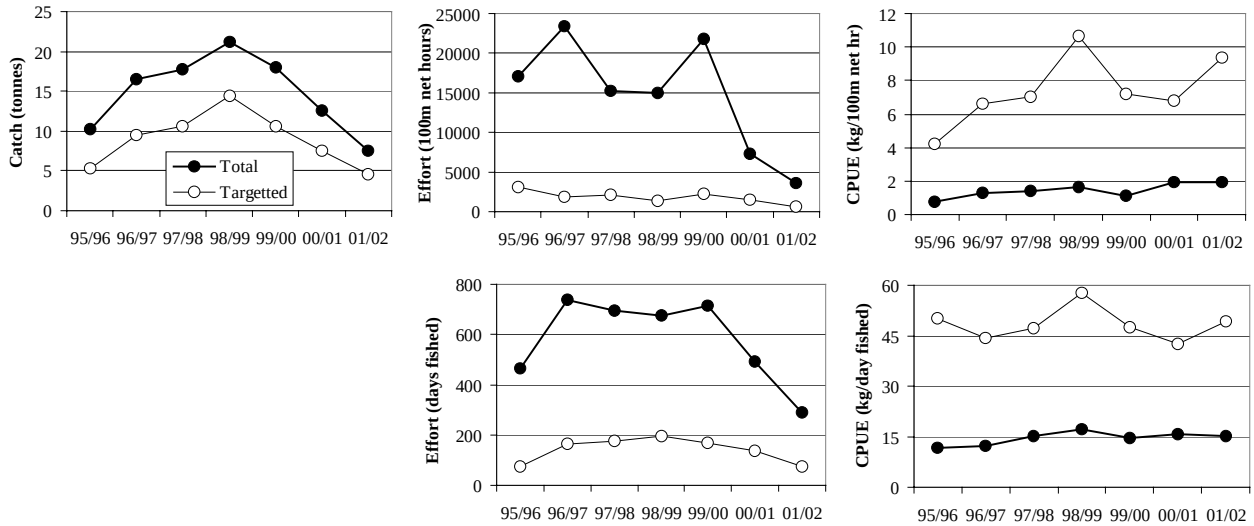


Fig. 3.4. Annual graball catch, effort (100m net hours and days fished) and CPUE (targeted and total) for striped trumpeter.

3.5 Evaluation of Trigger Points

Total catch

i. Total catch of a key target species is outside of the 1990/91 to 1997/98 range; or when,

ii. total catch of a key target species declines or increases in one year more than 30% from the previous year.

The 2001/02 striped trumpeter catch of just 40 tonnes was outside the reference period, being the lowest catch recorded since 1988/89. The current catch represented a decline compared to 2000/01 of about 20% and thus did not exceed the second catch trigger.

Fishing effort

> *Fishing effort for any gear type, or effort targeted towards a species or species group, increases by 10% from the highest of the 1995-97 levels.*

No effort triggers were exceeded in 2001/02.

Catch rates (CPUE)

> *In a given year, the CPUE of a key target species is less than 80% of the lowest value for the 1995-97 period.*

With the exception of daily catches for droplines, catch rates (total and targeted) values for each of the key methods were generally within historic ranges and therefore did not exceed this trigger.

Change in size composition

i. *A significant change in the size composition of commercial catches for key species; or when,*

ii. *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.*

Previous commercial and research catch sampling has indicated marked recruitment variability. The full significance of this phenomenon has yet to be fully evaluated.

3.6 Implications for Management

The sharp decline in catches in 2000/01 and again in 2001/02 gives rise to concern about the current status of the striped trumpeter stock. 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, with the fishery becoming dependent upon relatively few year classes. If, as implied by the most recent catch data, there has been poor recruitment 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, if this continues, may lead to recruitment over-fishing. The impact of recent management changes, however, cannot be discounted as a potential contributing factor to the down turn in catches.

Although a more rigorous assessment than is possible through examination of commercial catch data is required to assess the sustainability of the fishery, catch and effort trends need to be monitored closely over the coming years. Even without such an assessment 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.

The suitability of the legal minimum size limit of 35 cm in terms of yield-per-recruit is unknown but, being set well below the size at maturity, growth over-fishing is possible if a significant proportion of the catch is comprised of immature fish. Any increase in this minimum size would impact primarily upon the inshore graball fishery.

3.7 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 of the catch across methods. There is a need to refine life history and population parameters for striped trumpeter (including growth and mortality, reproductive biology, movements, etc) and to conduct yield per recruit analyses to determine the appropriate legal minimum size.

Based on previous research, fishery independent gillnet surveys have the potential to assess the relative abundance/presence of pre-recruits and could be valuable in predicting and interpreting catch trends.

4 Banded Morwong (*Cheilodactylus spectabilis*)

4.1 Management Background

The 'live fish' fishery for banded morwong began in the early 1990's. All holders of a fishing licence (vessel) were able to take this species and, as a result, there was a dramatic increase in fishing effort directed at the species. Reported landings increased from 7 tonnes in 1991/92 to 39 tonnes in 1992/93 and then to over 145 tonnes in 1993/94.

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 to (i) maintain adequate egg production by protecting large adults and (ii) 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 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 minimise wastage of fish at a time when they are most vulnerable to mortality in captivity and to protect spawning fish. Spawning closures have been implemented each year since that time.

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 fishing licence (banded morwong), 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 (banded morwong).

In November 2001, largely as a result of concerns about stock status, a daily bag limit of 2 fish was introduced for recreational fishers.

4.2 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. While they are found down to about 50 m in New Zealand, females and juveniles inhabit the shallow sections of the reef with 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 Tasmanian waters, banded morwong are present in a spawning condition between mid to late February and early May, with the distribution of oocytes 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, spawning on the same reef over several years (McCormick 1989b). The eggs and larvae are concentrated on the surface. Considerable numbers of *Cheilodactylus* sp. 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).

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, until about 45 cm, before slowing. Maximum recorded ages for female and male banded morwong are 86 and 81 years, respectively (Murphy and Lyle 1999). The age structure of banded morwong populations from some east coast sites provide some evidence of year class (recruitment) variability (Murphy and Lyle 1999). Such long lived species typically have relatively low productivity.

4.3 Previous Assessments

Previous assessments have been limited to the examination of trends in catch, effort and catch rates. Given evidence of population structuring at small spatial scales, analyses have been conducted at regional as well as state-wide levels. Overall, catch and effort declined steadily between 1995/96 and 1999/00, accompanied by a steady fall in CPUE. At state-wide and regional levels, catch and catch rate triggers were exceeded in 1999/00 giving rise to concerns about the sustainability of the fishery. Despite a slight increase in the 2000/01 catch, the catch trigger was again exceeded along with the catch rate trigger for the St Helens region.

Meetings of researchers, managers and industry in 2000 and again in 2001 have discussed management and research issues relevant to the banded morwong fishery. Industry members affirmed the view that recent catches reflect reduced fishing effort and that seals continued to be a major factor in determining fishing activity (effort) and success. It was also noted that a number of new participants had entered the fishery (and other experienced operators had exited the fishery) and this dynamic was likely to have had some influence on catch rates. A general observation supported by operators with several years of involvement in the fishery was that both the frequency of seal interactions and the quantities of fish lost to seals had increased over the history of the fishery. Amongst the industry members, seal interactions were considered to be a more significant factor influencing the downturn in catch and effort than variation in catch rates. Specific recommendations from the meetings have included a review of the appropriateness of the performance indicators, development of a specific research logbook to provide greater detail about the fishery and the need to develop fishery independent indicators of stock condition.

4.4 Current Assessment

4.4.1 The Fishery

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. Minor 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 by-product of netting operations primarily targeted at blue warehou.

Banded morwong catches declined steadily from over 100 tonnes to just 34 tonnes between 1994/95[3] and 1999/00, before increasing to 39 tonnes in 2000/01 and to 51 tonnes in 2001/02 (Table 2.1, Fig. 2.1).

4.4.2 Recent Developments

Monitoring of commercial catches for size composition resumed in 2001 and specimens for age determination were collected from the Tasman Peninsula and Bicheno regions in each of the 2001, 2002 and 2003 spawning seasons. Additional samples were collected from St Helens in 2002 and 2003. Preliminary examination of current and previous (1995-97) age and size structure information has been undertaken though further analyses will be conducted with data incorporated into an assessment model. This work is being undertaken as part of a Fisheries Research and Development Corporation project that seeks to develop a more robust stock assessment for banded morwong, including development of appropriate performance indicators. Interviews with key industry representatives are also being conducted to provide an industry perspective of resource status and to assist with hypothesis testing.

Results of the National Recreational Fishing Survey indicate 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.

4.4.3 2002 Assessment

This assessment has been restricted to examination of graball net catch and effort trends, this gear accounting for around 99% of the total catch of banded morwong. In an attempt to distinguish targeted fishing 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 seven years and had caught at least 2.5 tonnes since 1995/96.

[3] Note: the reported 1993/94 catch is unreliable because of over-reporting of catches.

Catch trends for total, targeted and 'selected' fishers were consistent, exhibiting sharp declines between 1995/96 and 1999/00 followed by a recovery to about 60% of the initial catch level in the most recent year (Table 4.1, Fig. 4.1). Over the past seven years there has been a marked decline in effort, though in the last two years effort has tended to stabilise or increase slightly (days fished). Up until 1999/00, gear based catch rates (i.e. kg/100m net hour) declined steadily for total effort but remained relatively stable for targeted and selected fisher effort. Since then catch rates have risen to the highest levels since 1995/96. By contrast, daily catches generally fell up until 1999/00 for targeted and selected fisher effort but have stabilised since at above 70% of the 1995/96 levels. These observations tend to support industry assertions that catch rates (fish per net) have changed little over time but the average amount of gear set each day has been reduced, largely as a response to seal interference.

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 (half degree fishing blocks), analyses have been undertaken at the regional or block level for the main fishing areas. Based on fishing blocks, regions have been defined as St Helens (5H1), Bicheno (5H3), Schouten (6H1), Maria (6H3 & 6G4) and Tasman Peninsula (7G2 & 7H1). Between 1995/96 and 1999/00 catches in most regions generally declined, St Helens was the exception with an expansion of catches up until 1997/98 (Figs 4.2- 4.3). Catches have tended to stabilise since 1999/00 apart from Bicheno where there has been a recent increase in catches. As a general rule, catch trends have been reflected changes in effort, with falling catches linked to reductions in effort and the recent increases in catches due to increase effort.

Although catch rates for banded morwong have been variable between years and between regions, there was an underlying decline evident up until 1999/00. Since then catch rates have either increased (Bicheno, Schouten, Maria and Tasman) or stabilized (St Helens).

Catch and catch rate indicators suggest that, initially at least, the fishery impacted on banded morwong populations. There has, however, been an apparent 'recovery' in catch and catch rates over past two years but this needs to be interpreted with caution and may not indicate the sustainability of current levels of exploitation. These fishery dependent indicators may be influenced by factors other than fish abundance, for instance management changes (licensing and size limits), shifts in the dynamics of the fishery (including expansion into new areas and changed/more efficient fishing practices) and impacts of seals. There is, therefore, considerable uncertainty surrounding the resource status but since banded morwong are sedentary and long-lived (low productivity), a precautionary approach to the management of the species is necessary. There is an urgent need to investigate fishery independent indicators of stock condition; for example population age structure.

Table 4.1 Graball catch, effort and CPUE for banded morwong.
[+] For gear units refer to Table 2.3.

Method	*Year*	*Catch (tonnes)*	*Effort [+](gear units)*	*CPUE [+](kg/gear unit)*	*Effort (Days)*	*CPUE (kg/day)*
Graball	1995/96	86.3	69476	1.15	1746	33.8
	1996/97	78.5	64564	1.09	1491	34.1
	1997/98	72.1	78519	0.97	1423	34.1
	1998/99	43.1	43897	0.95	899	31.2
	1999/00	33.8	47341	0.74	937	21.7
	2000/01	39.1	28595	1.32	1001	28.7
	2001/02	51.3	32515	1.62	1315	30.2

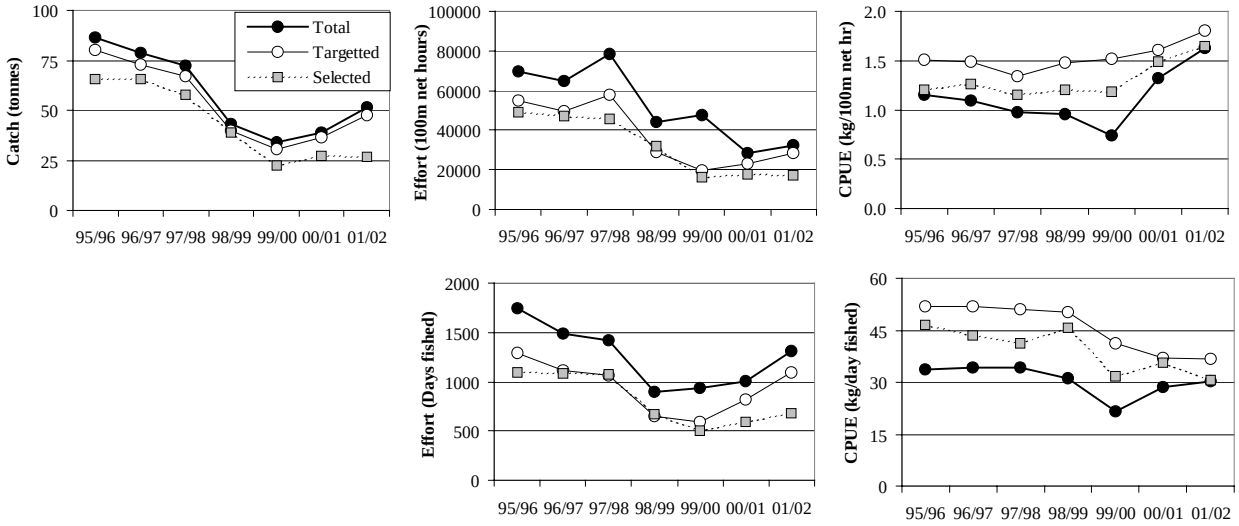


Fig 4.1 Annual graball catch, effort (100m net hours and days fished) and CPUE for banded morwong based on total (solid circle), targeted (open circle) and selected (grey square) effort.

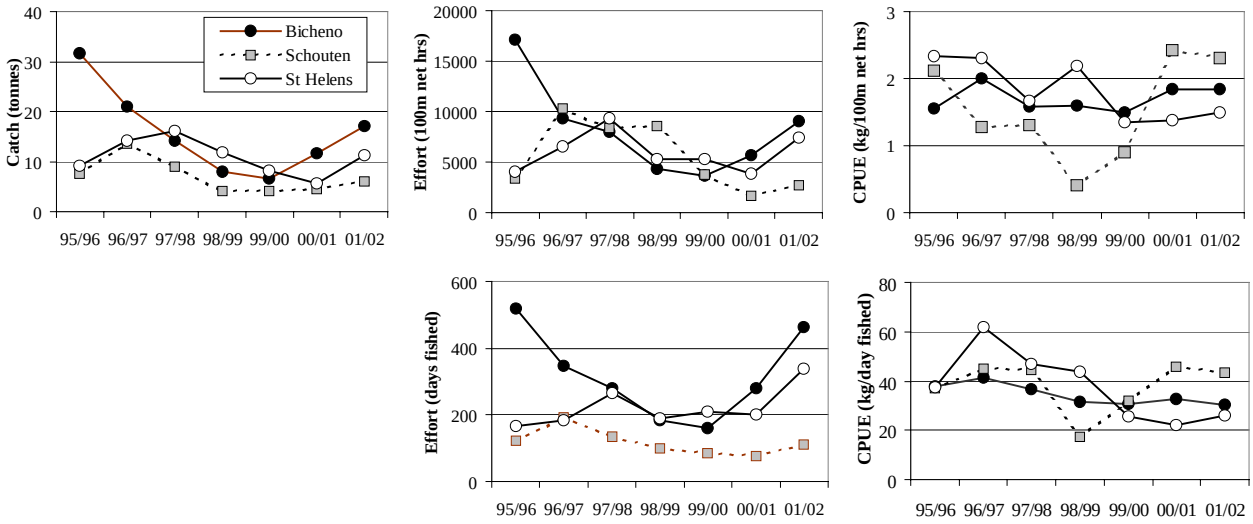


Fig. 4.2 Catch, effort (100m net hours and days fished) and CPUE for banded morwong by fishing region- Bicheno, St Helens and Schouten.

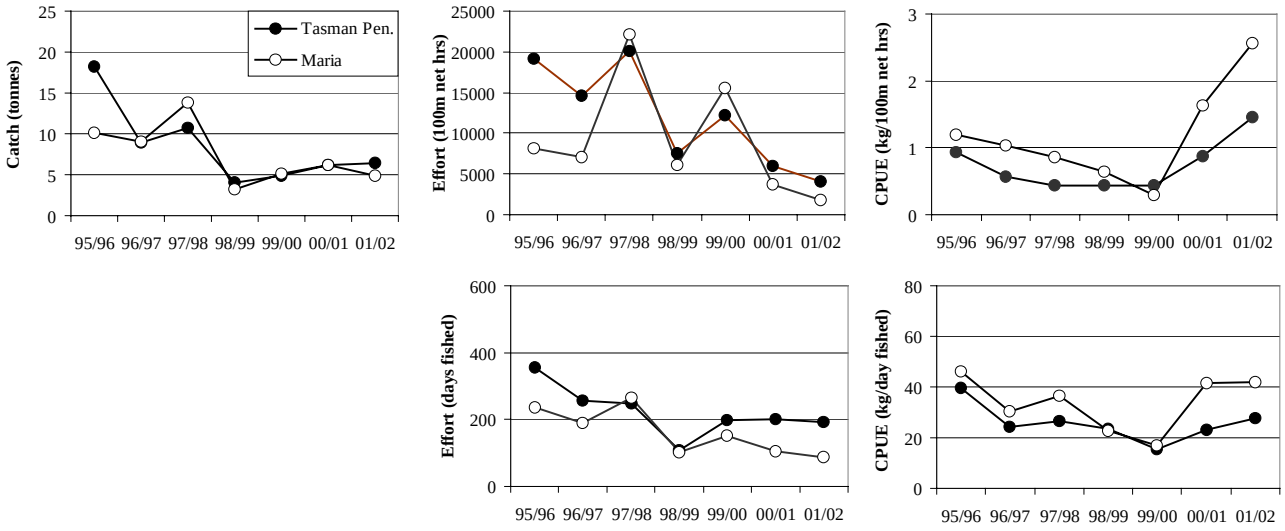


Fig. 4.3. Catch, effort (100m net hours and days fished) and CPUE for banded morwong by fishing region- Maria and Tasman Peninsula.

4.5 Evaluation of Trigger Points

Total catch

i. Total catch of a key target species is outside of the 1990/91 to 1997/98 range; or when,

ii. total catch of a key target species declines or increases in one year more than 30% from the previous year.

Total catch of banded morwong for the period 1990/91 to 1997/98 ranged from 6.9 to 145.5 tonnes (Table 2.1). However, given the rapid increase in landings over this period there is little value in the use of this full range in assessing catch trends. This is particularly the case for data prior to the development of the fishery (pre 1993/94), and for the 1993/94 reported catch, which is generally believed to have been significantly overstated. Therefore, for the purpose of trigger point assessment, catches for the period 1994/95 to 1997/98 have been adopted as the reference period.

As the 2001/02 catch of 51 tonnes was lower than the reference catch level and was just over 30% greater than in 2000/01, both catch triggers were exceeded. The recent increase in catch (and increased effort) may indicate a resurgence of interest in the fishery, the effects on the stocks being uncertain.

Fishing effort

Fishing effort for any gear type, or effort targeted towards a species or species group, increases by 10% from the highest of the 1995-97 levels.

There was increased fishing activity compared to 2000/01 in each of the major fishing regions, however, by comparison to the reference years current effort levels were low and the effort trigger was not reached.

Catch rates (CPUE)

In a given year, the CPUE of a key target species is less than 80% of the lowest value for the 1995-97 period.

State-wide and regional catch rates (based on gear units) had generally increased in 2001/02 to levels comparable (Bicheno) or above (Schouten, Maria and Tasman) those that applied in the reference years. Even though catch rates for St Helens were below the minimum for the reference period they were within 80% of this reference level. For the first time, catch rate triggers were not exceeded for banded morwong.

Change in size composition

i. *A significant change in the size composition of commercial catches for key species; or when,*

ii. *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.*

Commercial catch sampling of the size structure of banded morwong resumed in the latter half of 2001. Preliminary analyses indicate that the size structure in all regions has changed since the late 1990s, with a greater representation of smaller fish in current catches. Such changes are consistent with the expected impacts of fishing though the biological significance of these observations is not clear. Modelling of a range of fishery and biological inputs for banded morwong is being undertaken and is expected to prove informative regarding stock status.

4.6 Implications for Management

While catch rates have changed only slightly in the main fishing areas over the past seven years, it is likely that they have been maintained to some extent through the fish down of accumulated biomass (up to 50 or more year classes) rather than replacement biomass. Based on life history, in particular the longevity of the species, productivity is expected to be low. Therefore, if over-fishing occurs stock recovery will be slow even if the fishing effort is significantly reduced. Further, being a sedentary species the potential for localised depletion is high. A more rigorous assessment than is possible through examination of catch rate data is required to determine resource status and sustainability of the current fishing levels. Nevertheless, the general downward trends in key fishery indicators, and uncertainty about the reliability of the catch statistics, it is seems likely that fishing mortality is, at least locally, too high.

Little is known about the dynamics of the fishery, specifically whether catch rates are effectively being maintained through the exploitation of ‘new’ reef areas. Any such serial depletion of individual reefs would be masked in the catch and effort data provided by fishers because of the relatively large spatial scale that operations are reported in catch returns.

4.7 Research Needs

The Scalefish Fishery Research Advisory Group has accorded stock assessment of banded morwong high priority. An integral component of the stock assessment is the establishment and monitoring of suitable biological trigger points for this fishery. Catch sampling of banded morwong is being undertaken and should provide insight into the impact of fishing

on the size and sex structure of the populations. However, given that there is considerable variability in the size composition of the catches between small areas, sampling needs to be focussed regionally, even at the scale of discrete reef areas. This degree of sampling intensity may be difficult to achieve and justify in a fishery of this size. This will, in turn, put limits on the safe development of the fishery in Tasmania.

Changes to the minimum and maximum size limits for banded morwong were introduced in late 1998. There is a need to assess the effect that these changes may have had on catch rates in order to interpret the trends. Population age structure at key sites is being investigated for comparison with information from the late-1990's. It is hoped that these comparisons may prove informative in indicating changes that have occurred as a consequence of fishing. It is ultimately intended to develop a model for the banded morwong fishery, which will enable a more robust stock assessment based on depletion estimators.

5 Sea Garfish (*Hyporhamphus melanochir*)

5.1 Management Background

Traditionally a winter beach seine fishery, catches were initially centred off the northeast coast, including Flinders Island. More recently the fishery has extended to the east and southeast coasts and, with the introduction of dip nets, catches have increasingly been taken over the summer months.

Under the scalefish management plan all scalefish and rock lobster licence holders are entitled to use dip nets. The use of beach seine and purse seine nets is, however, restricted to those fishers who hold a fishing licence (beach seine A or B or purse seine licences).

A legal minimum size limit of 25 cm TL applies for sea garfish.

5.2 Stock Structure and Life-history

The sea garfish are endemic to Australian waters and are distributed from Eden in NSW to Kalbarri in Western Australia, including Bass Strait and Tasmanian waters (Gomon *et al*. 1994). They are found in sheltered bays, clear coastal waters and estuaries to depths of about 20 m. Fish school near the surface at night and close to the bottom, often over seagrass beds, during the day. They are predominantly herbivores with around 75% of their diet being comprised of seagrass and algal filaments (Klumpp and Nichols 1983). Other diet items include diatoms, insect larvae, worms and small crustaceans, particularly amphipods (St Hill 1996).

Morphometric studies suggest sea garfish may form two populations in Australia, i.e. an eastern stock around NSW, Victoria and Tasmania and a western stock around South Australia and Western Australia. A more recent study identitifed 4 genetically separate populations of garfish; they are based off Western Australia, western South Australia, eastern South Australia/Victoria and Tasmania, respectively (Donnellan *et al.* 2002). This study did not discriminate between fish sampled from the east coast of Tasmania from samples from Flinders Island.

Sea garfish in eastern Tasmania spawn over an extended period of at least five months, from October to February (Jordan *et al*. 1998). However, the bulk of spawning occurs between October and December, with a lower level of spawning activity in the latter half of the spawning period. Sea garfish are serial spawners, with asynchronous oocyte development occurring simultaneously in reproductively active ovaries (St Hill 1996).

Sea garfish eggs are about 2.9 mm in diameter and negatively buoyant, sinking immediately to the bottom after fertilisation, and become attached to filamentous drift algae (Jordan *et al*. 1998). There is no evidence in eastern Tasmania that eggs attach in clusters on seagrass blades as has been suggested in the literature. In this region, spawning occurs in shallow areas (<5 m deep) over beds of drift algae. However, seagrass may be of greater significance around areas such as Flinders Island where the majority of shallow water habitat consists of seagrass beds (principally *Posidonia australis* and *Amphibolis antarctica*). Sea garfish have a long egg duration of around 28-30 days and are unusual in that they hatch out as large (7.8-8.5 mm) post-flexion larvae. There is little information available on early life history and recruitment of sea garfish. Small juveniles (0+ cohort) have been caught in shallow sheltered waters of eastern Tasmania (Jordan *et al*. 1998). In

southwestern Australia, sea garfish may spend the first year of life in estuarine areas and the first 2 years in inshore waters (Lenanton 1982).

Growth of male and female sea garfish in eastern Tasmania is relatively rapid for the first 3 years, achieving a length of around 20 cm FL by 2 years of age and 25 to 30 cm by 3 years (Jordan *et al*. 1998). Growth then slows appreciably, reaching a maximum age of around 9 years when fish may be 40 cm long and weigh around 0.35 kg. After 3-4 years there is increasing variation in size-at-age, with fish at a length of 30 cm ranging from 3 to 8 years old. Insufficient data are available to determine whether males and females grow at different rates.

5.3 Previous Assessments

Previous assessments have been restricted to the examination of trends in catch and catch rates for beach seine and dip net methods. With the exception of 1995/96, annual garfish catches have fluctuated between 70-100 tonnes, without any consistent pattern or trend evident. Since 1995/96 the beach seine catch and catch rates have fluctuated only slightly. By contrast, dip net catch and effort increased immediately following the introduction of the management plan, triggering the catch and effort indicators and giving rise to concerns about a potential blow-out of effort. Since 1999/00, however, dip net catch and effort declined to within reference limits and did not exceed trigger levels in 2000/01.

Since all holders of scalefish licences continue to have access to dip nets and since garfish command premium prices there remains concern about the potential for further expansion in the dip net sector.

5.4 Current Assessment

5.4.1 The Fishery

Sea garfish are taken by a variety of fishing methods, with beach seining and dip nets accounting for 80-90% of the annual catch in recent years and purse seine and spear the bulk of the remainder (Fig 5.1). Both beach seine and dip net fishing are conducted close to shore and almost exclusively in depths of <10 m. Dip nets are used during the night over shallow areas of sand, seagrass and reef to target surface fish that are attracted to lights.

Sea garfish are taken commercially around Tasmania, apart from the west coast, with the bulk of the catch taken off the northeast and southeast coasts. Since 1996/97, annual catches from the northeast (defined as fishing blocks 3G4, 4G2, 4G4, 4H1, 4H3) have declined steadily from around 50 tonnes in 1996/97 to around 30 tonnes in 2000/01 and 2001/02 (Fig. 5.2). Over the same period, east coast (blocks 6G4, 6H1, ES13, ES14, ES15, ES16) catches fluctuated without an obvious trend between 5 and 24 tonnes p.a. By contrast catches from the south-east coast, which include those taken in Norfolk and Frederick Henry Bays (blocks 7G1, 7G2, ES17, ES18, ES19), increased from just 4 tonnes in 1996/97 to around 20 tonnes p.a. in each of the past four years. The majority of the northeast catch is taken by beach seine while dip nets, and to a lesser extent beach seines, represent the dominant methods used off the east coast. Dip nets and more recently purse seine account for the bulk of the southeast coast catch.

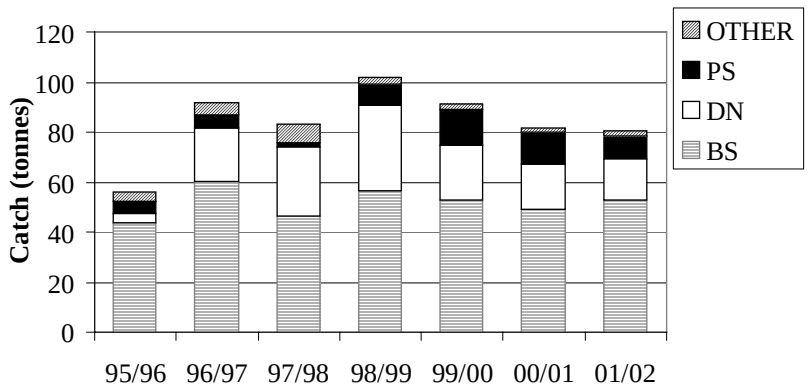


Fig.5.1. Annual catch of sea garfish by method. BS is beach seine; DN is dip net; PS is purse seine, OTHER is all other methods.

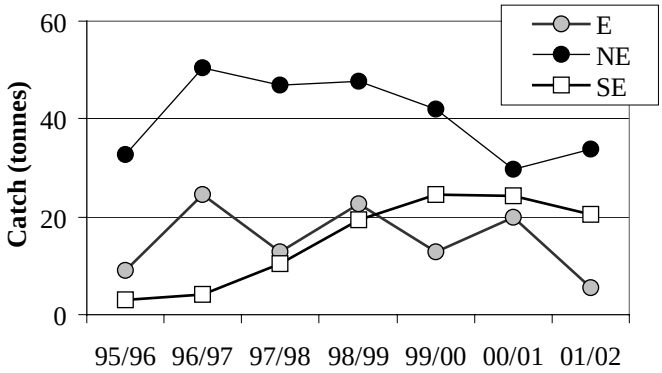


Fig. 5.2. Annual catch of sea garfish by major fishing regions. NE includes Flinders Island and the northeast coast of Tasmania, E is east coast including Great Oyster Bay and SE is southeast coast including the Tasman Peninsula, Norfolk and Frederick Henry Bays and Bruny Island.

5.4.2 Recent Developments

A study of garfish stock structure, age and growth, reproductive biology and fisheries off southern Australia (focussed on Western Australia, South Australia and Victoria) has been recently completed (Jones *et al*. 2002).

There has been no recent research or catch sampling of garfish in Tasmania.

5.4.3 2002 Assessment

This assessment has been restricted to the examination of trends in catch, effort and CPUE for beach seine and dip nets, being the primary fishing methods for sea garfish.

The 2001/02 catch of 81 tonnes was virtually unchanged compared to the previous year and was within the catch range for the reference period 1990/91 to 1997/98 (Table 2.1).

Beach seine catches of garfish have remained relatively stable since 1996/97 despite declining effort up until 2001/02 (Table 5.1, Fig. 5.3). Catch rates have trended upwards since 1997/98 although in the current year they fell to levels more consistent with those

recorded in the late 1990s. After increasing rapidly to a peak of 34 tonnes in 1998/99, dip net catches have fallen gradually to about 16 tonnes in the current year (Table 5.1, Fig. 5.3). The recent decline in dip net catch reflects falling effort rather than variability in catch rates.

For schooling species such as garfish, catch rate indicators are likely to be relatively insensitive to declines in abundance, perhaps more so for gear, such as beach seine, that is used to target schools of fish. Some industry members have expressed concerns about the effects of dip nets on the schooling behaviour of garfish. Specifically it has been suggested that intensive dip net activity tends to cause schools to break up, which could reduce opportunities to use beach seines to target the species and even impact on catch rates. In regard to the latter, there was no evidence of a decline in beach seine catch rates as dip net effort increased, though such impacts may have been localised and may be masked in this state-wide analysis.

It is not possible to determine whether current catches are sustainable based on this analysis of key fishery dependent indicators.

Table 5.1. Catch, effort and CPUE for key fishing methods for sea garfish.
[+] For gear units refer to Table 2.3. * 5 or fewer vessels involved, data cannot be shown.

Method	*Year*	*Catch (tonnes)*	*Effort [+](gear units)*	*CPUE [+](kg/gear unit)*	*Effort (Days)*	*CPUE (kg/day)*
Beach seine	1995/96	43.6	698	41.6	377	68.0
	1996/97	60.1	1046	37.7	529	65.8
	1997/98	46.2	744	38.0	409	60.3
	1998/99	56.5	689	52.5	296	104.7
	1999/00	53.0	660	52.1	316	102.1
	2000/01	49.1	538	64.5	263	117.0
	2001/02	52.8	821	41.2	357	86.3
Dip net	1995/96	*	*	9.1	*	30.7
	1996/97	21.4	1486	12.3	353	42.6
	1997/98	27.7	1654	13.0	396	50.4
	1998/99	34.0	2570	10.6	521	45.6
	1999/00	21.4	2131	7.5	460	30.7
	2000/01	17.9	1360	8.5	354	30.7
	2001/02	16.4	1417	8.2	345	32.9
Purse seine	1995/96	4.6	286.0	8.2	120.0	16.8
	1996/97	5.4	120.0	26.1	61.0	43.0
	1997/98	*	*	44.1	*	54.5
	1998/99	*	*	77.5	*	102.3
	1999/00	*	*	92.3	*	148.6
	2000/01	*	*	106.5	*	162.7
	2001/02	*	*	67.6	*	111.5

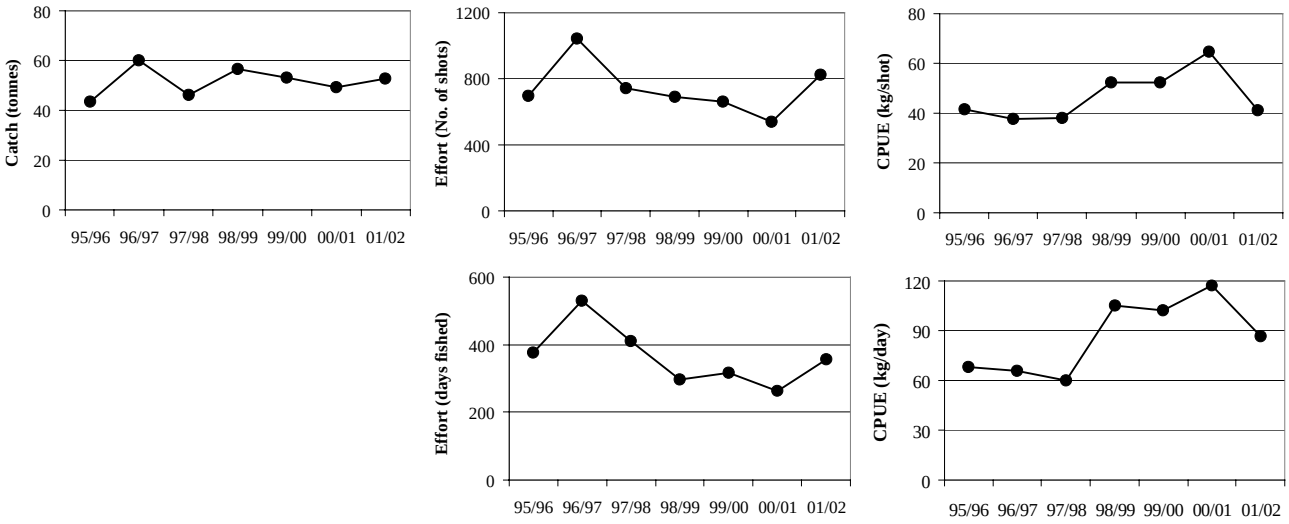


Fig. 5.3. Annual beach seine catch, effort (number of shots and days fished) and CPUE for sea garfish.

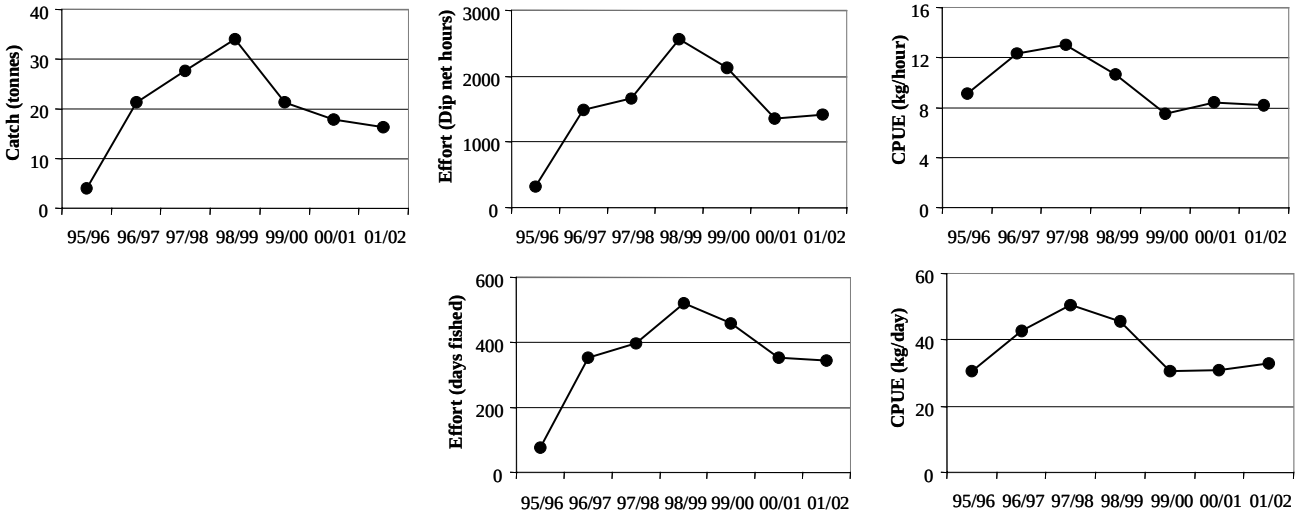


Fig. 5.4. Annual dip net catch, effort (dip net hours and days fished) and CPUE for sea garfish.

5.5 Evaluation of Trigger Points

Total catch

i. Total catch of a key target species is outside of the 1990 to 1997 range; or when,

ii. total catch of a key target species declines or increases in one year more than 30% from the previous year.

The total catch of sea garfish in 2001/02 was within the reference range and virtually unchanged compared to 2000/01. Thus neither of the catch triggers were reached.

Fishing effort

> *Fishing effort for any gear type, or effort targeted towards a species or species group, increases by 10% from the highest of the 1995-97 levels.*

Beach seine effort rose in the current year but was still below the 1996/97 peak. There was little change in dip net effort compared to 2000/01 which remained within the range of the reference period. Effort triggers were not, therefore, exceeded for either of the primary garfish fishing methods.

Catch rates (CPUE)

> *In a given year, the CPUE of a key target species is less than 80% of the lowest value for the 1995-97 period.*

Since 1999/00 dip net catch rates have been very stable each year whereas beach seine catch rates remained within or slightly above reference values. Although catch rate triggers were not exceeded it is generally recognised that, for schooling species such as garfish, CPUE may not be very sensitive indicator of stock abundance.

Change in size composition

i. *A significant change in the size composition of commercial catches for key species; or when,*

ii. *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.*

No recent data for garfish are available to assess against this criterion.

5.6 Implications for Management

Although catch levels in the Tasmanian garfish fishery have fluctuated very little over recent years, interest in the species is high and it is possible that effort could increase over a relatively short period, particularly in the dip net sector since it is a method available to all scalefish licence-holders.

Limited information is available on the stock structure of sea garfish within Tasmania and thus it is not possible to evaluate whether a regional management approach would be appropriate.

There is concern amongst those industry members who use beach seines regarding the effects of dip net fishing on the schooling behaviour of garfish, including possible impacts on spawning success. There is no objective information available to test these concerns.

There is little evidence for concern over the stock status but there is a real potential for effort to expand. 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.

5.7 Research Needs

Stock assessment, critical habitat requirements, impact of management arrangements and gear interactions on sea garfish have been accorded high research priority by the Scalefish Fishery Research Advisory Group.

Information indicating the level of fishing pressure that can be sustained on sea garfish is required. This could probably be best achieved by sampling from the commercial fishery and estimating key population parameters for modelling in yield per recruit analysis. Integral to this is the need to analyse otoliths for age, validate annuli, construct age length keys and estimate mortality parameters for sea garfish.

The significance of seagrass habitats for spawning and feeding of sea garfish will require further sampling in areas along the north coast and Flinders Island. Information on the stock structure of sea garfish is required.

6 Wrasse (Family: Labridae)

6.1 Management Background

Historically wrasse (several species) have had limited commercial value, being used primarily as rock lobster bait. A 'live fish' fishery for wrasse developed the early 1990's and anyone holding a fishing licence (vessel) was entitled to take these species. As a result, there was a dramatic increase in fishing effort and reported landings from State waters increased from around 70 tonnes in 1991/92 to 100 tonnes in 1992/93 and to almost 180 tonnes in 1994/95.

On 31 May 1994, a Ministerial warning was issued explaining that any catches taken after that date would not be used toward catch history, should previous catches be used to determine future access. In the same year, minimum and maximum size limits (28 and 43 cm TL) were introduced for wrasse; primarily to match market requirements (by restricting the size range to that of the highest value) and to allow fish to breed several times prior to attaining the minimum size limit.

In 1996 an interim live fish endorsement on the fishing licence (personal) was issued to take banded morwong and wrasse. Eligibility for an endorsement was based on a demonstrated history of taking these species, and the total number of endorsements issued was around 90. These arrangements continued until the scalefish fishery management plan was implemented in late 1998.

Under the management plan, a specific licence was introduced for the marketing of live wrasse in State waters. To qualify for a fishing licence (wrasse), applicants had to prove that they had caught at least one tonne of wrasse during the period 1 January 1993 to 31 May 1994. There are currently 58 fishing licences (wrasse). Only wrasse licence-holders are permitted to sell live wrasse and only wrasse and rock lobster licence-holders are permitted to have in their possession more than 30 kg total weight of wrasse.

The size limits for wrasse were revised in November 2001 and a minimum size of 30 cm, with no upper size limit, was introduced.

6.2 Stock Structure and Life-history

Eight species of wrasse occur in Tasmanian waters with purple wrasse (*Notolabrus fucicola*) and blue-throat wrasse (*N. tetricus*) the main commercial species. Both species are distributed in southeast Australia (Tasmania, Victoria, New South Wales and South Australia) with purple wrasse also occurring in New Zealand. The other six wrasse species have overlapping ranges with some encompassing southern Western Australia and New Zealand. Purple wrasse are found in very shallow water down to depths of 25 m while blue-throat wrasse generally occur in deeper water down to 50 m. The stock structure of wrasse in Australian waters has not been examined.

The sex of purple wrasse appears to be genetically based and is determined before sexual maturity is reached (Barrett 1995). In contrast, a small proportion of blue-throat wrasse between 27 and 32 cm change sex from female to male, accompanied by change in body shape and colour. Sex change appears to be determined by a combination of factors, including social structure and size or age of individuals (Barrett 1995). Functional males with female colour morphology have been found.

Length at first maturity of female blue throat wrasse is about 15 cm, which corresponds to an age of around 2 to 3 years. This small size at maturity means females may spawn for at least 4 to 5 years before reaching the present minimum size limit (30 cm). On the other hand, male blue-throat wrasse are derived from mature females and are not protected by the minimum size limit[4]. Both male and female purple wrasse attain maturity at around 15 cm and are, therefore, able to reproduce for several years before entering the fishery. In purple wrasse both sexes are afforded protection by the minimum size limit. Spawning in Tasmania occurs throughout their range between August and January (Barrett 1995). There are no estimates of fecundity. While male blue-throat wrasse are territorial, females are home ranging and sedentary on inshore rocky reefs, showing strong site attachment (Barrett 1995).

Wrasse eggs and larvae are believed to be pelagic and larvae recruit to rocky reefs at approximately 1.5 to 2.0 cm in length. Growth in juveniles is rapid, reaching a mean length of around 12-15 cm after two years and 20 cm after five years, with growth considerably slower in older fish (Barrett 1995). In Tasmania the maximum reported ages for purple and blue-throat wrasse are about 20 and 10 years, respectively (Barrett 1995, Ewing unpubl. data). Recent Victorian studies (Smith *et al*. 2003) in have indicated maximum ages 16 and 23 years for purple and blue-throat wrasse, respectively, suggesting that blue-throat wrasse are longer-lived than previously thought.

6.3 Previous Assessments

Previous assessments have been restricted to analyses of catch, effort and catch rate trends for trap, handline and graball. During between 1995/96 and 2000/01 the annual catch of wrasse combined across all gear types has ranged between about 85 and 110 tonnes.

General stability in catch rates for trap and handline methods has been a feature of the fishery, with any variability in catches between years largely a function of changes in effort. It has been noted, however, that stability in catch rates at the state-wide level may mask more localised effects of fishing which, coupled with the fact that two species are involved, does lead to some uncertainty when making inferences about resource status.

6.4 Current Assessment

6.4.1 The Fishery

Operators targeting the live fish market primarily take wrasse with fish traps and handlines. In 2001/02 almost 90% of the total catch of 89 tonnes was taken by trap and handline fishing (Fig 6.1). Graball catches tend to of minor importance, since few fish caught by this method are suitable for sale on the live fish market. Incidental catches are also regularly taken in rock lobster pots and by a variety of other methods.

Based on fishers returns, the annual ‘live wrasse’ catch has ranged between 55 tonnes (1999/00) and 82 tonnes (1996/97) for the seven years since 1995/96 (averaging 65 tonnes p.a.). Reported usage of wrasse as bait has ranged between 9-13 tonnes p.a. over the same period (averaging 11 tonnes). It is probable that both ‘live fish’ and bait usage are underestimated since almost 20% of the catch in each year was reported as ‘whole fish’, some of which may be marketed live or used as bait. Further, it is uncertain as to how

[4] Note: the maximum size limit of 43 cm was removed in November 2001, this limit would have afforded some protection to the larger males within the population.

comprehensively the use of wrasse for bait is reported, especially amongst rock lobster fishers.

Wrasse are targeted over shallow reefs close to shore, with the majority of trap caught fish taken in depths of less than 10 m, while a higher proportion of the handline catch is taken in depths of 10-20 m. Industry reports suggest that purple wrasse comprise the bulk of the trap catch whereas blue-throat wrasse dominate line catches.

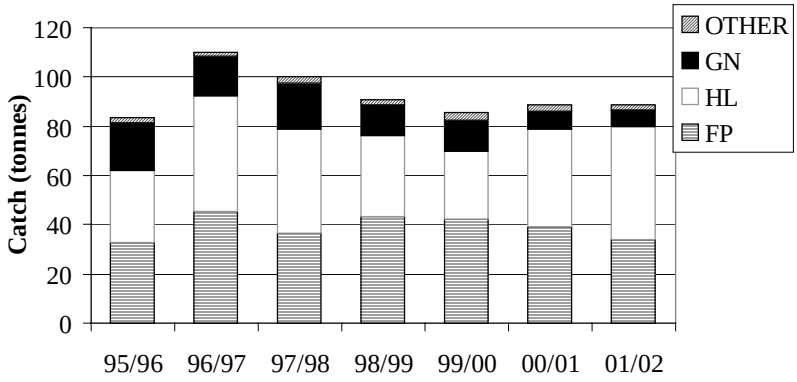


Fig. 6.1. Annual catch of wrasse by method. FP is fish trap; HL is handline; GN is graball.

Wrasse are taken commercially around the entire Tasmanian coastline, with the bulk of the catch taken from the east (defined as blocks 5H1, 5H3, 6G4, 6H1, 6H3, ES13, ES14, ES15, ES16) and southeast (blocks 7F3, 7F4, 7G1, 7G2, 7G3, 7H1) coasts (Fig 6.2). Moderate catches have also been taken from the north-east (including Flinders Island) (blocks 3F1, 3F2, 3G1, 3G2, 3G3, 3G4, 3H3, 4G2, 4G4, 4H1, 4H3) with relatively small catches from the northwest coast (blocks 4D2, 4D4, 4E1, 4E2, 4E3, 4E4, 5D2). Although annual catches have only fluctuated slightly since the mid-1990s, there have been marked regional changes in the distribution of catches (Fig. 6.2). Initially, catches from the southeast dominated but since 1996/97 have declined each year. By contrast over the past three years in particular the east coast fishery has expanded and in 2001/02 this region accounted for about 40% of the total catch. The past two years have also seen an increase in catches from the north east.

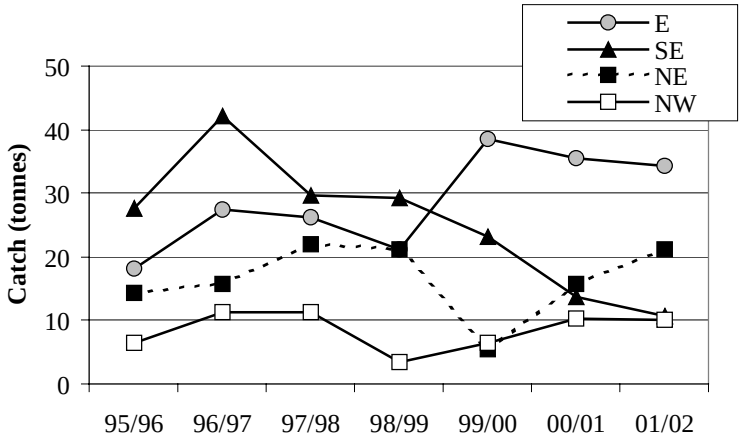


Fig 6.2 Annual catch of wrasse by fishing regions - E is east coast, SE is south-east coast, NE is north east coast, including Flinders Island and NW is north west coast (refer text).

6.4.2 Recent Developments

Projects examining aspects of the early life history and age and growth of purple wrasse on the south and east coasts of Tasmania are being finalised. Reporting of this research is nearly complete but was not available for this report. Further analyses will be conducted as part of a Fisheries Research and Development Corporation project that seeks to develop a more robust stock assessment for wrasse, including development of appropriate performance indicators. Interviews with key industry representatives are also being conducted to provide an industry perspective of resource status and to assist with hypothesis testing.

A major study of the fisheries biology of wrasse (principally blue-throat) in Victoria was completed (Smith *et al*. 2003) and relevant findings will be incorporated into the model development.

Results of the National Recreational Fishing Survey indicate that in 2000/01 the recreational catch of wrasse in the order of 13 tonnes.

6.4.3 2002 Assessment

The total catch of wrasse, combined across all gear types, has remained remarkably stable, at around 90 tonnes p.a. over the past four years (Table 2.1). This stability, however, masks the spatial dynamics of the fishery which have exhibited declining production in the southeast set against increased catches from the east coast and, in the most recent year, also the northeast (Fig. 6.2).

The current assessment is limited to examination of trends in fish trap and handline catch, effort and CPUE for the period 1995/96 to 2001/02 (Table 6.1). Fish trap catches and catch rates have remained relatively stable over the past seven years, although catch rates reached their highest level in the current (Table 6.1, Fig. 6.3). By contrast, handline catches have fluctuated with peaks in 1996/97 and 2001/02 and a trough in 1999/00. Despite such variability, catch rates have exhibited a gradual increase over time (Table 6.1, Fig. 6.4).

Purple and blue-throat wrasse account for the bulk of the catches reported as wrasse for fish trap and handline methods, respectively. In the absence of species level information, catch and catch rate trends for these two gear types have been assumed to be proxies for the

relevant species, thus overcoming some of the uncertainties caused by grouping the species together. General stability or even increasing catch rate trends for each of the major fishing methods implies 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 at which the fishery impacts on the fish populations, that is at the level of individual reefs. 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 indicate significant fishery impacts.

Table 6.1. Catch, effort and CPUE by key fishing methods for wrasse.
[+] For gear units refer to Table 2.3.

Method	*Year*	*Catch (tonnes)*	*Effort [+](gear units)*	*CPUE [+](kg/gear unit)*	*Effort (Days)*	*CPUE (kg/day)*
Fish trap	1995/96	32.7	8217	3.04	1137	15.7
	1996/97	45.6	10495	3.69	1555	16.9
	1997/98	36.4	9738	3.23	1625	13.7
	1998/99	43.5	10447	3.83	1328	19.3
	1999/00	42.1	11329	3.22	1455	20.0
	2000/01	39.4	9700	3.32	1344	20.2
	2001/02	34.0	5788	5.31	1008	24.3
Hand line	1995/96	29.2	7803	2.92	857	22.3
	1996/97	46.8	13346	3.03	1210	24.4
	1997/98	42.2	11236	2.84	1016	27.0
	1998/99	32.5	6850	3.58	620	31.7
	1999/00	28.1	6322	3.59	732	25.1
	2000/01	39.7	8495	3.37	997	24.2
	2001/02	45.7	9274	3.94	908	37.3

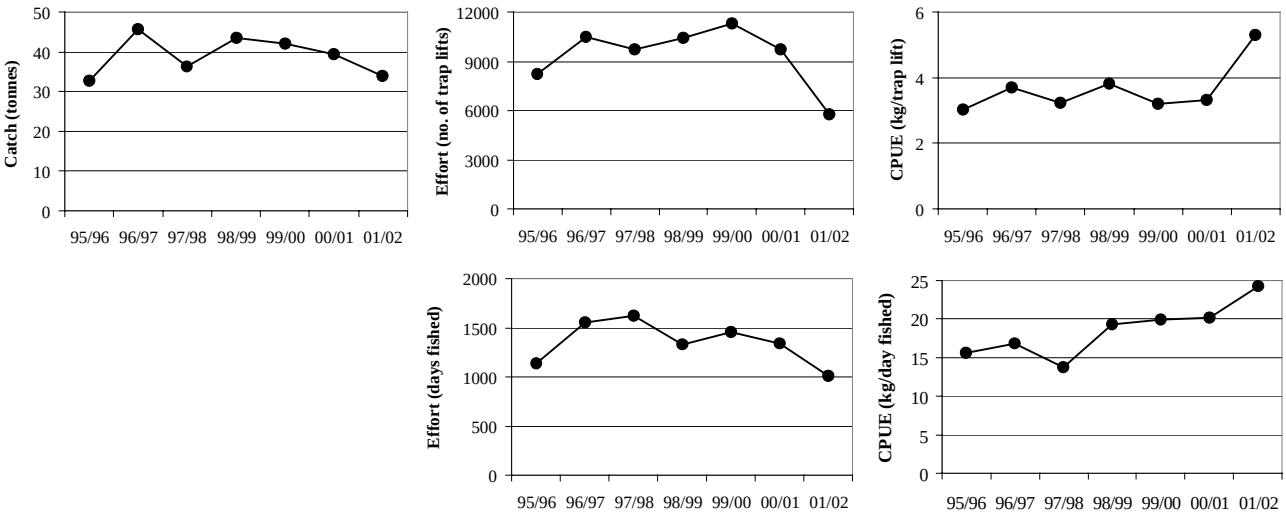


Fig. 6.3. Annual fish trap catch, effort (trap lifts and days fished) and CPUE (catch per unit effort) for wrasse.

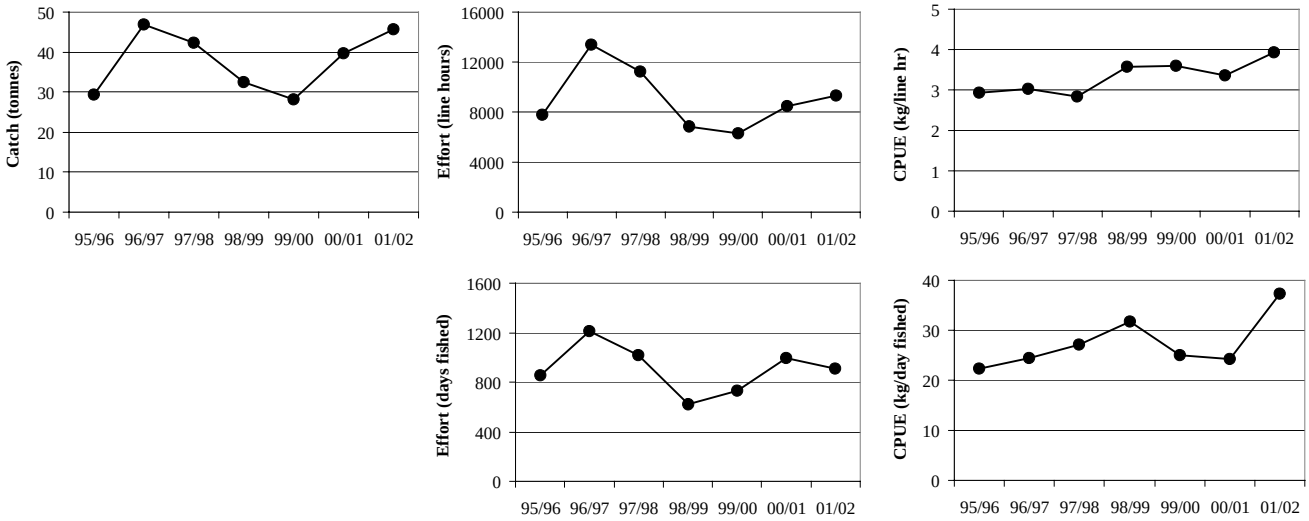


Fig 6.4. Annual handline catch, effort (line hours and days fished) and CPUE (catch per unit effort) for wrasse.

6.5 Evaluation of Trigger Points

Total catch

i. Total catch of a key target species is outside of the 1990/91 to 1997/98 range; or when,

ii. total catch of a key target species declines or increases in one year more than 30% from the previous year.

Total catch of wrasse for the period 1990/91 to 1997/98 ranged from 57 to 178 tonnes (Table 2.1). However, given the rapid increase in wrasse landings between 1990/91 and 1992/93 as the live fishery developed there is a case against using the full range to establish a meaningful catch history against which future catch levels can be compared. A further consideration is the suggestion that 1993/94 and 1994/95 catches were significantly overstated in the light of expectations that the fishery was about to become limited entry, with access based on catch history. Therefore, for the purpose of trigger point assessment, catches for the period 1995/96 to 1997/98 have been adopted as the reference period.

As the 2001/02 catch of 89 tonnes was within the reference range and virtually unchanged from 2000/01, no catch triggers were exceeded.

Fishing effort

Fishing effort for any gear type, or effort targeted towards a species or species group, increases by 10% from the highest of the 1995-97 levels.

Current effort levels for the primary methods, handline and trap, were within reference values and thus effort triggers were not exceeded.

Catch rates (CPUE)

In a given year, the CPUE of a key target species is less than 80% of the lowest value for the 1995-97 period.

Catch rates for handline and trap were slightly higher than the peak values for the reference years and therefore the CPUE trigger was not exceeded. However, these observations are based on the entire State and not at spatial scales appropriate to the life history of the species and may mask localised changes in catch rates.

Change in size composition

i. *A significant change in the size composition of commercial catches for key species; or when,*

ii. *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 formal examination of available size structure information was not available for this assessment.

6.6 Implications for Management

While input controls (limited entry) have capped participation in the live wrasse fishery, it is unknown whether current harvest levels are sustainable. Under present arrangements, there is potential for localised depletions, especially if effort becomes concentrated in particular regions. There is for example, already evidence for a concentrating of effort and catch off the east coast, especially blocks 6G4, 6H1 and 6H3.

The impact of the recent size limit changes on future catch rates and population structure warrant examination. There are concerns that blue throat males may not be adequately protected by the current minimum size limit. Males are derived from mature females after they have entered the fishery and this, coupled with the fact that they are strongly site attached, suggests that they are vulnerable to depletion. The situation is exacerbated by the observation that males are less abundant than females.

Wrasse are currently managed and reported in catch returns as a single group, rather than at the species level. This clearly has implications for stock assessment, producing uncertainty in the interpretation of fishery indicators. This is especially the case because purple and blue-throat wrasse have such different life history strategies. Management of these species would be improved if the species were reported separately in catch returns.

There is a need to assess accurately the levels of usage of wrasse as rock lobster bait and specifically to ensure that such usage is reported in the catch returns. As all holders of rock lobster licences have unrestricted access to wrasse for bait there is potential for this sector, along with the live fish fishers, to impact significantly on stocks.

6.7 Research Needs

The Scalefish Fishery Research Advisory Group has accorded stock assessment, impact of management arrangements and impacts of different fishing gear on wrasse populations as high research priorities.

Research into the recruitment rates of juveniles to reefs, total biomass estimates and the sustainability of current fishing levels need to be undertaken. There is also a need to refine population parameters for purple and blue-throat wrasse (including growth and mortality) and to conduct yield per recruit analysis to determine appropriate size limits.

Although revised size limits have only just taken effect, there is a need to assess the impacts of these changes on catch rates and to model the impacts of removing the maximum size limit on blue-throat wrasse stocks.

7 Southern calamary (*Sepioteuthis australis*)

7.1 Management Background

A dramatic rise in southern calamary catches, from historic levels of under 20 tonnes to almost 100 tonnes in 1998/99, 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. Similar closures were implemented in 2000 and 2001, while in 2002 closures were extended to include adjacent fishing grounds in Mercury Passage.

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, was introduced for recreational fishers.

7.2 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 is 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 (Pecl 2000) although growth is extremely variable. Maximum recorded ages of female and male southern calamary are 263 and 275 days respectively, with males appearing to live slightly longer on average than females. Males attain a greater size at age than females. The maximum recorded size of females and males are 2 kg and 398 mm dorsal mantle length (ML) and 3.6 kg and 538 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 growing faster (Pecl 2000).

On the east coast of Tasmania, males account for around 60% of the commercial catch. In summer and winter, the majority of males taken by the fishery are mature, with immature males very rarely caught. 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. In summer, females appear to have the potential to lay larger batches of eggs than do 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, macro-algae and also embedded directly into sand. 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 (Moltschaniwskyj *et al*. 2003).

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. A pilot tagging study suggests that once on the spawning grounds individuals are site-specific (Jackson and Pecl unpublished data). Movement prior to arrival on the spawning grounds is unknown.

7.3 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) triggers have been exceeded each year since 1998/99.

7.4 Current Assessment

7.4.1 The Fishery

Southern calamary are taken by a variety of methods including purse seine, beach seine, squid jig, spear and dip net, with squid jigs the primary method, accounting for around 66% (68 tonnes) of the catch in 2001/02 (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.

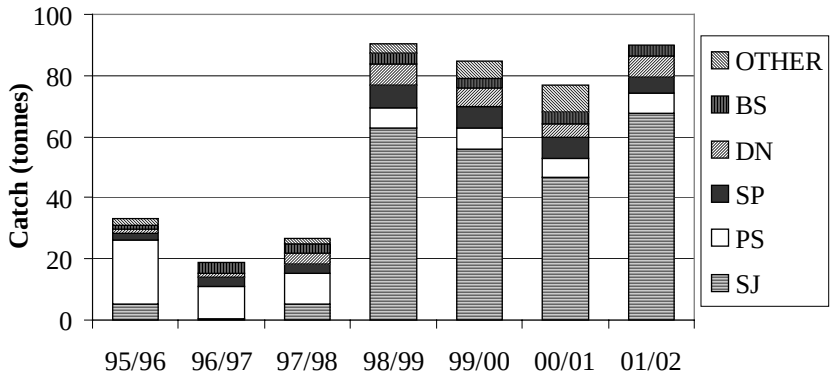


Fig. 7.1. Annual catch of southern calamary by method. SJ is squid jig; PS is purse seine; SP is spear; DN is dip net; BS is beach seine.

7.4.2 Recent Developments

A major study of calamary population dynamics and reproductive ecology has been recently completed, contributing significantly to our knowledge of the species (Moltschaniwskyj *et al*. 2003). Research is due to commence in 2003 examining movement dynamics of calamary, with particular reference to movement patterns onto and away from the main spawning grounds.

During the summer of 2001/02 many calamary fishers reported 'yellowing, stinky and rotting' squid in their catch from Great Oyster Bay and areas further south. A telephone survey of all major calamary fishers followed, with most fishers reporting that 10-30% of their catch (on average) from Great Oyster Bay had been affected and was unsaleable. Muscle and skin samples of the affected squid were found to have large quantities of small ciliated burrowing protozoans, probably resulting in secondary infections of mixed gram negative and filamentous gram-negative rods, mixed vibrio and flavobacteria, and necrosis of surrounding tissues (Les Gabor, Fish Health Unit, TAFI, unpub data). The last report of diseased squid was February 2002, however the effect of the disease on stock levels, or on catch and catch rate estimates over this time (i.e. some fishers reported catch of diseased squid and others did not) is unknown. While the cause of this phenomenon is unclear, the impact of this disease in shaping the population structure or characteristics of survivors for 2001/02 is uncertain.

7.4.3 2002 Assessment

Over the past four 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 over 75 tonnes p.a. (Table 2.1). This expansion has been almost exclusively due to increased squid jig effort (Table 7.1, Fig. 7.1). The most recent catch of 103 tonnes represents the highest on record and was about 34% higher than the 2000/01 catch.

This assessment is restricted to an examination of trends in catch, effort and catch rates for squid jig and purse seine methods. It should be noted, however, that as five or fewer vessels

were involved in the use of purse seines in some years, some catch data have not been reported.

State-wide, jig effort in 2001/02 was at the highest level on record, up by 25% based on jig hours and 15% on days fished compared to 2000/01 (Table 7.1). Jig catch rates increased slightly over 2000/01 levels but remained well below the 1998/99 peak. By contrast, purse seine catch rates continued to decline and were outside (below) reference values. The shift away from purse seine and towards the use of squid jigs suggests that the purse seine data may not be a very sensitive or useful performance indicator. Furthermore, it should be noted that in the context of the recent developments, the relevance of earlier catch, effort and catch rate indicators is questionable and greater emphasis should probably be placed on the implications of the more recent trends in these indicators.

Trends in catch, effort and CPUE have been examined in more detail for the three primary fishing regions, namely Great Oyster Bay (blocks 6H1, ES13 & ES14), Mercury Passage (6H3, 6G4 & ES16) and Tasman Peninsula (7G2). Collectively these regions accounted for almost 80% of the 2001/02 jig catch. Whereas the fishery was initially concentrated in Great Oyster Bay, there has been general increase in activity in Mercury Passage over the past three years, with similar levels of catch currently taken from the two regions (Fig.7.2). This shift can be attributed to increased fishing in Mercury Passage, at least partly in response to the short-term closures of Great Oyster Bay imposed each year since 1999. The general decline in catch rates for both areas was arrested in 2001/02, with a slight increase evident. The significance of this up turn is unknown but did occur at a time of record production and may reflect increased abundance or availability of the species in the most recent season. Although a minor component of the fishery, Tasmania Peninsula catches fell slightly in 2001/02, reflecting decreased effort (Fig. 7.2). Catch rates (kg per jig hour) for this region have fluctuated without obvious pattern since 1997/98 and, due to catch rate declines in the more productive regions, are now comparable to those for Great Oyster Bay and Mercury Passage.

The resource status of southern calamary and the sustainability of current catch levels are uncertain. Declining jig catch rates for the primary fishing regions is of concern and may indicate that the fishery has impacted significantly on stocks. The observation that calamary have a life span of generally less than one year, with no accumulation of recruitment across a number of years, 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.

Table 7.1. Catch, effort and CPUE by key fishing methods for southern calamary.
[+]For gear units refer to Table 2.3. * 5 or fewer vessels involved, data cannot be shown.

Method	*Year*	*Catch (tonnes)*	*Effort (gear units)*	*CPUE (kg/gear unit)*	*Effort (Days)*	*CPUE (kg/day)*
Squid jig	95/96	*	*	10.0	*	77.1
	96/97	0.3	127	2.6	18	16.7
	97/98	5.3	687	5.6	114	29.5
	98/99	62.9	6571	9.0	498	81.9
	99/00	55.9	7464	6.2	714	51.5
	00/01	46.7	8740	4.3	665	44.2
	01/02	67.8	10956	4.9	762	51.5
Purse seine	95/96	21.0	322	31.1	139	63.6
	96/97	*	*	28.6	*	51.7
	97/98	*	*	29.8	*	54.0
	98/99	*	*	27.0	8	37.8
	99/00	6.9	203	20.3	95	39.3
	00/01	*	*	18.9	*	33.2
	01/02	*	*	16.2	*	35.4

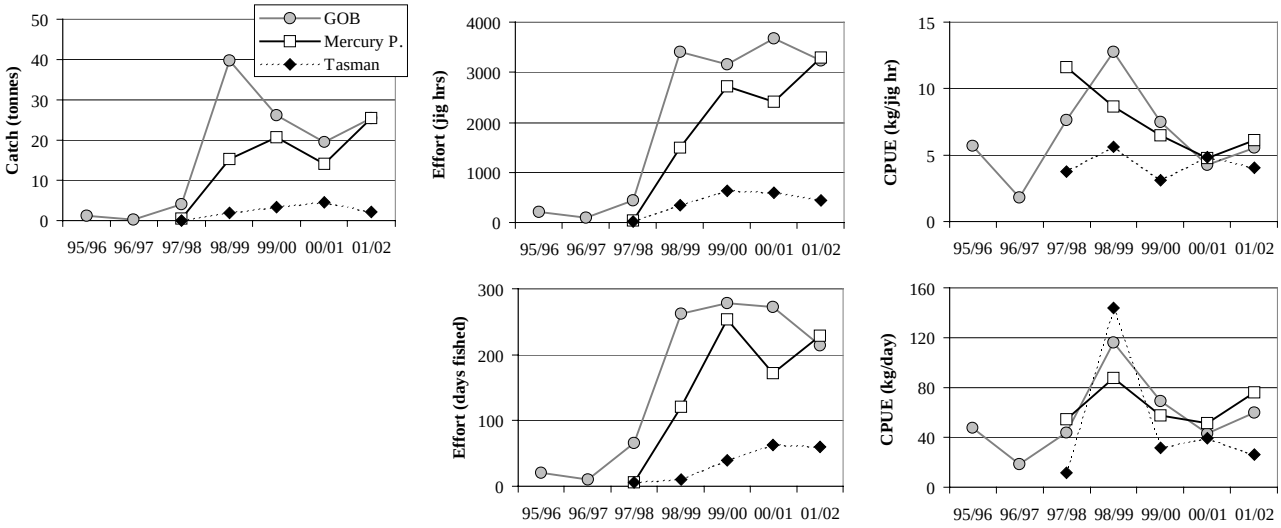


Fig. 7.2. Annual squid jig catch, effort (jig hours and days fished) and CPUE by major fishing region for southern calamary.

7.5 Evaluation of Trigger Points

Total catch

i. Total catch of a key target species is outside of the 1990 to 1997 range; or when,

ii. total catch of a key target species declines or increases in one year more than 30% from the previous year.

The 2001/02 catch of southern calamary is the highest recorded, representing a 34% increase over the pervious year, thereby exceeding both catch triggers. As noted above, however, the validity of using a performance indicator based on the 'under-developed' state of the fishery should be reviewed.

Fishing effort

Fishing effort for any gear type, or effort targeted towards a species or species group, increases by 10% from the highest of the 1995-97 levels.

Jig effort increased again in 2001/02, with about 15% more fisher days compared to 2000/01. Current jig effort is substantially higher than the reference period and therefore the effort trigger has been exceeded for the fourth year.

Catch rates (CPUE)

In a given year, the CPUE of a key target species is less than 80% of the lowest value for the 1995-97 period.

State-wide and regional CPUE values for jigs in 2001/02 were within the reference range, representing slight improvements over the previous year. Catch rate triggers were not therefore exceeded.

Catch rate analyses do not, however, take account of searching time, that is visual searching for evidence of spawning activity (egg masses on spawning beds) and/or time spent 'exploratory' fishing. Conversely, there is potential that increased fishing effort/fisher interactions on the fishing grounds will have a negative impact on individual catch rates through gear saturation effects. Southern calamary are a schooling species that aggregates to spawn, at which time they can be effectively targeted using jigs or purse seines. As a consequence, catch rates can be expected to remain relatively stable even with decreasing stock abundance. Therefore, declines in CPUE need to be examined carefully.

Change in size composition

i. significant change in the size composition of commercial catches for key species; or when,

ii. 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.

Commercial and research sampling indicates a considerable range of sizes, and possibly age structure of southern calamary in the commercial fishery. The significance of observed differences between sites and years has yet to be fully evaluated.

7.6 Implications for Management

All holders of scalefish fishing licences are entitled to use squid jigs and, given growing interest in this species, there is considerable potential for further expansion in effort. If effort in this fishery continues to rise then action may be required to restrict fishing mortality.

Currently there is limited information 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.

As a consequence of the short life span (less than one year), annual recruitment to the population is essential since there is no accumulation of recruitment across a number of years to stabilise the population against recruitment fluctuations. The growth and reproductive characteristics of 'micro-cohorts' differ substantially, depending upon the timing of hatching and subsequent environmental conditions. Environmental factors may therefore be as important as fishing mortality in driving the population dynamics and determining spatial patterns of abundance.

Subsequent analyses of catch and catch rate information (including additional data available to February 2003[5]) using surplus production modelling has suggested that harvest rates are very high (almost 80% in 2002/03) within the main area of the fishery (Great Oyster Bay and Mercury Passage), implying that the fishery has impacted significantly on stocks and that current catch levels are not sustainable (Moltschaniwskyj *et al*. 2003). There is considerable uncertainly associated with the model outputs but they do indicate that maintaining the status quo for the southern calamary fishery is a high-risk strategy and that catches in Great Oyster Bay and Mercury Passage do need to be reduced in some effective way.

7.7 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] The part year catch of calamary for 2002/03 was 93 tonnes.

8 Other key scalefish

8.1 Bastard trumpeter

Bastard trumpeter are widely distributed throughout southern Australia and also New Zealand. Little is known about their biology though, as for the related striped trumpeter, juveniles tend to be associated with shallow coastal reef habitats whereas adult fish appear to occur offshore on deep reefs (Murphy and Lyle 1999). There is evidence of marked recruitment variability in bastard trumpeter, with a particularly strong cohort spawned in 1993 (Murphy and Lyle 1999). However, there is no information available on the strength of subsequent year classes. The current minimum legal size limit of 35 cm is well below the size at maturity and the fishery takes few, if any, mature individuals.

Bastard trumpeter catches have declined steadily since the mid-1990s (Fig. 2.1) and the current catch of 23 tonnes is the lowest reported since 1987/88 (Lyle and Jordan 1999). The species has significance to recreational fishers, with an estimated 43 tonnes taken in 2000/01, almost double the size of the corresponding commercial catch. Industry representatives have expressed concerns about the scarcity of the species in recent years.

Bastard trumpeter are taken almost exclusively by graball (Fig. 8.1). Since 1995/96 there has been an underlying decline in catch and effort although catch rates have remained relatively stable (Table 8.1, Fig.8.2). Catch rates are probably a poor indicator of stock status in this instance, since bastard trumpeter are largely taken as a by-catch of gillnetting (Lyle 1998). Under such circumstances, total catch is probably a better indicator of abundance/availability.

As noted above, bastard trumpeter, like the related striped trumpeter, exhibit strong recruitment variability that can result in short-term variability in catches. The development of pre-recruit indices of abundance (in conjunction with striped trumpeter) may represent a feasible means of explaining (and even predicting) some of the variability in catches.

Assessment against performance indicators indicate that the current catch is below reference levels and therefore the catch trigger has been exceeded for the second year. Effort and catch rate triggers were not exceeded.

Table 8.1. Graball catch, effort and CPUE for bastard trumpeter.
[+]For gear units refer to Table 2.3.

Method	*Year*	*Catch (tonnes)*	*Effort [+](gear units)*	*CPUE [+](kg/gear unit)*	*Effort (Days)*	*CPUE (kg/day)*
Graball	1995/96	59.4	76986	0.87	2408	14.0
	1996/97	50.3	80101	0.74	2074	12.4
	1997/98	39.6	58508	0.69	1825	11.6
	1998/99	46.1	60421	0.78	1860	12.2
	1999/00	34.4	70934	0.67	1810	11.4
	2000/01	25.2	39674	0.86	1321	10.6
	2001/02	22.6	18834	1.19	1043	12.9

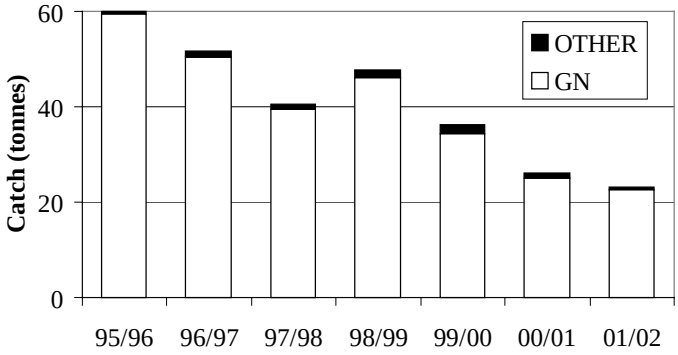


Fig. 8.1. Annual catch of bastard trumpeter by method. GN is graball net; OTHER all other methods.

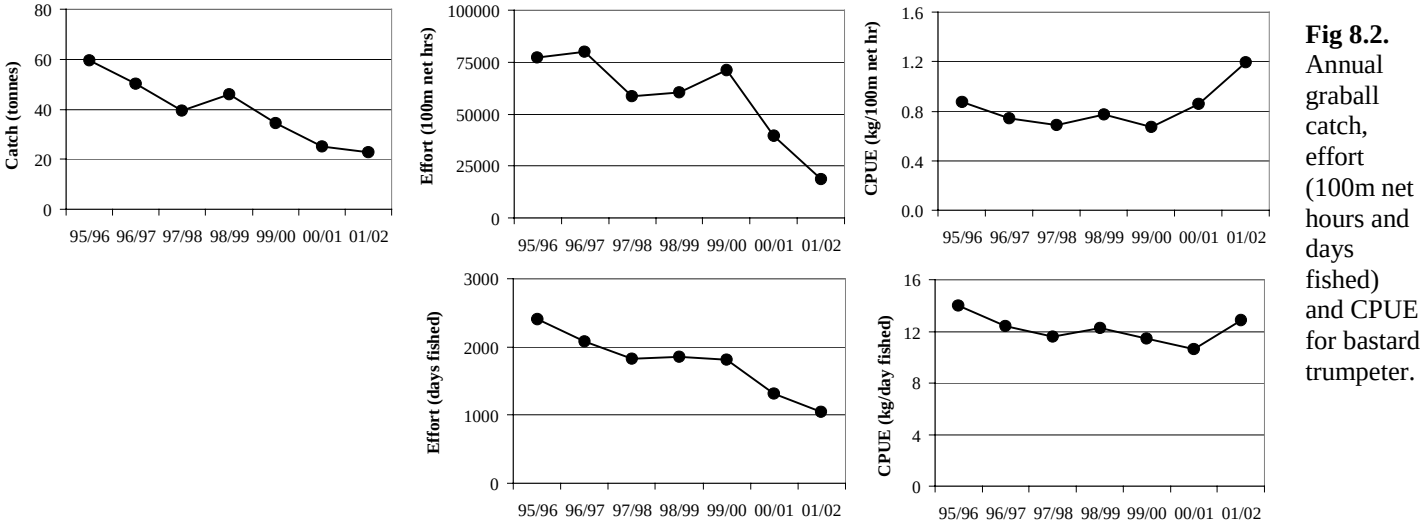


Fig 8.2. Annual graball catch, effort (100m net hours and days fished) and CPUE for bastard trumpeter.

8.2

Blue warehou

Blue warehou occur in the shelf and upper slope waters of south-eastern Australia and New Zealand. Recent studies have indicated that there are two stocks of blue warehou in Australian waters, one to the west of Bass Strait and one to the east. The fishery for blue warehou in Tasmanian State Fishing waters is centred off the south-east coast and thus probably targets the eastern stock. Catches are also taken off the north-east and north-west 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. In addition, the availability of blue warehou in coastal waters appears to be influenced by prevailing oceanographic conditions. These factors combine to produce marked inter-annual variability in abundance and hence catch from State waters, as demonstrated in Fig. 2.1. However, availability will also be influenced by overall stock size, this species being the subject of a larger trawl and gillnet fishery in Commonwealth waters. The blue warehou assessment, therefore, needs to be considered in the context of the overall fishery. Recent analyses of fishery dependent indicators for the Commonwealth South East Fishery and Tasmanian fisheries suggest that there has been a significant decline in blue warehou abundance in recent years (Smith and Wayte 2002).

Blue warehou are a Commonwealth managed species although 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.

Although the Tasmanian catch of 66 tonnes in 2001/02 was almost double that for 2000/01 it was still less than the minimum level for the reference period, triggering both catch performance indicators (Fig 2.1). The species is taken primarily gillnets, in particular graball nets but is also small mesh nets (off the north coast) and as a by-catch in shark nets (Fig. 8.3 and Table 8.2). Significantly, in 2001/02 about half the catch was taken by beach seine off the north-east coast (Fig. 8.3). In many respects this was unusual, with fishers reporting the presence of good 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, substantially lower than recreational catches taken in 1997 and 1998 (Lyle 2000) but consistent with the depressed state of the commercial fishery.

Since 1995/96, graball catches have fluctuated markedly, rising to a peak of almost 260 tonnes in 1998/99 and then falling to just 18 tonnes in 2001/02. 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.

Based on the targeting criteria, it is evident that blue warehou are primarily taken with targeted fishing effort and that there has been a dramatic fall in targeted (and overall) effort over the past two years (Fig 8.4). Consistent with reduced availability, graball catch rates have also declined since 1998/99, though were still within reference values in 2001/02.

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. Total allowable catches (TAC) for the Commonwealth fishery were reduced to just 600 tonnes in 2002 reflecting concern over stock status, down from over 2,000 tonnes in 1998. Significantly, the 2002 Commonwealth trawl and non-trawl catch of blue warehou was less that 320 tonnes, substantially lower than the allocated TAC.

Assessment of performance criteria indicate that the catch triggers have been exceeded, with current catch below reference values even though the 2001/02 catch was well over 30% greater than in 2000/01.

Table 8.2. Catch, effort and CPUE by key fishing methods for blue warehou.
[+]For gear units refer to Table 2.3.

Method	*Year*	*Catch (tonnes)*	*Effort [+](gear units)*	*CPUE [+](kg/gear unit)*	*Effort (Days)*	*CPUE (kg/day)*
Graball	1995/96	50.6	42045	0.77	786	25.9
	1996/97	111.9	86533	1.06	1340	32.5
	1997/98	176.3	118660	1.36	1801	42.0

	1998/99	257.2	98122	2.07	2126	53.5
	1999/00	176.1	94637	1.69	1768	47.8
	2000/01	29.5	18917	1.04	611	23.3
	2001/02	18.1	11864	1.27	486	22.0
Small mesh	1995/96	20.7	4093	1.97	140	49.7
	1996/97	9.3	3388	1.61	132	38.0
	1997/98	4.8	3668	0.75	100	22.8
	1998/99	8.9	3075	0.85	106	22.0
	1999/00	9.4	2740	1.33	85	36.7
	2000/01	4.8	3222	0.80	97	22.1
	2001/02	9.5	4163	1.34	106	42.7
Shark mesh	1995/96	8.7	40104	0.09	132	41.3
	1996/97	6.8	70373	0.05	196	20.4
	1997/98	3.1	73768	0.02	226	7.0
	1998/99	6.1	66864	0.03	239	8.1
	1999/00	1.3	28460	0.03	140	5.2
	2000/01	0.8	12725	0.04	112	4.1

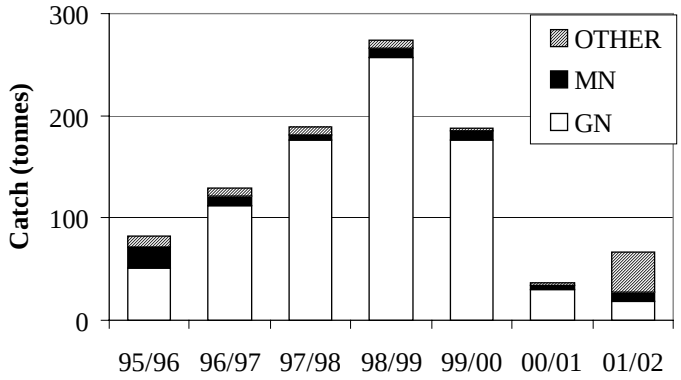


Fig. 8.3. Annual catch of blue warehou by method. GN is graball net; MN is small mesh net; OTHER all other methods.

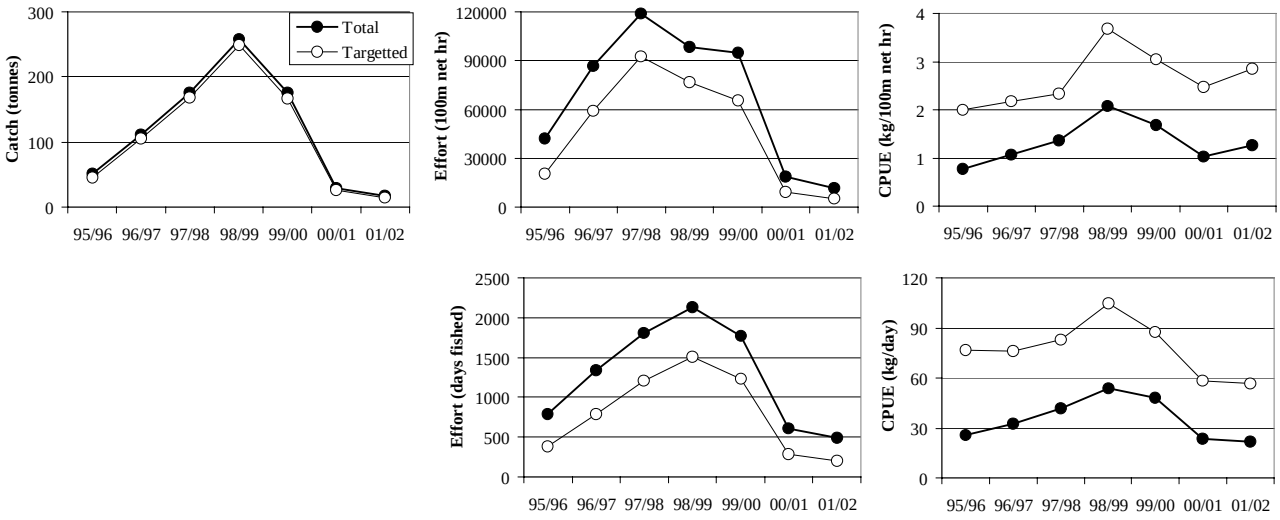


Fig 8.4. Annual graball catch, effort (100m net hours and days fished) and CPUE (catch per unit effort) for blue warehou. Targeted and total catch, effort and CPUE indicated.

8.3 Arrow squid

Arrow squid are found throughout the shelf waters of southern Australia, from Geraldton in Western Australia to latitude 27°S in southern Queensland and including Bass Strait and Tasmania. They are also common in New Zealand waters where they support a major fishery. Arrow squid are an oceanic squid but are commonly found schooling in shallow coastal and estuarine waters at certain times of the year. Catches of up to several thousand tonnes are taken by Commonwealth jig operators (mainly around eastern and western Victoria) and SEF trawlers (as a by-catch) each year.

There was a dramatic expansion in arrow squid catches in State Fishing Waters in 1999/00, with catches peaking at about 480 tonnes (Table 2.1). The increased catches were almost exclusively due to targeted squid jig effort, in particular the operation of automatic squid vessels (Fig. 8.5). Since then catches have fallen dramatically such that in the current year just 2 tonnes was caught, the lowest catch since 1989/90 (Lyle and Jordan 1999). The catch in 2001/02 was just 5% of that for 2000/01.

Marked inter-annual variability in availability of arrow squid in coastal waters is a feature of the species and thus poor catches are not necessarily indicative of stock status, as evidenced by large catches taken in the Commonwealth squid fishery even during periods of very low production in Tasmania.

Based on the performance criteria, both catch triggers were exceeded in 2001/02 but in contrast to previous years because catches were lower than reference values.

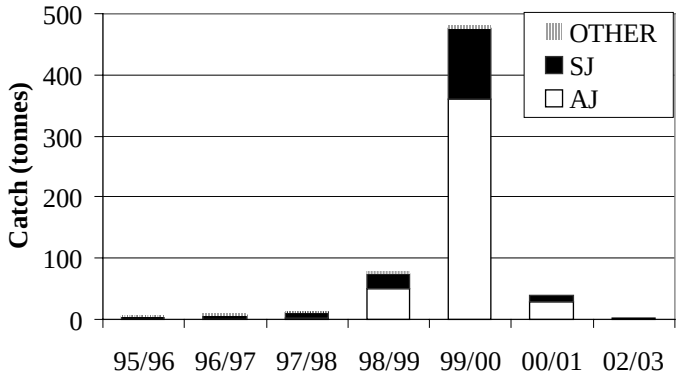


Fig. 8.5. Annual catch of arrow squid by method. AJ is automatic jig; SJ is squid jig; OTHER all other methods.

8.4 Other species

Catch, effort and CPUE for the main fishing methods for Australian salmon, flounder, flathead and jackass morwong are presented in Table 8.3. Reference should also be made to Table 2.1 and Fig. 2.1 for recent catch history.

8.4.1 Australian salmon

The total catch of Australian salmon in 2001/02 of 458 tonnes was just 5% lower than in the previous year and within reference levels (Fig. 2.1). Beach seine catch, effort and catch rates, summarised in Table 8.3, indicate that current effort levels are within or below reference values and that catch rates (either catch per shot or catch per day) are slightly lower than the minimum for the reference period. 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 even the geometric mean approach to calculating catch rates may provide biased estimates and, in any case catch rates are probably not a particularly sensitive indicator for a schooling species such as Australian salmon.

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

No triggers were exceeded.

8.4.2 Flathead

Flathead catches have remained relatively stable at between 50-60 tonnes since 1995/96, though the 2001/02 catch of 47 tonnes represented a 25% decline compared to the previous year (Table 2.1, Fig 2.1). Flathead are taken using a wide variety of methods, the most important being handline and Danish seine (Table 8.3). Since there are fewer than five Danish seine operators in the State catch data cannot be shown for this sector.

Flathead are the most commonly caught species by recreational fishers and in 2000/01 the estimated recreational harvest was about 360 tonnes, substantially higher than the commercial catch. However, there are two main species of flathead taken in inshore waters, the sand flathead and the tiger flathead. Limited commercial catch sampling has indicated

that the majority of the commercial catch (taken by Danish seine in recent years) is comprised of tiger flathead whereas sand flathead account for the vast majority (>90%) of the recreational catch. Similarly, Commonwealth trawl catches of flathead (recently in the order of about 3,000 tonnes in the SEF) are almost exclusively comprised tiger flathead. In this regard, the interactions between the two sectors in relation to flathead would appear to be low.

The most recent catch was just below the lower reference catch level though handline effort and catch rates are within reference levels. While Danish seine catch per shot was below the reference level, catch per day was within reference levels. There is little doubt that Danish seine catch rates will be influenced by the level of target fishing for flathead and as such analyses should distinguish targeted from non-targeted effort.

8.4.3 Flounder

Flounder catches have declined steadily since 1995/96 and are currently below the minimum reference level, at just 10 tonnes (Fig. 2.1) this represents the lowest catch since 1986/87 (Lyle and Jordan 1999). 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.

Industry members have commented that while there have been declines in flounder stocks, there has also been some changes in the markets for the species that have impacted on the amount of effort directed at flounder. Consistent with this observation, has been the general reduction in graball and spear effort, with spear catch rates (catch per hour) lower than reference values although daily catches have been maintained within reference values (Table 8.3). By contrast, graball catch rates were the highest since 1995/96, but since catches were very low the significance of this observation is uncertain.

The catch trigger was exceeded for the fourth year.

8.4.4 Jackass morwong

The performance indicator for catch was triggered for jackass morwong, with the 2001/02 catch of about 15 tonnes only slightly higher than the previous year but lower than the minimum for the reference period. Jackass morwong are taken by a variety of methods, the most important being graball net. It is apparent from Table 8.3 that the decline in graball catch was due to an overall reduction in effort, with catch rates comparable to reference years.

The recreational catch in 2000/01 was 45 tonnes, some three times larger that the commercial catch from State waters. However, as for blue warehou, jackass morwong are taken by trawl methods in Commonwealth waters, where catches are significantly greater than those from State waters (820 tonnes in 2001). Interestingly, trawl catch rates in 2001 were the lowest since 1990, though the resource implications for this decline remain poorly understood (Smith and Wayte 2002).

The catch trigger was exceeded for the fourth year.

Table 8.3 Catch, effort and CPUE by method for key species for the period 1995/96 to 2001/02.

[+] For gear units refer to Table 2.3; * 5 or fewer vessels involved, data cannot be shown.

Species	*Method*	*Year*	*Catch (tonnes)*	*Effort (gear units)* [+]	*CPUE (kg/gear unit)* [+]	*Effort (Days)*	*CPUE (kg/day)*
Australian salmon	Beach seine	1995/96	387.2	207	338.44	97	496.4
		1996/97	253.8	236	137.91	101	224.5
		1997/98	437.5	352	198.49	140	331.9
		1998/99	352.5	153	243.03	76	405.0
		1999/00	328.2	145	166.65	97	221.1
		2000/01	454.2	173	133.88	105	193.4
		2001/02	432.2	165	135.34	96	200.4
Flathead	Danish seine	1995/96	*	*	30.7	*	70.4
		1996/97	*	*	22.6	*	62.3
		1997/98	*	*	35.7	*	106.4
		1998/99	*	*	31.2	*	109.5
		1999/00	*	*	21.2	*	64.7
		2000/01	*	*	37.8	*	128.9
		2001/02	*	*	19.8	*	60.2
	Handline	1995/96	9.2	5884	1.37	449	12.3
		1996/97	9.7	5248	1.86	432	14.6
		1997/98	10.0	6402	1.90	388	17.9
		1998/99	7.9	4805	1.77	281	18.9
		1999/00	6.4	4583	1.58	262	17.4
		2000/01	5.3	2919	1.83	253	14.2
		2001/02	7.9	4546	1.82	385	14.8
Flounder	Graball	1995/96	18.7	72962	0.23	642	19.7
		1996/97	11.9	47595	0.25	460	18.3
		1997/98	13.9	34620	0.32	518	17.0
		1998/99	12.2	25051	0.35	527	13.0
		1999/00	5.8	14288	0.37	300	13.2
		2000/01	4.2	11769	0.22	232	8.5
		2001/02	5.2	8633	0.47	246	13.1
	Spear	1995/96	8.7	1195	6.30	306	20.7
		1996/97	15.3	1695	7.38	412	25.9
		1997/98	10.3	1437	5.98	396	18.7
		1998/99	8.5	1093	6.09	299	18.9
		1999/00	8.0	997	6.18	244	21.7
		2000/01	4.6	609	6.15	146	23.0
		2001/02	3.6	780	5.08	145	18.6
Jackass morwong	Graball	1995/96	17.6	13500	1.28	468	19.3
		1996/97	11.4	11758	1.38	368	13.7
		1997/98	14.6	23979	0.77	603	12.3
		1998/99	10.9	10678	1.01	431	13.1
		1999/00	9.2	7607	1.22	311	16.1
		2000/01	9.8	6158	1.45	359	15.0
		2001/02	11.3	5493	1.81	399	16.8

Acknowledgements

In addition to the contributions of SFAWG members, Graeme Ewing, Alan Jordan, Gretta Pecl, Natalie Moltschaniwskyj and Dirk Welsford provided valuable inputs into this report. Kate Hodgson undertook much of the data analyses and updated the catch and effort database. Malcolm Haddon extensively reviewed the report and provided many useful suggestions that have improved the document.

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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	*Pseudolabris* 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	*Cheliodactylus 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. As 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*[6].

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.

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

Commonwealth logbook data:

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

i) Area restrictions

Commonwealth logbook records were only included if the catch was taken in fishing blocks adjacent to Tasmania *and* the maximum depth of the fishing operation was less than 200 m. These conditions were applied to all records *except* where striped or bastard trumpeter were caught, these species being managed in all waters adjacent to Tasmania under Tasmanian jurisdiction. All records that included catches of these species were included for analysis.

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.

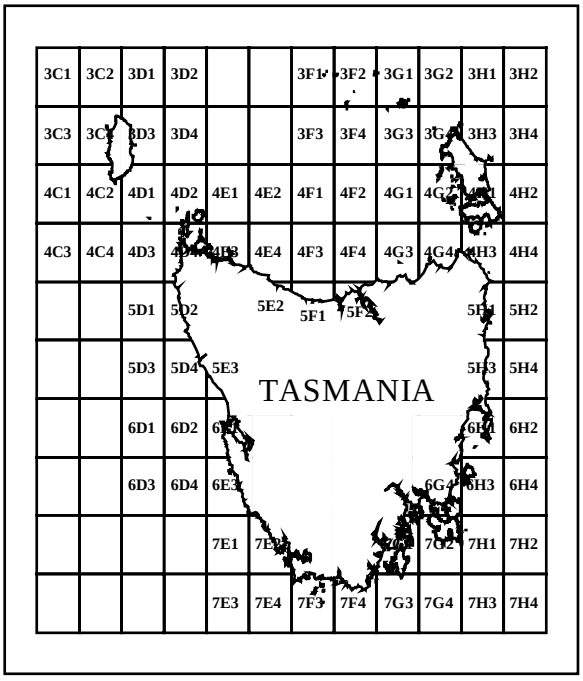

Fig. A1 Block numbers for fishing blocks used in calculation of catch figures.

ii) Duplicate records

A number of records in Commonwealth logbooks had matching records (fisher, date, gear type) in the Tasmanian logbook 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 where there was extra information in the Commonwealth record, e.g. catch of a Commonwealth species that was not recorded in the Tasmanian logbook.