FISHERY ASSESSMENT REPORT

TASMANIAN SCALEFISH FISHERY – 2001

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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 22 February 2002 to consider background documents and provide input into the assessments. The Working Group participants were:

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Scalefish Fishery Assessment - 2001

Summary

The Tasmanian commercial scalefish fishery is a multi-species fishery involving a wide variety of fishing methods. Many of the species are also important to the State's recreational fishery.

An important element of the Scalefish Management Plan, introduced in 1998, is the explicit identification of performance indicators. These indicators have two primary functions:

- to monitor performance of the management plan in relation to effort and catch levels, 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 – 2000/01 is presented, with more detailed analyses of catch and effort by method for the period 1995/96 – 2000/01. An important improvement in these analyses has been the inclusion of Commonwealth logbook data for dual endorsed operators fishing in Tasmanian waters and for Commonwealth catches of species managed under Tasmanian jurisdiction (i.e. striped and bastard trumpeter).

Catch and effort information are presently available for a six year period, the first three years being used as the reference period to define the trigger points. In this regard there are only three years of data available to assess fishery performance.

The most important developments in the fishery since the introduction of the management plan have been the expansion of dipnet, dropline and squid jig effort to historically high levels. However, by 2000/01 effort for each of these methods, with the exception of squid jigs, had fallen to within or below reference levels (Table 1). Dramatic increases in squid jig effort reflect increases in effort targeted at southern calamary and automatic jig effort targeted at arrow squid. These developments have resulted in the effort trigger being exceeded again in 2000/01. Notwithstanding the fact that effort triggers were not been exceeded for other methods, there are continuing concerns regarding the level of latent effort from licence-holders who are currently either not active in the fishery or are participating at low levels.

Table 1 Effort trigger point assessment by major fishing methods
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, southern calamary and arrow squid. In each case, the assessment involved an examination of catch, effort and catch rate trends. Descriptions of these fisheries, including fishing methods, seasonality and spatial distribution of catches have been provided in previous assessment reports and are updated here.

Striped trumpeter

Sharp falls the catch of striped trumpeter across all methods in 2000/01 resulted in catch triggers being exceeded.

The 2000/01 catch of striped trumpeter of 50 tonnes was equivalent to just 50% of that taken in the previous year and was the lowest recorded since 1990/91. Falls in catches were apparent across each of the three main fishing methods, dropline, handline and graball net, and generally reflected lower effort levels in 2000/01 compared to the previous year. The resource status is uncertain, however, reduced graball net catches (primarily juvenile fish) and reductions in offshore targeted (dropline and handline) and non-targeted catches (shark net) suggest that the biomass of new recruits and adults may have declined significantly in the current year. While fishing will have acted to reduce biomass, noting that commercial catches in the two previous years were historically very high, the species does exhibit strong recruitment variability which will produce inter-annual variability in fishable biomass. There is no evidence to support strong recruitment over the past few years.

The impact of recent management changes can not be discounted as a potential contributing factor to the down turn in catches, though the present trip limits do not appear to be limiting catches in any significant way.

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. Even without such an assessment the expectation is that this fishery is declining and will continue to do so without action.

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

The catch trigger was exceeded for banded morwong in 2000/01, with the catch rate trigger also exceeded for the St Helens region.

The fishery for banded morwong expanded in the early 1990's with the development of live fish markets for the species. However, the annual catch has declined steadily since 1994/95 and appears to have stabilised over the past two years at around 40 tonnes. Reductions in effort and catch rates contributed to this decline although in 2000/01 there was an improvement in catch rates for most regions to within reference levels.

The 2000/01 catch was below the minimum reference level but was slightly higher than in 1999/00, thus only one of the catch triggers was exceeded. State-wide, catch rates were within the reference range, however, on a regional basis St Helens catch rates were less than 80% of the lowest reference level and therefore exceeded the catch rate trigger.

Catch and catch rate indicators suggest that the fishery has impacted on banded morwong populations. The apparent minor 'recovery' in catch and catch rates in the most recent year should be interpreted with caution and should 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 recent 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.

Banded morwong are long-lived and productivity is expected to be very low. In addition, individuals demonstrate strong site attachment, suggesting that the species will be susceptible to localised over-fishing. Research and commercial catch sampling has indicated that there is size structuring within the population at small spatial scales (to the level of a particular reef), which suggests that assessment at fishing block and regional levels may be insensitive to more localised changes in abundance.

There is considerable uncertainty surrounding the banded morwong resource status and, given its life history characteristics, a precautionary approach to the management of the species is necessary. There is an urgent need to investigate fishery independent indicators of stock condition.

Sea garfish

No triggers were reached for sea garfish in 2000/01.

The 2000/01 sea garfish catch was slightly lower than in the previous year, due to minor falls in dipnet, beach seine and purse seine catch and effort levels. The total catch of 74 tonnes was, however, within the reference range. Dipnet catch rates were roughly equivalent to the lowest previous value (1995/96) whereas beach seine catch rates were the highest on record. Sea garfish are a schooling species and catch rates are considered to be neither reliable nor sensitive indicators of abundance trends.

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

Wrasse

No triggers were exceeded for wrasse in 2000/01.

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 three years, at around 90 tonnes p.a. In 2000/01 catch rates for handline, trap and graball methods were either within reference values or slightly higher.

Wrasse demonstrate strong site attachment and therefore, any assessment, even at the smallest reporting scale (block level) may mask more localised changes in abundance and should be treated with caution. 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. 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.

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

Southern calamary

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

The fishery for southern calamary expanded markedly in 1998/99 and, reflecting the development of this as a target fishery, catches since then have exceeded those for the reference period. The 2000/01 catch of 76 tonnes was slightly down on the previous year. Jig effort continued to escalate, up by 16% from the 1999/00 peak level and, although catch rates were within the reference values, they were about 30% lower than in the previous year. Declines in catch rates were evident in both of the major fishing regions, namely Great Oyster Bay and Mercury Passage.

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 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.

Arrow squid

Catch and effort triggers for arrow squid were exceeded for the third year.

The 2000/01 catch of about 40 tonnes represented less than 10% of that for the previous year despite automatic jig effort equivalent to about one third of the 1999/00 peak level. Arrow squid occur seasonally in coastal waters and availability is highly variable between years, as evidenced from catches in the past two seasons.

The resource status of arrow squid is unknown and the sustainability of current catch levels is uncertain. The relationships between arrow squid populations from southeastern Tasmania and those exploited in the Commonwealth fishery in Bass Strait are not known. However, given the existence of squid fisheries in waters adjacent to Tasmania it would also be prudent to consider management of the Tasmanian fishery in the context of the wider fishery off southern Australia.

Other key species

Catch, effort and catch rates were also examined for blue warehou, Australian salmon, bastard trumpeter, flounder and jackass morwong. The 2000/01 catches of all of these species, except for Australian salmon, fell compared with 1999/00. In each case, catches were outside (below) the appropriate reference ranges, indicating that catch triggers were exceeded. In addition, the rate of fall exceeded 30% for blue warehou. By contrast, the Australian salmon catch was almost one third higher in 2000/01 but was still within reference catch range. Effort and catch rate triggers for Australian salmon, blue warehou and jackass morwong were not exceeded. The catch rate (daily catch) trigger for flounder was exceeded for gillnet but was within the reference range for spear collection.

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 –2000/01.
Y triggered; N not triggered; arrows indicate direction of change; $^{\phi}$ applies to particular regions only, # 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 ↓	Y ↓	N	N
Banded morwong*	Y ↓	N	N	Y^{ϕ}
Sea garfish	N	N	N	N
Wrasse**	N	N	N	N
Southern calamary	Y ↑	N	Y	N
Arrow squid	Y ↑	Y ↓	Y	N
Australian salmon	N	Y ↑	N	N
Bastard trumpeter	Y ↓	N	N	N
Blue warehou	Y ↓	Y ↓	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 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

The performance of the Scalefish Fishery Management Plan, in meeting the objectives of maintaining biomass and recruitment, will be measured through a combination of performance indicators relating to the sustainability of the key target species, and the fisheries dependent on these species.

Performance indicators (or trigger points) will be assessed relative to the years 1990 to 1997, and/or the first two years of the management plan where such time series data do not exist. Analysis of fishery performance under this (initial) strategy will be examined and measured variously by the use of:

- trends in effort in the fishery;
- variations in the total catch of a species from year to year, or between seasons, regions and sectors;
- trends in catch per unit effort (CPUE) for a species;
- significant changes in biological characteristics of a fish species or population, such as a change in size or age structure; and

- other indicators of fish stock stress - e.g. disease or pollution effects.

It is recognised, however, that not all performance indicators are suitable for all species or fishing methods.

1.4 Trigger Points

Trigger points are levels of, or rates of change in, the 'performance' of the scalefish fishery 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.

A trigger point will be 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.

Historically, Australian salmon and barracouta dominated the Tasmanian scalefish catch, with a wide variety of other species also taken but in smaller quantities. With changing market preferences and availability, landings of barracouta declined during the mid-1970's and currently only small quantities are marketed for human consumption. Australian salmon continue to be an important commercial and recreational species in Tasmania, the bulk of the commercial catch being used as rock lobster bait (Lyle and Jordan 1999).

During the late 1980's a fishery for blue warehou developed off southern Australia. At the time gillnetters and trawlers operating in Commonwealth waters accounted for the bulk of the catch, while the inshore Tasmanian catch represented only a minor component of the fishery. Blue warehou have continued to be an important inshore commercial and recreational target species in Tasmania and, with falling catches from the Commonwealth sector, Tasmanian catches have represented a significant portion of the total fishery production in recent years. Although now managed as a quota species in the South East Fishery (SEF), State catches of blue warehou are subject to a memorandum of understanding with the Commonwealth and are managed under status quo arrangements, that is catches are to remain within historic levels. Formal assessments of blue warehou, incorporating data from the Tasmanian fishery, are undertaken as part of the South East Fishery Assessment Group (SEFAG) process.

Blue eye trevalla have traditionally been an important offshore species to Tasmania. In 1997, an Offshore Constitutional Settlement (OCS) agreement gave the Commonwealth management responsibility for the species, along with blue grenadier, gemfish, hapuka and others. Assessment of these and a number of other demersal trawl species, including flathead, jackass morwong and ocean perch, is undertaken by SEFAG.

The development of markets for live fish in the early 1990's saw a rapid expansion of banded morwong and wrasse landings, species that previously had little commercial value. More recently, catches of southern calamary and arrow squid have also risen sharply due to increased market opportunities and/or availability.

Shark, particularly school shark and gummy shark, have also been an important component of the Tasmanian fishery in terms of both volume and value. In December 2000, OCS arrangements between Tasmania and the Commonwealth saw management responsibility for the major shark species passed over to the Commonwealth. In January 2001 individual transferable quotas were introduced for school and gummy shark. The Southern Shark Fishery Assessment Group (SSFAG) is responsible for shark stock assessments and, therefore, sharks are not considered further in this report.

Scalefish also represent the mainstay of the recreational fishery, with many of the same species targeted by both recreational and commercial fishers. Line fishing is the primary fishing method employed by recreational fishers but the recreational use of gillnets and beach seines is also permitted. Flathead, Australian salmon and barracouta are the main line caught species, with blue warehou, bastard trumpeter, flounder and mullet comprising the bulk of the gillnet catch (Lyle 2000).

This report represents the fourth in a series of annual assessments of the scalefish fishery and incorporates catch and effort information available up to and including June 2001. Copies of previous assessment reports (Lyle and Jordan 1999, Jordan and Lyle 2000, Lyle and Hodgson 2001) 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 provided monthly summaries of catches (landings) but were often incomplete or very limited in terms of providing any effort and fishing method information. Lennon (1998) discussed limitations of these catch returns in some detail and, in summary, noted that they provide only basic information about production levels but are of little value for effort and catch rate analyses.

In early 1995, a new General Fishing Return was introduced, replacing the monthly return, with catch and effort information reported on a daily basis for each fishing method used. The revised returns provide greater detail about fishing operations, including more explicit specification of the fishing method, greater spatial resolution (½ degree rather than 1 degree blocks), details about effort and depths fished, and the form of the harvested product. Recent amendments (1999) to the catch return have included the provision for fishers to nominate target species and indicate whether there had been any 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 operators do not explicitly indicate whether fishing occurred in State or Commonwealth waters it has been necessary to incorporate all activity reported in coastal fishing blocks. For details of data restrictions and manipulations involving Commonwealth data refer to Appendix 2.

In 1996 Tasmania assumed management responsibility for striped and bastard trumpeter through OCS arrangements with the Commonwealth and therefore all catch and effort data relevant to these species, including catches from Commonwealth waters, have been incorporated in 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 2001. All catch returns available as at October 2001 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 July to 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) tending to be concentrated between late spring and early autumn. In addition, it better reflects 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, dropline and longline effort 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. 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:

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

In the 2001 Scalefish stock assessment report, geometric means have been used for calculating catch rates (CPUE). This is because CPUE data are typically log-normally distributed and the arithmetic mean does not accurately describe the data. 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

A national survey of recreational fishing was undertaken in 2000/01 and will provide catch and effort information for the recreational sector at national, state and regional levels. Survey results were unavailable at the time of writing but will be incorporated in future assessments.

A previous state-wide survey of fishing activity by licensed recreational fishers, conducted between December 1996 - April 1998, represents the only reliable information about recreational effort and catches in Tasmania (Lyle, 2000).

2.3 Recent catch trends

Annual commercial catches by species since 1990/91 are presented in Table 2.1. Overall, scalefish catches have declined from over 2000 tonnes in the early 1990s to between 1000 – 1500 tonnes in recent years (Fig 2.1). The 2000/01 catch of 1042 tonnes represented a decline of about 13% when compared with the previous year and is the lowest catch reported since 1984/85 (refer to Appendix 2.3 in Lyle and Jordan, 1999). Marked falls in blue warehou and striped trumpeter catches, along with decreases for most other species, with the notable exception of Australian salmon, contributed significantly to the overall fall in scalefish production.

The sharp rise in the cephalopod catch in 1999/00, to over 600 tonnes, was the result of increased arrow squid catches combined with relatively high catches of calamary and octopus. A marked drop in arrow squid catches in 2000/01 resulted in an overall decline in cephalopod catches to about 180 tonnes.

Catch trends for the major species are summarised in Fig. 2.1. 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 2000/01 catch of 483 tonnes represented an increase of just over 30% compared with 1999/00 but 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.

Barracouta catches declined sharply from around 350 tonnes in the early 1990s to around 60 tonnes by 1993/94. Since then landings have remained at low levels, reflecting, in part at least, low market demand coupled with reduced availability. The most recent catch of just 15 tonnes is slightly less than the lower reference catch level.

Catches of flounder have tended typically to range between 30 – 40 tonnes but over the past two years landings have fallen below 20 tonnes, with just 10 tonnes reported in 2000/01. It is unclear as to whether this is a reflection of reduced abundance or changed market demand but recent catches remain below reference catch levels.

The catch history for bastard trumpeter has been characterised by relatively minor fluctuations between years, with catches in the range of 35 – 65 tonnes p.a. The 2000/01 catch of 26 tonnes, however, represented almost a 30% reduction compared with the previous year, to the lowest level since 1990/91. Striped trumpeter production generally increased from the early 1990's, from around 50 tonnes to over 100 tonnes, but fell sharply in 2000/01 to about 50 tonnes. The reasons for recent declines in catches of both trumpeter species are unclear, but may be linked to reduced availability since markets, especially for striped trumpeter, are well established.

Flathead and jackass morwong catches both 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 between 50-60 tonnes, while jackass morwong catches have declined steadily since 1997/98, from 34 tonnes to just 12 tonnes in 2000/01.

Apart from the mid-1990's, sea garfish production has remained relatively stable at between 80 – 100 tonnes p.a.

The development of live fish markets for banded morwong and wrasse during the early 1990's resulted in marked increases in landings of both species. Subsequent to 1995/96, wrasse catches stabilised at around 85 - 100 tonnes p.a. whereas banded morwong catches have declined steadily, from almost 90 tonnes in 1995/96 to under 40 tonnes in 2000/01.

Since the early 1990's, blue warehou catches have fluctuated widely, between around 100 – 300 tonnes. The most recent catch of 40 tonnes represented a decline of almost 80% compared to the previous year and was well below the minimum reference catch level. This species is also harvested in the Commonwealth managed South East Fishery (SEF) by both trawl and gillnet methods.

After increasing sharply in 1999/00 to 480 tonnes, arrow squid catches fell by about 90% to just 40 tonnes in 2000/01. Although the most recent calamary catch was slightly down on 1999/00, at 76 tonnes, it was still substantially higher than levels during the reference period.

Table 2.1 Annual 'Tasmanian' scalefish and cephalopod production (whole weight) by species for the period 1990/91 to 2000/01.
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*
Scalefish											
Australian salmon	815.9	651.9	867.0	878.8	682.1	412.7	287.3	476.0	384.7	363.7	483.1
Barracouta	351.5	268.3	205.4	59.6	25.2	19.9	53.8	65.2	27.6	23.8	15.1
Boarfish	7.2	9.4	7.6	10.1	9.1	7.3	10.4	9.4	7.0	7.3	7.9
Bream	5.7	3.5	1.4	7.4	7.2	2.5	9.9	1.0	0	0.1	0.2
Cod	10.0	11.3	11.6	14.5	12.7	22.4	15.3	10.2	9.8	9.0	3.9
Dory	2.8	1.3	6.0	1.1	1.0	0.4	1.0	1.3	0.2	0.2	0.2
Eel	0.2	0.5	0.9	2.2	3.1	2.1	1.4	1.7	2.0	1.2	0.8
Flathead	165.3	118.1	98.8	121.4	91.1	57.8	51.8	62.9	50.6	60.3	62.9
Flounder	44.0	36.8	31.8	27.3	27.1	33.3	29.3	26.7	22.8	15.4	10.4
Garfish	80.9	80.1	82.3	82.9	69.3	56.0	91.6	83.0	101.7	91.2	73.8
Gurnard	20.5	19.0	19.3	19.3	14.0	14.2	12.4	9.9	7.1	9.9	7.7
Latchet	13.9	10.0	6.5	12.4	11.9	6.1	3.3	1.9	1.1	2.3	1.5
Leatherjacket	12.2	14.0	13.1	23.3	27.7	14.5	12.6	13.3	12.9	16.5	16.2
Ling	5.1	13.6	30.0	41.6	33.2	21.7	23.8	11.8	5.0	2.2	5.1
Mackerel, blue	3.0	2.1	0.3	8.5	5.7	2.0	1.3	1.0	0.5	2.1	0.1
Mackerel, jack	6.1	11.1	32.8	48.4	39.7	26.2	19.3	19.7	59.8	13.7	8.6
Marblefish	0.2	0.9	0.3	1.0	1.8	3.5	5.6	3.0	2.6	4.2	3.9
Morwong, banded	7.0	6.9	39.2	145.5	105.8	86.7	79.0	72.6	43.1	34.1	38.0
Morwong, jackass	136.9	111.9	83.2	117.6	63.1	27.2	19.2	34.1	18.2	16.3	11.9
Morwong, other	3.8	5.6	5.2	13.9	8.1	5.4	7.5	7.5	6.3	1.5	2.6
Mullet	31.2	22.2	26.2	19.5	23.8	10.4	11.2	16.0	14.5	20.9	13.1
Pike, long-finned	0.1	0	0.1	0.3	0.2	0.3	3.1	3.9	9.5	10.0	6.4
Pike, short-finned	10.4	9.5	11.0	12.4	18.6	13.7	15.2	17.7	3.2	5.3	6.5
Pilchard/anchovy	0.1	0	3.8	14.6	12.1	6.2	4.3	15.4	2.8	1.7	3.2
Stargazer	10.7	3.0	1.2	4.3	1.5	0.2	0	0.3	0.1	0.2	0.1
Trevally, silver	15.0	12.2	2.5	5.9	15.5	5.9	4.6	7.8	8.0	3.2	1.5
Trevally, unspec.	5.6	1.4	9.5	2.4	6.1	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	25.9
Trumpeter, striped	74.5	58.2	52.7	56.5	72.4	60.3	80.4	81.1	107.4	100.8	48.8
Trumpeter, unspec.	0.7	0	0	0.4	0.1	0.2	0.1	0.6	3.5	0.1	0
Warehou, blue	257.6	317.6	187.7	250.1	205.4	82.2	128.9	189.5	274.3	185.0	39.7
Warehou, spotted	0.7	0.4	4.2	8.8	3.4	14.6	15.6	4.8	0	0	0
Whiting	124.2	152.3	84.3	97.9	81.4	25.3	39.3	48.1	30.4	31.3	42.5
Wrasse	57.2	71.7	97.3	142.4	178.0	83.4	110.1	100.0	90.7	85.2	86.3
Other	106.8	92.1	77.6	60.0	25.2	21.1	23.8	21.2	19.4	10.8	8.7
Total Scalefish	**2450.3**	**2154.1**	**2134.8**	**2367.1**	**1933.4**	**1206.0**	**1224.3**	**1459.3**	**1374.5**	**1165.8**	**1036.8**
Cephalopod											
Calamary	8.2	7.5	5.8	9.7	12.6	33.0	19.0	26.6	90.6	84.6	76.0
Cuttlefish	0.5	0.7	0	1.1	0.8	0.2	0.3	0.2	0	0	0
Octopus	32.2	35.2	47.4	58.2	55.3	76.9	40.8	43.4	85.5	61.5	62.0
Squid, arrow	35.1	7.2	7.0	7.7	8.6	5.7	7.8	12.9	79.7	480.5	39.6
Total cephalopod	**76.0**	**50.6**	**60.2**	**76.7**	**77.3**	**115.8**	**67.9**	**83.0**	**255.8**	**626.7**	**177.6**

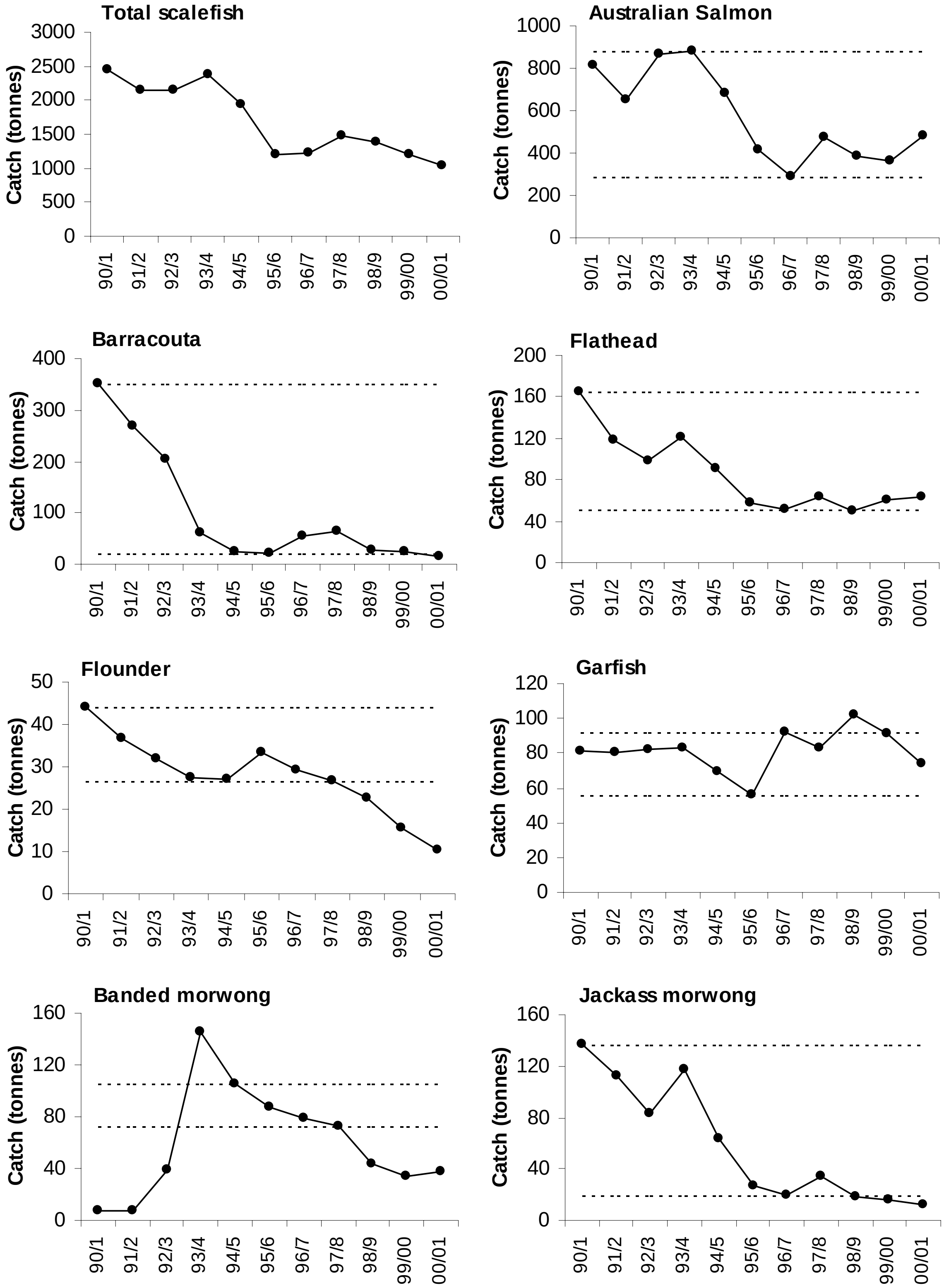


Fig. 2.1 Annual catches for key scalefish species 1990/91 to 2000/01. Dotted lines indicate upper and lower catch levels for the catch reference period (1990/91-1997/98 for all species except banded morwong [1994/95-1997/98] and wrasse [1995/96-1997/98]).

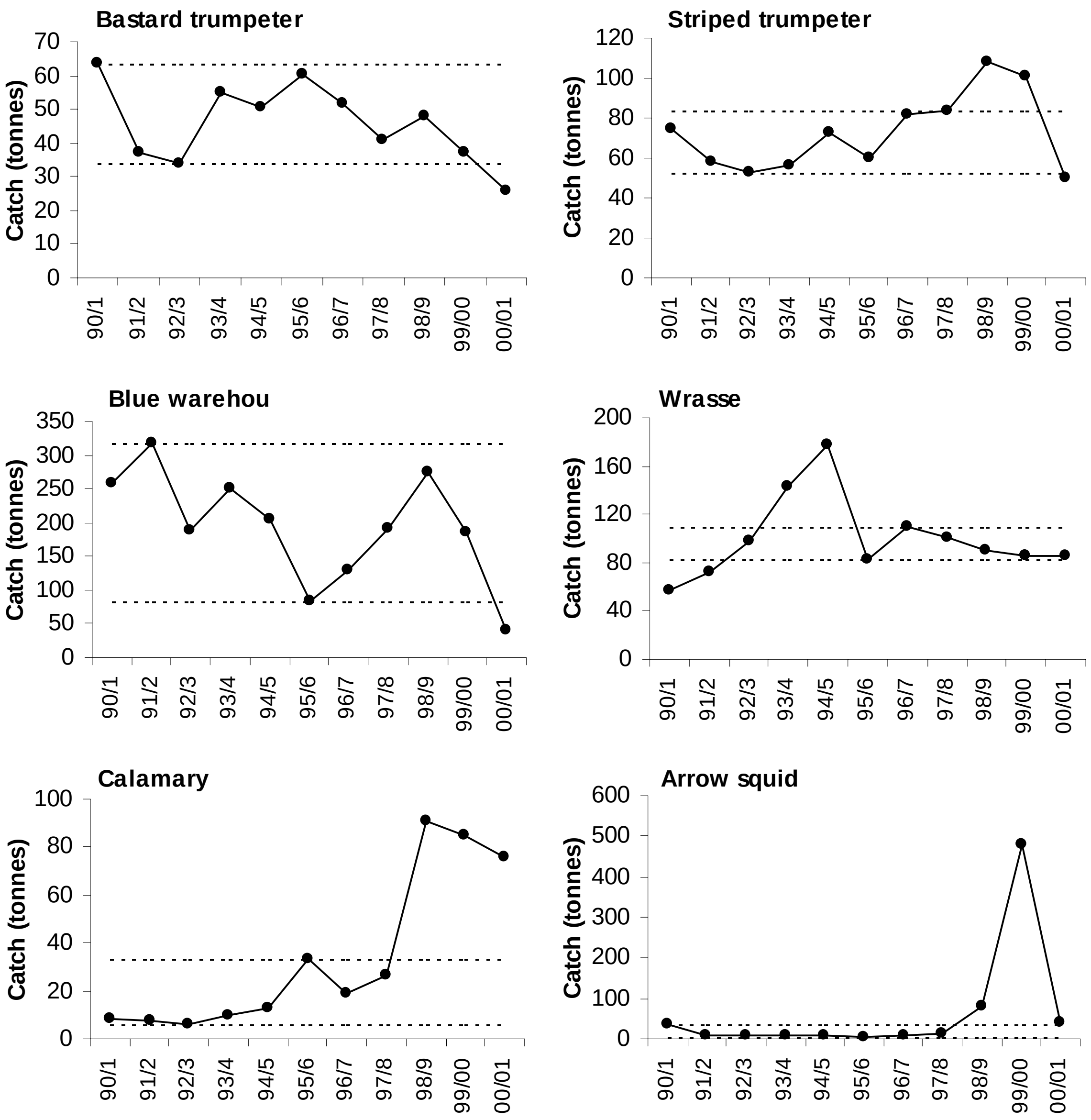


Fig. 2.1 Continued.

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 an array of fishing gears are represented it has been necessary to express effort in units appropriate to the 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 recently become apparent that some fishers may 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 the 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 2000/01 for most gear types were within range (small mesh net, dropline, fish trap and dip net methods) or lower (beach seine, purse seine, graball, handline and spear methods) (Table 2.2). The only exception was squid jig effort, which was higher than reference values. Compared to 1999/00, effort in the most recent year was lower for all gear types apart from beach seine (number of shots had increased despite fewer days fished), dropline (number of hook lifts had increased but days fished declined), handline (line hours declined but days fished increased) and small mesh nets (both net hours and days fished were higher).

Since 1995/96, trends in effort for the key 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 dipnet effort increased sharply. While a range of factors, including availability of target species and market developments have had an influence, there is little doubt that there was also a direct impact of the management change. 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 and increase in effort towards less regulated[1] methods (hooks, jigs and dipnets).

Considering effort by gear type alone, however, can mask important dynamics within the fishery itself, such as shifts in species targeting. This is particularly pertinent where individual species may be targeted using a variety of gear types and a given gear type can be used to target different species (Fig. 2.2).

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 decline in garfish effort over the past four years. The general decline in purse seine effort has been driven largely by a decline in effort directed at calamary and is set against only minor variation in garfish effort in recent years.

Lyle (1998) concluded that there are effectively three main components to the graball fishery, comprising targeted fishing for blue warehou, banded morwong and flounder, with a range of species commonly taken as by-catch of these sub-fisheries. When effort is analysed based on the occurrence of these 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 drop off over the past two years. Effort directed at banded morwong and flounder has declined steadily since 1995/96.

The two main handline fisheries, for striped trumpeter and for wrasse, indicate different trends. There was only a minor increase in the handline effort for striped trumpeter up until

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

the fall in the most recent year and this contrasts with wrasse where effort peaked initially in 1996/97, fell to 1998/99 but has since climbed steadily.

A general decline in spear effort can be attributed to the decline in flounder spearing. Interestingly, there has been a general increase in spear effort for calamary over the same period.

A significant expansion in jig effort (particularly evident in days fished) commenced in 1998/99 and was initially directed at calamary but in 1999/00 there was also a dramatic increase in effort targeted at arrow squid, including the activity of automatic jig vessels (not represented in Fig 2.2). Although effort had declined for both species by 2000/01, it still remained well above 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. dipnets for garfish, droplines for striped trumpeter and fish traps for wrasse. Species based effort is also considered in more detail in Chapters 3-9.

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. An outcome of the 2001 management plan review has been the initiation of an independent examination of the scalefish fishery to examine options that could reduce the levels of latent effort in the fishery.

Table 2.2 Total annual catch and effort by major fishing methods for the period 1995/96-2000/01.
Gear units of effort are defined in Table 2.3. ## does not include automatic jigs * Five or fewer vessels involved, data not shown.

				Effort	
	Method	*Year*	*Catch (tonnes)*	*Gear units#*	*Days fished*
Seine	Beach seine	1995/96	467.3	1024	524
		1996/97	364.1	1351	681
		1997/98	520.7	1184	573
		1998/99	440.4	869	397
		1999/00	422.8	867	428
		2000/01	526.0	891	384
	Purse seine	1995/96	35.2	418	185
		1996/97	30.4	337	153
		1997/98	41.8	319	154
		1998/99	73.0	228	142
		1999/00	33.7	248	123
		2000/01	17.5	188	85
Gillnet	Graball	1995/96	347.9	223679	5439
		1996/97	378.7	231305	5182
		1997/98	446.3	232088	5249
		1998/99	494.9	167664	4706
		1999/00	357.5	161289	4170
		2000/01	169.8	87382	3079
	Small mesh net	1995/96	38.7	11019	286
		1996/97	27.0	7964	260
		1997/98	21.8	7875	246
		1998/99	31.0	7767	272
		1999/00	22.4	6309	202
		2000/01	20.3	8267	240
Hook	Dropline	1995/96	19.9	438	158
	(< 200 m)	1996/97	30.0	433	203
		1997/98	24.7	540	222
		1998/99	31.8	669	309
		1999/00	30.5	416	288
		2000/01	15.3	508	236
	Handline	1995/96	76.0	17188	1627
		1996/97	94.5	21583	1895
		1997/98	97.7	21131	1703
		1998/99	87.9	17884	1271
		1999/00	90.9	16957	1464
		2000/01	81.0	14270	1573
Trap	Fish trap	1995/96	41.8	8265	1401
		1996/97	57.2	10710	1796
		1997/98	49.9	9880	1875
		1998/99	53.7	10893	1558
		1999/00	56.1	11064	1637
		2000/01	52.0	9046	1505

Table 2.2 Continued

	Method	Year	Catch (tonnes)	Effort Gear units#	Days fished
Other	Squid jig##	1995/96	8.7	8022	94
		1996/97	6.5	10491	71
		1997/98	15.0	4133	186
		1998/99	89.6	10014	591
		1999/00	173.6	173280	999
		2000/01	58.1	15994	713
	Spear	1995/96	14.0	1383	361
		1996/97	19.2	1845	462
		1997/98	13.8	1554	437
		1998/99	17.2	1377	390
		1999/00	16.0	1482	375
		2000/01	12.4	1106	285
	Dipnet	1995/96	*	*	*
		1996/97	24.1	1511	361
		1997/98	33.4	1711	409
		1998/99	42.4	2708	557
		1999/00	29.3	2311	500
		2000/01	22.6	1419	363

Table 2.3 Table of effort gear units by fishing method

Method(s)	*Effort gear units*
Beach seine/purse seine	No. of shots
Graball/shark net/small mesh net	100 m net hours
Dropline/bottom longline	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

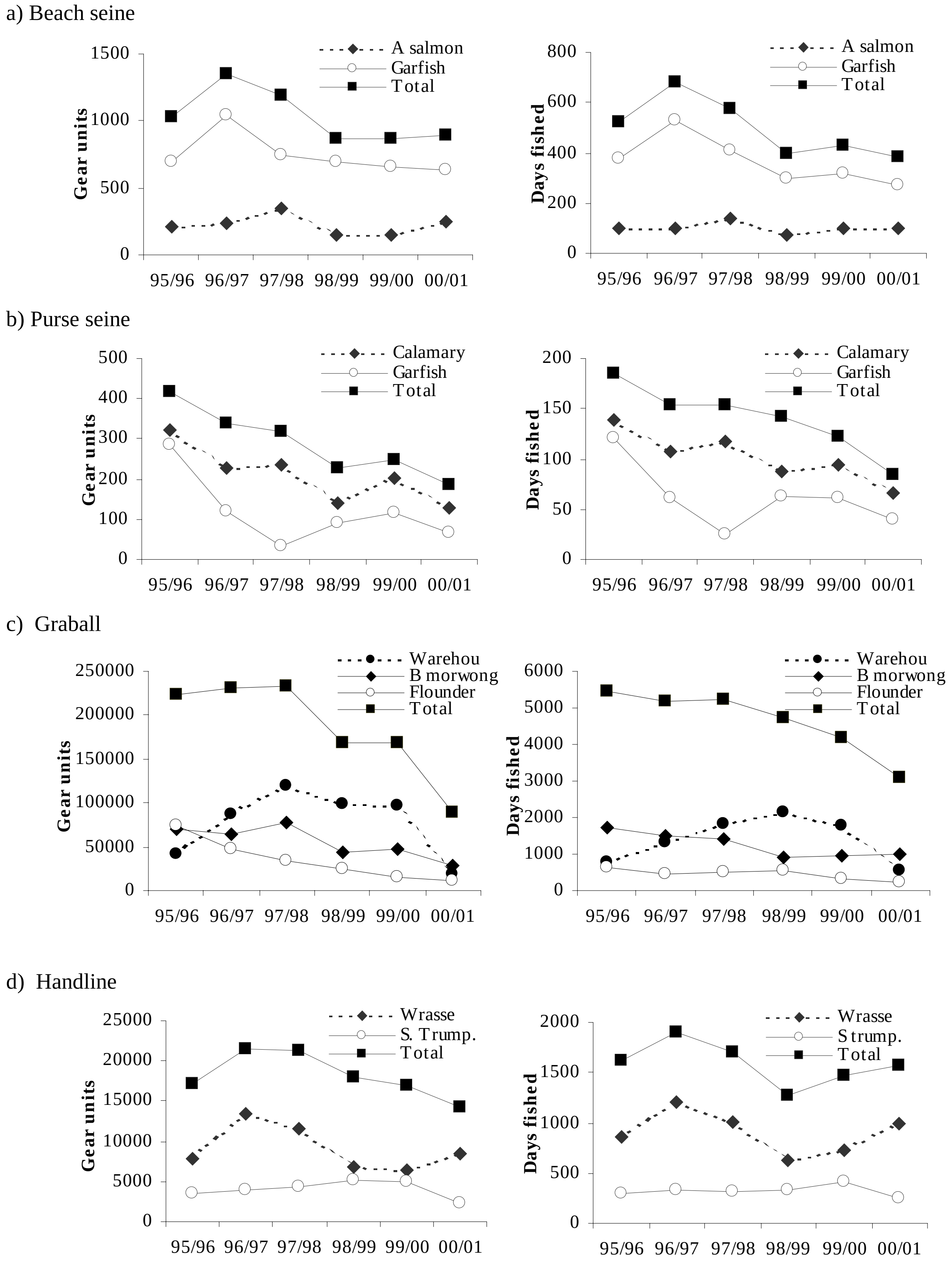
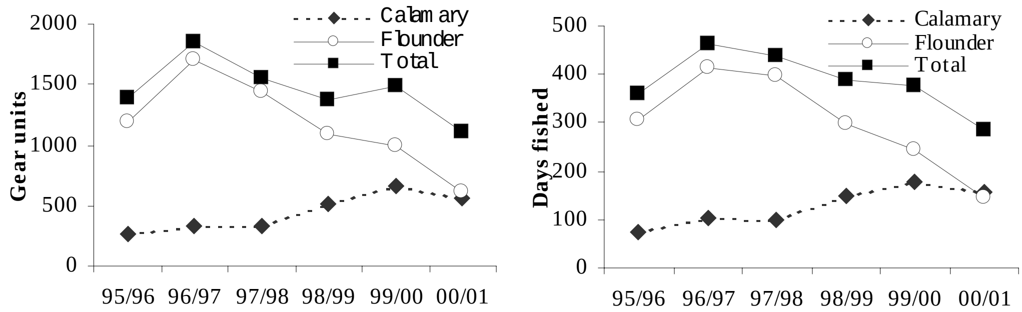


Fig 2.2 Annual effort by method for key species, expressed as gear units (refer Table 2.3) and days fished.

e) Spear



f) Squid jig

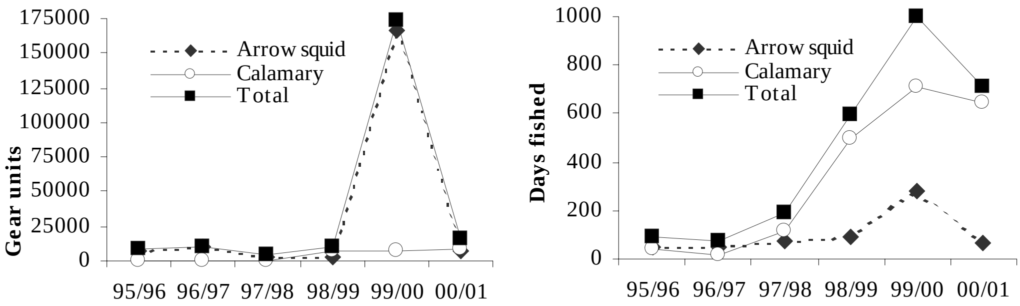


Fig 2.2 Continued.

2.5 Catch rates

Catch rate or catch per unit effort (CPUE) is often used in fisheries assessment as an index of resource relative abundance. In the context of the scalefish management plan, a catch rate trigger is exceeded when the catch rate falls below 80% of the lowest catch rate for the reference year (1995/96 to 1997/98). CPUE values by method for key species are discussed in detail in Chapters 3-9.

2.6 Recreational fishery

2.6.1 Gillnet fishery

Since the introduction of licences for recreational nets in 1995/96, the number of licensed nets has generally increased from around 8,900 to a peak of over 11,000 in 1999/00 (Table 2.5). There was a 2% reduction in the total number of nets licensed in 2000/01, mainly due to a fall in the number of second graball net licences issued. 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 2.5 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*
Graball Net 1	5615	6290	6685	6709	7477	7401
Graball Net 2	2612	2678	2683	2426	2652	2515
Mullet Net	656	684	738	739	879	845
Total gillnet licences	**8883**	**9652**	**10106**	**9874**	**11008**	**10761**

Results of a Statewide survey of recreational gillnetting conducted between December 1996 – April 1998 indicated a total of 560,000 hundred meter net hours of effort was expended for a catch of in excess of 400 tonnes of finfish (Table 2.6). By comparison, commercial graball effort was around 314,000 hundred meter net hours for the same period, resulting in a catch of over 560 tonnes. More recent statistics are not available.

Blue warehou dominated the recreational gillnet catch, representing about 45% by weight. Species of secondary importance by weight included bastard trumpeter, Australian salmon, silver trevally and striped trumpeter. For the majority of species the recreational component was significant in relation to the commercial gillnet catch (Table 2.6), and therefore it is important that the impact of the recreational catch is also taken into account in stock assessment.

Table 2.6 Comparison of catch and effort for recreational and commercial gillnet fisheries for key species. Based on the period Dec 1996 – April 1998.

	Gillnet catch (tonnes)	
Species	*Recreational*	*Commercial*
Blue warehou	191.6	230.9
Bastard trumpeter	42.0	73.3
Australian salmon	28.3	27.5
Silver trevally	30.3	3.6
Striped trumpeter	22.4	28.6
Cod	14.7	7.9
Leatherjacket	12.4	4.7
Mullet	10.1	6.3
Wrasse	10.0	28.0
Jackass morwong	9.5	20.1
Flounder	8.5	18.7
Jack mackerel	7.1	5.4
Flathead	6.5	4.5
Banded morwong	1.8	105.8
Effort (100 m net hours)	*560160*	*314170*

2.6.2 Other methods

Apart from gillnetting, there has been no comprehensive assessment of the recreational scalefish fishery to date. However, information about the fishing activity of recreational licence holders has been collected. Although data do not include the activity of non-licensed recreational fishers, it was evident that species such as flathead, Australian salmon, barracouta and striped trumpeter are important to the line fishery while flounder are commonly targeted using spears (Lyle 2000). Based on incomplete fishery coverage (i.e. licensed fishers only), the estimated flathead and barracouta catches for 1996-98 each exceeded 100 tonnes, while catches of 10-30 tonnes were estimated for Australian salmon, cod, striped trumpeter and jackass morwong during the same period. These findings confirm that recreational catches of several key species are significant and may exceed the commercial catch.

When the results of the 2000/01 national recreational fishing survey become available they are expected to provide for a comprehensive assessment of recreational catch and effort and will be incorporated in future assessments.

2.7 Uncertainties

While considerable attention has been given to ensure comparability of commercial catch and effort data over time (refer Appendix 2), it is acknowledged that some recent administrative changes in the reporting of catches may have, nonetheless, exerted an 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 short time series available and the level of detail collected from the commercial fishery. Within the context of the time series, six 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, 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 CPUE.

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 validation of the Tasmanian logbook data 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.

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 factor in the dynamics of the fishery, including impacts of management change when assessing the fishery as a whole.

The lack of comprehensive information about the recreational fishery is a major uncertainty, although the current national survey will provide an important snapshot of this fishery. There is also a need to consider on-going monitoring of the recreational fishery, without which 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 still 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.

As an indicator of fishery and resource status, a considerable time series of catch and effort data is required. In the short to medium term, uncertainty will be associated with this fishery in regards to the implications of trends in catch and effort. Data quality is also of concern and in the face of such uncertainty, management should adopt a precautionary approach, at least until assessments can be further refined. 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 Memorandum of Understanding accompanied the OCS, specifying trip limits for Commonwealth only fishers of 100 kg for South East Non-Trawl (SENT) permit holders and 20 kg for all other permit holders.

When the Tasmanian scalefish fishery management plan was implemented in 1998, gear restrictions were introduced for all commercial scalefish fishers operating in State waters. However, after the introduction of the management plan those fishers who held 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 20kg and 100kg 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 impending 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 (increased from 33 cm with the introduction of the scalefish management plan). This size is still 9 cm smaller than the size at maturity of females and 18 cm smaller than maturity in males.

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 31 years and, while this has yet to be validated, the incremental structure in sectioned otoliths is clear and unambiguous. 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.

Few biological parameters have been defined for striped trumpeter (see Appendix 3). The growth parameters are based on few fish larger than 70 cm and are derived from unvalidated age estimates for fish over 5 years old.

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 was evidence, based on limited ageing of catch samples, that the strong 1993 and 1994 cohorts had contributed significantly to the recent catches.

The primary management response to limit further expansion in the fishery was the introduction of the 250 kg trip limit for commercial operators and a bag limit of 5 fish for recreational fishers.

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 the dominant gear types (Fig. 3.1). There is also a minor by-catch of striped trumpeter in rock lobster pots.

In 2000/01 handline and dropline methods together accounted for around 55% of the annual catch of 50 tonnes. Hook fishing operations are conducted 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 a number of other reef fish species. In 2000/01 about 25% of the catch was taken by graball net.

Striped trumpeter are also caught by longline and in shark nets, primarily as a by-product of fishing for school and gummy shark. In 2000/01 these methods accounted for just 11% (i.e. 5.3 tonnes) of the reported catch, significantly lower in both relative and absolute terms compared to previous years (despite limited variation in effort levels). Between 1995/96 and 1999/00 shark net and longlines accounted for 14-27 tonnes p.a. (mean 19 tonnes), representing 18-25% (mean 22%) of the striped trumpeter catch.

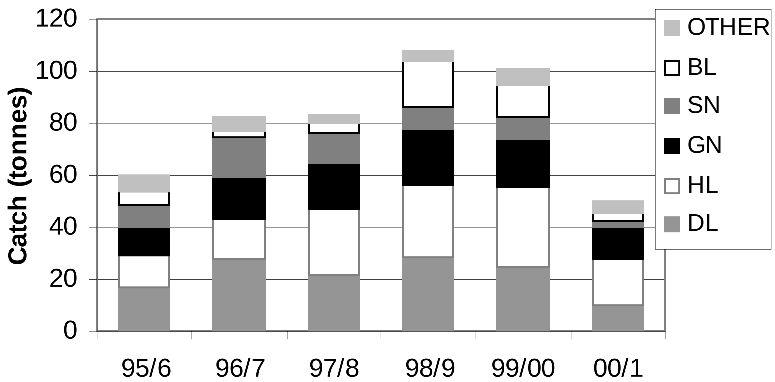


Fig. 3.1. Annual catch of striped trumpeter by method. DL is dropline; HL is handline; GN is graball; SN is shark mesh net; BL is bottom longline.

3.4.2 Recent developments

Fishers reported that the introduction of the 250 kg trip limit had had some impact on fishing operations, with less incentive for fishers to target striped trumpeter on a fishing trip. This impact should in theory be reflected in terms of reduced daily catches and reduced effort. In practice there has been a minor reduction in daily catches, with just under 1% of reported daily catches in 2000/01 exceeding 250 kg compared to an average of almost 5% for the previous five year period. There has been a more significant impact in overall days fished, which were just 75% of the average for the previous five year period. However, reduced abundance/availability of striped trumpeter can not be discounted as factor in producing the observed decline in effort.

There has been no recent research or biological monitoring of the striped trumpeter fishery.

3.4.3 2001 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 2000/01 commercial catch of 50 tonnes was equivalent to just 50% of that taken in the previous year and was the lowest since 1990/91.

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, handline and dropline catches were, for the most part, targeted whereas only a minor proportion of the graball catch met the targeting criteria.

The most conspicuous catch trend for these methods was the initial increases in production to 1998/99 or 1999/00, followed by sharp falls in 2000/01, to levels comparable or below those for 1995/96. For both hook methods, catch trends generally reflected effort levels, with handline catch rates (based on gear units) rising gradually over the period and, except for a peak in 1999/00, dropline catch rates were generally consistent between years. By contrast, daily catches (based on targeted and total effort) have declined steadily over the past 2-4 years for the hook methods. While it is possible that the 250 kg trip limit may have impacted in 2000/01, it is significant that the declining trend was already evident prior to the trip limit introduction. This apparent mis-match in catch rates is difficult to explain without a better understanding of the dynamics in the fishery but it does imply that fishers have used less gear or fished for shorter periods on average each day while maintaining catch rates per unit of gear.

Since striped trumpeter are only occasionally encountered by gillnets (compare striped trumpeter graball effort with graball effort levels in Table 2.2) and are only rarely, by definition, targeted. Thus total graball catch rather than catch rates may be a better indicator of abundance/availability of juvenile fish (based on the assumption that - the distribution of the graball effort overlaps the distribution of the juvenile fish). For instance, although graball catches between 1995/96 and 1997/98 were influenced by strong 1993 and 1994 cohorts entering the fishery, catch rates revealed only minor variations. There is also circumstantial evidence that the 1996 year class was relatively strong and would have recruited to the gillnet fishery in 1998/99. The subsequent decline in graball catches in the most recent year presumably reflects the movement of this year class offshore as they grew larger in size.

Although there are no size composition data available for shark net catches, the large mesh size of shark nets (>150 mm) will tend to select for larger/older fish. An increased proportion of small (<50 kg) catches and, conversely, a lower occurrence of large catches, in the shark gear was largely responsible for the decline in striped trumpeter by-catch in 2000/01. For instance, only 17% of shark net shots in which striped trumpeter were reported yielded more than 50 kg in the most recent year. This compares with an annual average of 43% for the previous five years. Similarly, just 38% of longline sets produced catches of over 50 kg compared to the five year average of 55%. Although not a target species, the decline in striped trumpeter by-catch in shark gear may potentially represent an indicator of reduced abundance/availability of older fish.

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 may 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, reduced biomass of both new recruits and adults may have influenced the recent drop in catches across all methods. 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	48.8

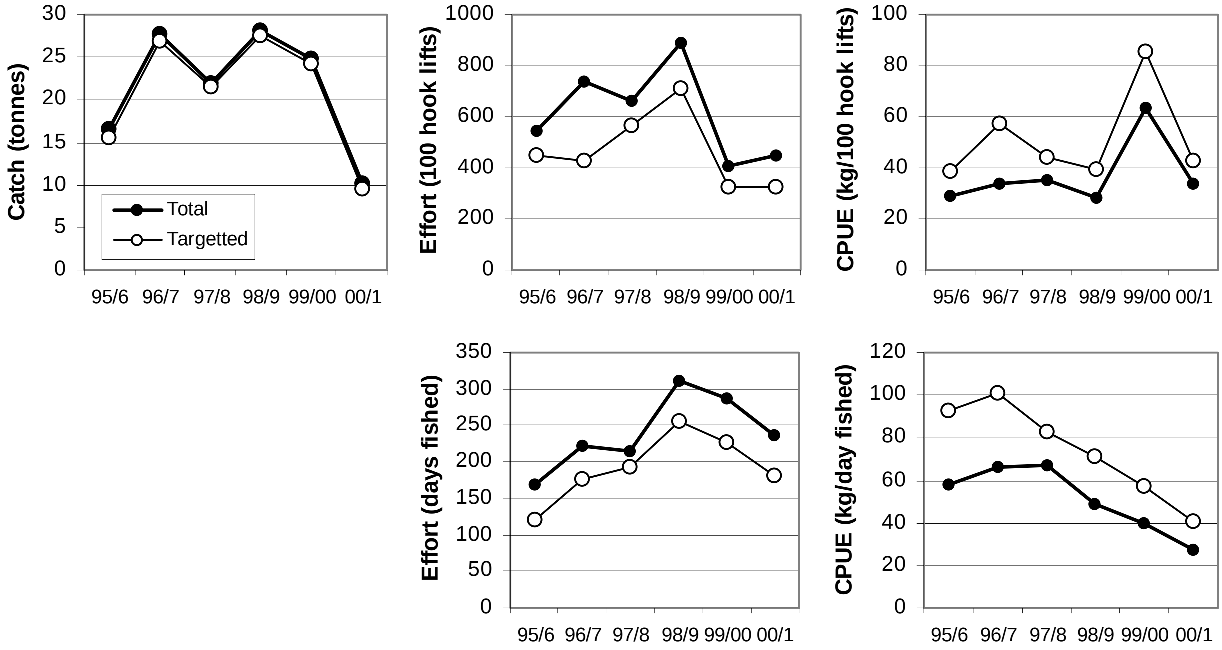


Fig. 3.2. Annual dropline catch, effort and CPUE (targeted and total) for striped trumpeter.

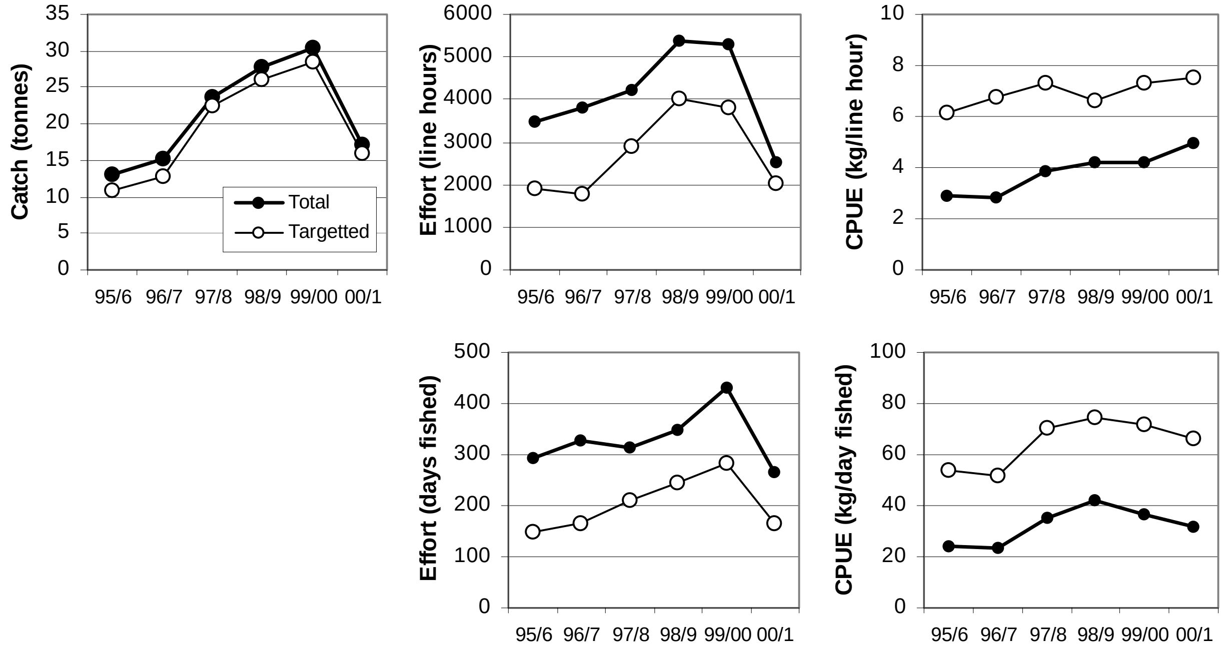


Fig. 3.3. Annual handline catch, effort and CPUE (targeted and total) for striped trumpeter**.**

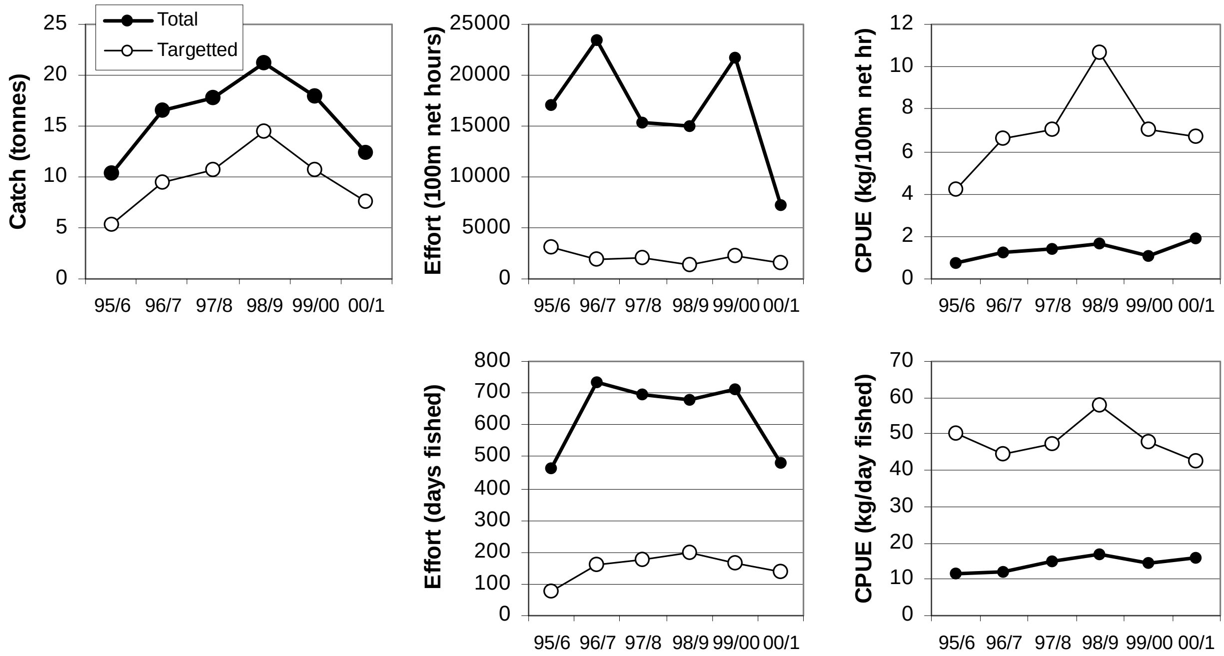


Fig. 3.4. Annual graball catch, effort and CPUE (targeted and total) for striped trumpeter.

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 2000/01 striped trumpeter catch of just 50 tonnes was outside the reference period, representing a decline of about 50% compared to 1999/00. On this basis both 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.

No effort triggers were exceeded in 2000/01.

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 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, can not be discounted as a potential contributing factor to the down turn in catches, though the present trip limits do not appear to be limiting catches in any significant way.

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. 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 in some significant manner.

The suitability of the legal minimum size limit of 35 cm in terms of yield-per-recruit is unknown though appears likely to permit growth over-fishing if a significant proportion of the catch is in this size range. In addition, as this size limit is well below the size at maturity it is considered a risk prone strategy in terms of egg-per-recruit and hence the sustainability of the fishery. 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 fishery for this species in Tasmania 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. There is also a paucity of information about the offshore fishery.

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 species 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.

The range of biological parameters that have been defined for banded morwong are presented in Appendix 4.

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 a small spatial scale, analyses have been conducted at regional as well as statewide levels. Overall, catch and effort have declined steadily since 1995/96, accompanied by a steady fall in CPUE. At statewide and regional levels, catch and catch rate triggers were exceeded in 1999/00 giving rise to concern about the sustainability of the fishery.

A meeting of researchers, managers and industry was convened in late 2000 to discuss resource and management issues relevant to the banded morwong fishery. Industry confirmed that catch declines were the result of reductions in fishing effort and not market driven. Several key operators had either left the fishery or significantly reduced their level of activity by either targeting other species, and thus taking banded morwong largely as a by-product, or by reducing the amount of gear set each day. Many operators reported that increased interactions with seals had caused them to either curtail fishing on a given day or reduce the quantity of net set. 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.

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 nets 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 and bastard trumpeter.

Banded morwong catches declined steadily from over 100 tonnes to just 34 tonnes between 1994/95[2] and 1999/00, before increasing slightly in 2000/01 to 38 tonnes (Table 2.1, Fig. 2.1).

4.4.2 Recent Developments

Monitoring of commercial fishing operations resumed in late 2001 and specimens for ageing analysis were collected from the Tasman Peninsula and Bicheno areas during the 2001 spawning season. These data have not been analysed to date but will be incorporated with data from sampling scheduled to continue throughout 2002.

A forum involving industry, managers and researchers met in October 2001 to consider management and research needs for the 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 recently (and other experienced operators had exited the fishery) and this dynamic was likely to have had some influence on catch rates. Specific recommendations from the forum 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.

4.4.3 2001 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 selected group of ‘experienced’ fishers. Experienced fishers were those who had participated in the fishery for at least two of the last six years and had caught at least 2.5 tonnes since 1995/96.

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

State-wide catch trends, based on total effort, targeted effort and effort for 'selected' or experienced fishers, were consistent, exhibiting sharp declines since 1995/96 that were only arrested in 2000/01. Current catch levels are just 50% of those at the start of the period (Table 4.1, Fig. 4.1). Over the past six years there has been a marked decline in effort, though in the last two years effort has stabilised at a low level. Prior to 2000/01, gear based catch rates (i.e. kg/100m net hour) declined steadily for total effort but were relatively stable for targeted and selected effort. In the most recent year, all gear based catch rate indicators rose to the highest levels reported since 1995/96. By contrast, daily catches for targeted effort has continued to fall over the entire six year period. Daily catches for total and selected effort did, however, show a slight improvement in 2000/01.

Seal interference has been identified as a major determinant of how much gear is fished each day. In order to investigate the issue of seal interference further, data for days on which fishers reported seal interference in their logbooks have been analysed separately from records where interference was not flagged (Fig 4.2). It is clearly apparent from this analysis that only a small proportion of the effort (hence catch) was flagged as impacted by seal interference, just 15% of the total fishing days over the six year period. In 2000/01, however, 28% of the fishing days were impacted by seals. Rather than implying that the problem is not as widespread as suggested by industry it is more likely that fishers have not consistently reported seal interference. Where seal interference was indicated, catch rates were generally lower that when no interference was reported, suggesting that this factor needs to be considered when interpreting catch rate trends. The reported high catch rates in 2000/01 appear to be inconsistent with the increase in reported seal interactions. Either there was some confusion over reporting requirements, which has affected the data quality, or the impact of seals has either been exaggerated or reduced in recent years.

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 a regional level for the main fishing areas. The regions, based on fishing blocks, have been defined as St Helens (5H1), Bicheno (5H3), Schouten (6H1), Maria (6H3 & 6G4), Tasman Peninsula (7G2 & 7H1) and Bruny (7G1 & 7G3) and data are presented in Figs 4.3- 4.5. Annual catches in the Bicheno, Schouten, Maria and Tasman Peninsula regions fell consistently between 1995/96 and 1998/99 whereas for St Helens there was an initial expansion of catches to 1997/98. Since 1998/99, annual catches in each of the regions, apart from St Helens and Bicheno, have remained generally stable. Catches from St Helens continued to fall steadily whereas the latest catches from the Bicheno region doubled those for 1999/00. As a general rule, the catch trends have reflected changes in effort, with falling catches linked to reduction in effort.

Regionally, catch rates have been variable both within and between years but generally declined up to 1999/00. In 2000/01, CPUE increased in all regions to levels equivalent or slightly higher than for the reference period (1995/96 – 1997/98). The only region where catch rates remained below reference levels was St Helens where, although there was a slight increase in gear based catch rates, daily catches continued to decline.

As noted in previous assessments, catch rates tend to increase moving south to north along the east coast. While this possibly implies that the more northern reefs support greater densities of banded morwong catch rates may also be influenced by the fact that the fishery developed initially in the south-east and this area may have been fished down to a greater extent.

Catch and catch rate indicators suggest that the fishery has impacted on banded morwong populations and the apparent minor ‘recovery’ in catch and catch rates in the most recent year should be interpreted with caution and does not indicate the sustainability of current levels of exploitation. That effort remained low despite this reported increase in catch rates is also remarkable.

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. Such shifts in location of fishing would lead to a serial depletion of reef areas that receive too much fishing effort. There is, therefore, great uncertainty surrounding the resource status and, 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 the age structure of the commercial catch and of the population.

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	34.0	47285	0.70	942	21.7
	2000/01	37.4	27464	1.36	980	28.3

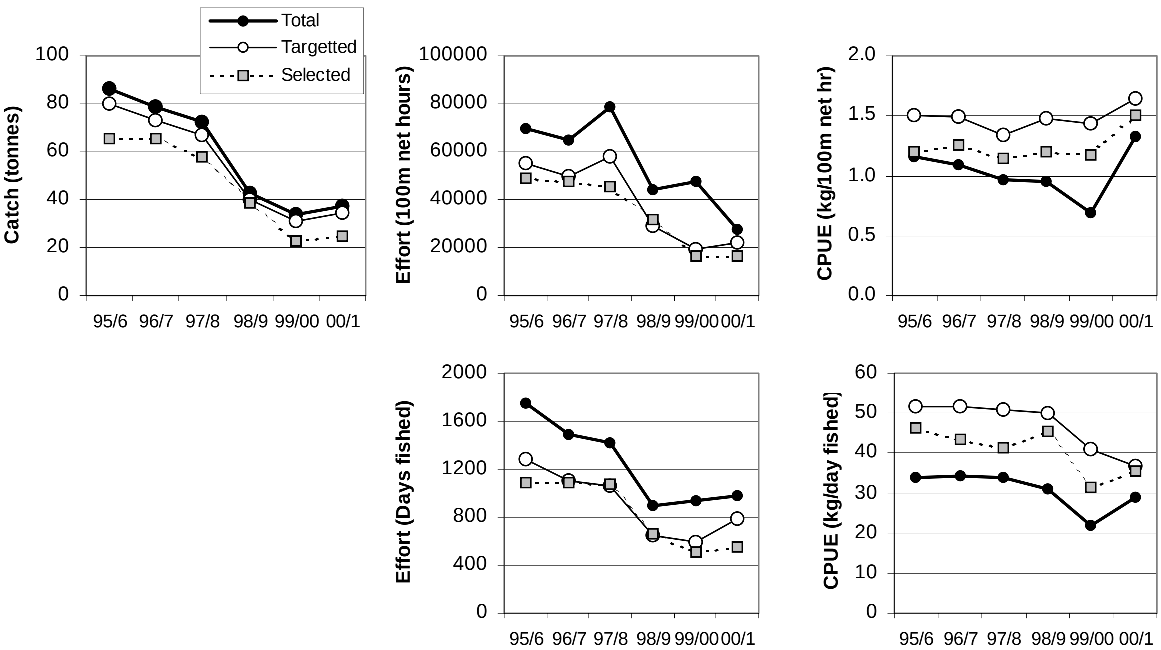


Fig 4.1 Annual graball catch, effort and CPUE (catch per unit effort) for banded morwong based on total (solid circle), targeted (open circle) and selected (grey square) effort.

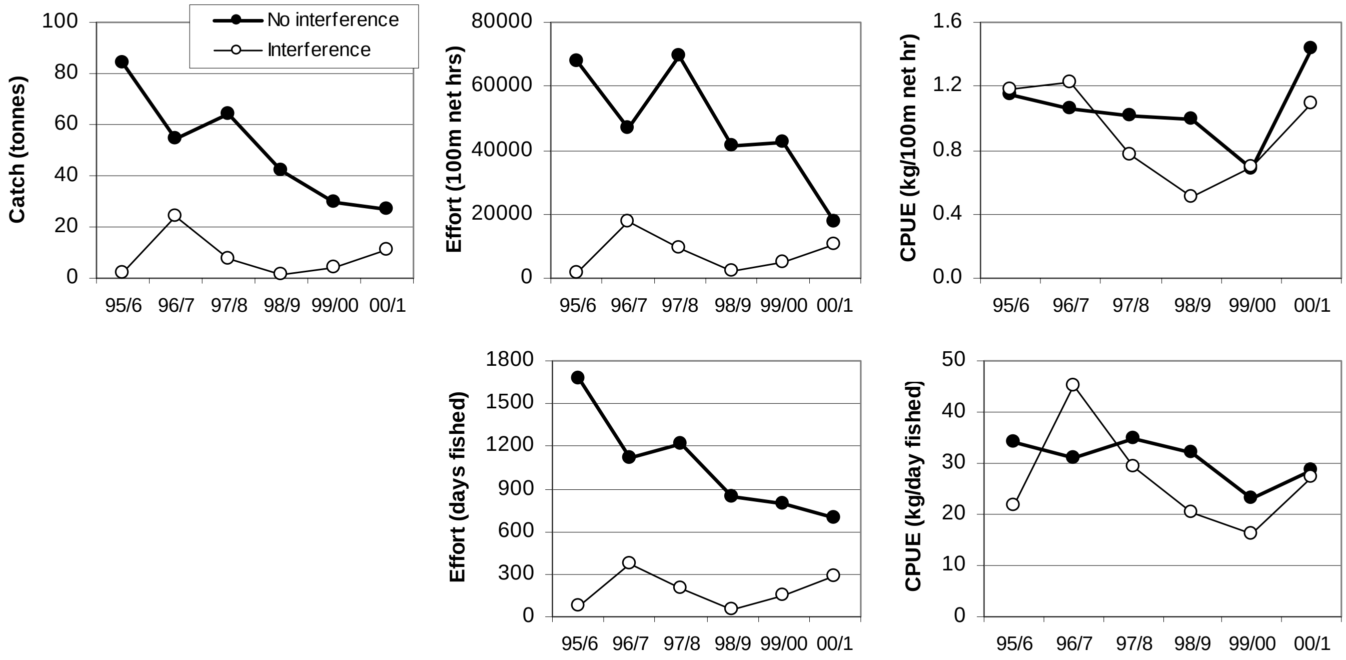


Fig. 4.2 Catch, effort and CPUE (catch per unit effort) for banded morwong where seal interference was reported (open circles) and where no interference was recorded (solid circles) on the logbook returns.

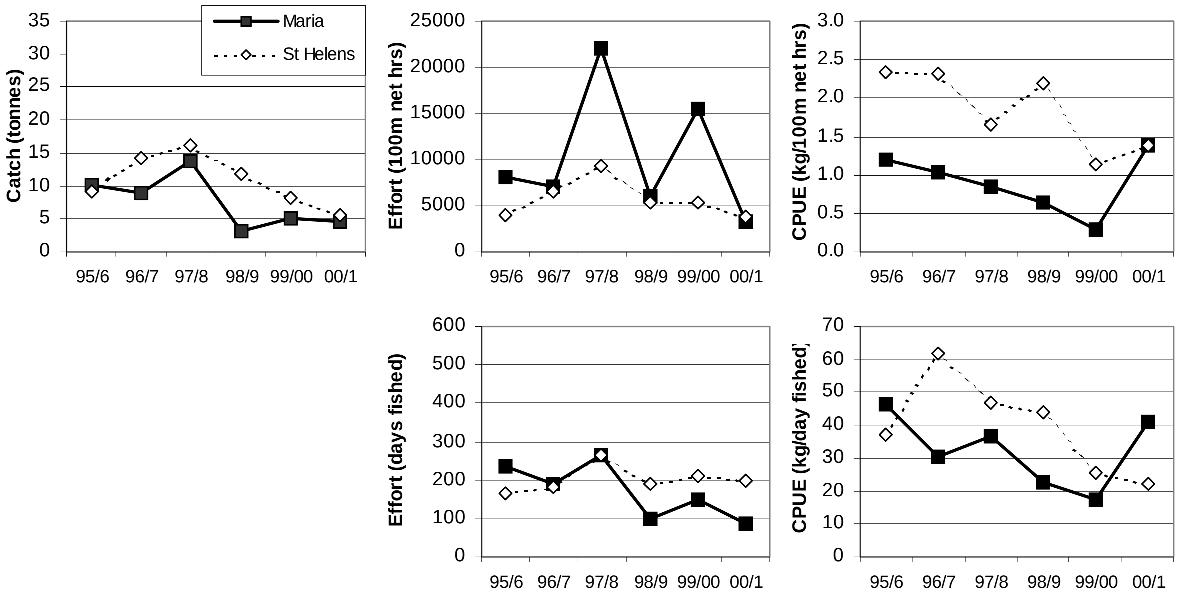


Fig. 4.3. Catch, effort and CPUE (catch per unit effort) for banded morwong by fishing region- Maria Island and St Helens.

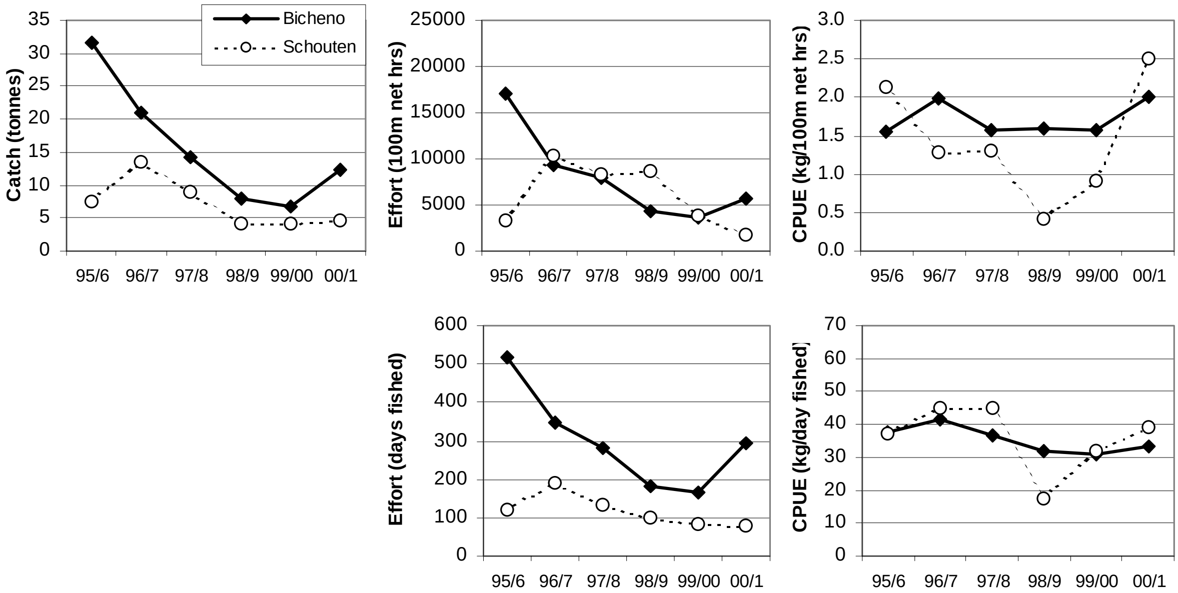


Fig. 4.4. Catch, effort and CPUE (catch per unit effort) for banded morwong by fishing region- Bicheno and Schouten Island.

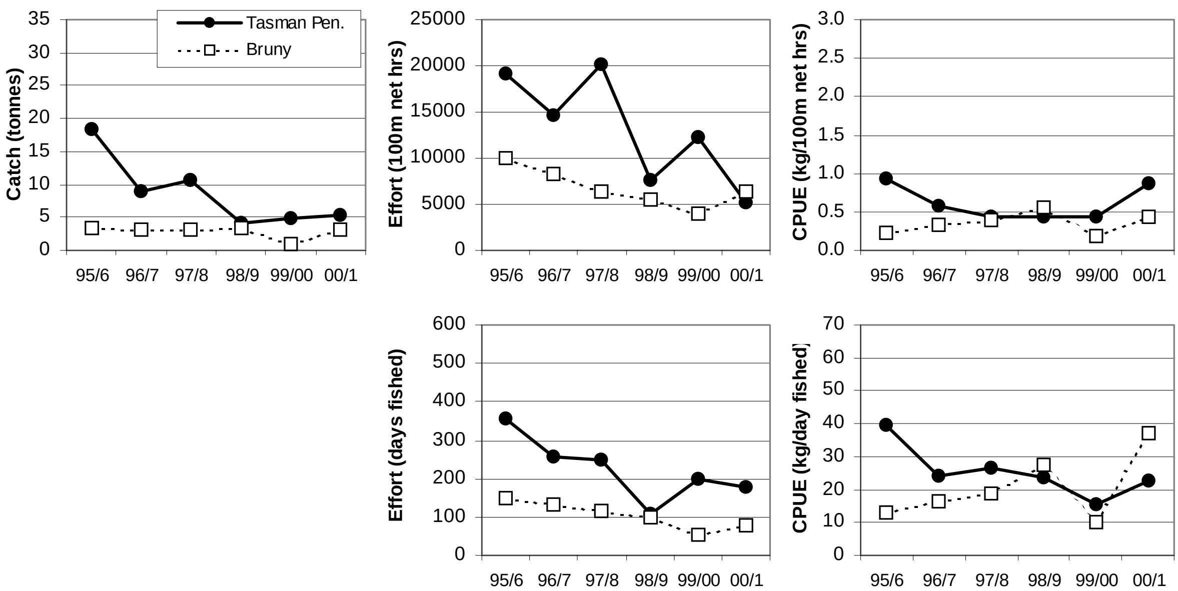


Fig.4.5. Catch, effort and CPUE (catch per unit effort) for banded morwong by fishing region- Tasman Peninsula and Bruny Island.

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 of banded morwong 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 was probably 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.

The 2000/01 catch of 38 tonnes was outside (lower) reference period catches, indicating that the catch trigger had been exceeded for the third year running. The current catch was, however, only slightly higher (11%) than for 1999/00 and therefore the second catch trigger was not 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.

Overall, effort was lower than during the reference period; Bicheno was the only region that experienced any increase in fishing effort, though current effort levels were still low by comparison with the reference years. 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.

Statewide and regional catch rates had generally increased in 2000/01 to levels above the respective CPUE triggers. St Helens was the only exception, where daily catches were on average just 60% of the lowest values for the reference period, indicating that the trigger had been exceeded for this region.

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 only resumed in the latter half of 2001 and will be used to compare with information collected prior to 1997. Data collection will be undertaken throughout 2002 and preliminary analyses, including the determination of age structure, should be available for the 2002 assessment.

4.6 Implications for Management

While catch rates have changed only slightly in the main fishing areas over the past six 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, with such a low productivity species, with the general downward trends in the fishery, and uncertainty about the reliability of the latest 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.

Over the past six years there has been a trend towards the use of larger mesh sizes by fishers (primarily in response to size limit increases) that will have implications for catch and catch rates. That is, catch rates will reflect, to some extent, changes in mesh size and size regulations. For instance, modelling undertaken at the time the current size limits were proposed indicated a slight decline in catch rates, assuming that mesh size or the size structure of the catch remained static (Murphy and Lyle 1998). There is no empirical information to test the above.

The age structure of the banded morwong population indicates recruitment variability, which will have implications for the size composition and catch rates in the fishery.

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. Commercial catch sampling of banded morwong is currently in progress and should provide inferences about the effects that fishing is having 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 have had on catch rates in order to interpret the trends. Population age structure at key sites will be investigated in 2001 and 2002 for comparison with information from the mid-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 stock discrimination study indicated that there are 4 genetically separate populations of garfish; they are based off Western Australia, western South Australia, eastern South Australia/Victoria and Tasmania, respectively. The study did not discriminate between fish sampled from the east coast of Tasmania from samples from Flinders Island (Donnellan *et al.* 2002).

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.

The range of biological parameters that have been defined for sea garfish in Tasmania are presented in Appendix 5.

5.3 Previous Assessments

Previous assessments have been restricted to 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 around 70-100 tonnes, without any consistent pattern or trend between years. Since 1995/96 the beach seine catch has fluctuated only slightly and more recent levels of effort have fallen while catch rates have increased 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. Dip net catch and effort declined in 1999/00 to within reference limits and, along with beach seines, did not exceed trigger point levels in that year.

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 dipnet 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 the entire Tasmanian coastline (apart from the west coast), with the greatest portion of the catch being taken off the northeast coast, including Flinders Island, and off the east and southeast coasts. Since 1996/97, annual catches from the northeast (blocks 3G4, 4G2, 4G4, 4H1, 4H3) have declined steadily from around 50 tonnes in 1996/97 to 27 tonnes in 2000/01 (Fig. 5.2). Over the same period, east coast (blocks 6G4, 6H1, ES13, ES14, ES15, ES16) catches fluctuated without an obvious trend between 13 and 24 tonnes p.a., whereas south-east coast catches, including Norfolk and Frederick Henry Bays (blocks 7G1, 7G2, ES17, ES18, ES19), increased from just 4 tonnes in 1996/97 to about 20 tonnes p.a. in each of the past three 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.

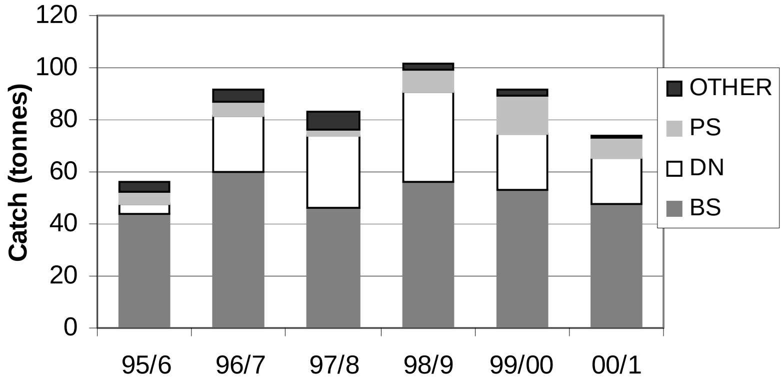


Fig.5.1. Annual catch of sea garfish by method. BS is beach seine; DN is dip net; PS is purse seine.

5.4.2 Recent Developments

A recent study of the fishery and biology of sea garfish examined aspects of reproductive biology, early-life-history, size composition and age and growth in Tasmanian waters (Jordan *et al*. 1998). 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).

5.4.3 2001 Assessment

The 2000/01 catch of 74 tonnes represented almost a 20% reduction on the previous year but was within the catch range for the reference period 1990/91 to 1997/98 (Table 2.1).

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.

Beach seine catch and effort peaked in 1996/97 and since then catches have remained relatively stable (Table 5.1, Fig. 5.3). Relatively high beach seine CPUE for the past three years has contributed to the maintenance of catch levels, despite slight falls in effort. After increasing rapidly, dipnet catches fell sharply in 1999/00 and again by a further 17% in 2000/01 (Table 5.1, Fig. 5.3). The recent decline in catches has been more a response to reduction in effort than variability in catch rates.

The lack of consistency in catch rate trends for the two methods over the past six years complicates any interpretation of stock status. As a schooling species, however, CPUE for garfish is likely to be relatively insensitive to declines in abundance, perhaps more so for gear such as beach seine which is used to target schools of fish. Some industry members have expressed concerns about the effects of dipnets on the schooling behaviour of garfish. Specifically it has been suggested that intensive dipnet activity tends to cause schools to break up, which could reduce opportunities to use beach seines to target the species and even impact on 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 the 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 can not 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	53.1	661	52.1	316	103.4
	2000/01	47.6	630	59.6	271	110.2
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	17.7	1339	8.5	345	32.1

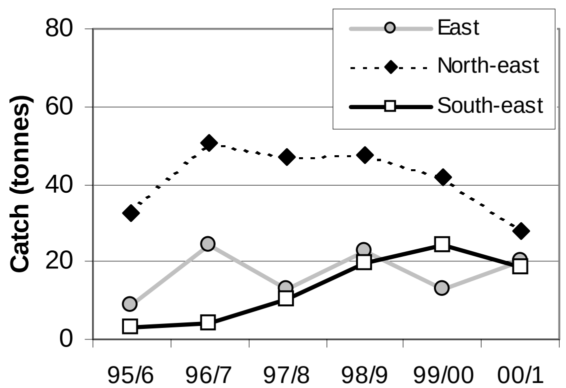


Fig. 5.2. Annual catch of sea garfish by major fishing regions. NE includes Flinders Island and the northeast coast of Tasmania, E is east coast including Great Oyster Bay and SE is southeast coast including the Tasman Peninsular, Norfolk and Frederick Henry Bays and Bruny Island.

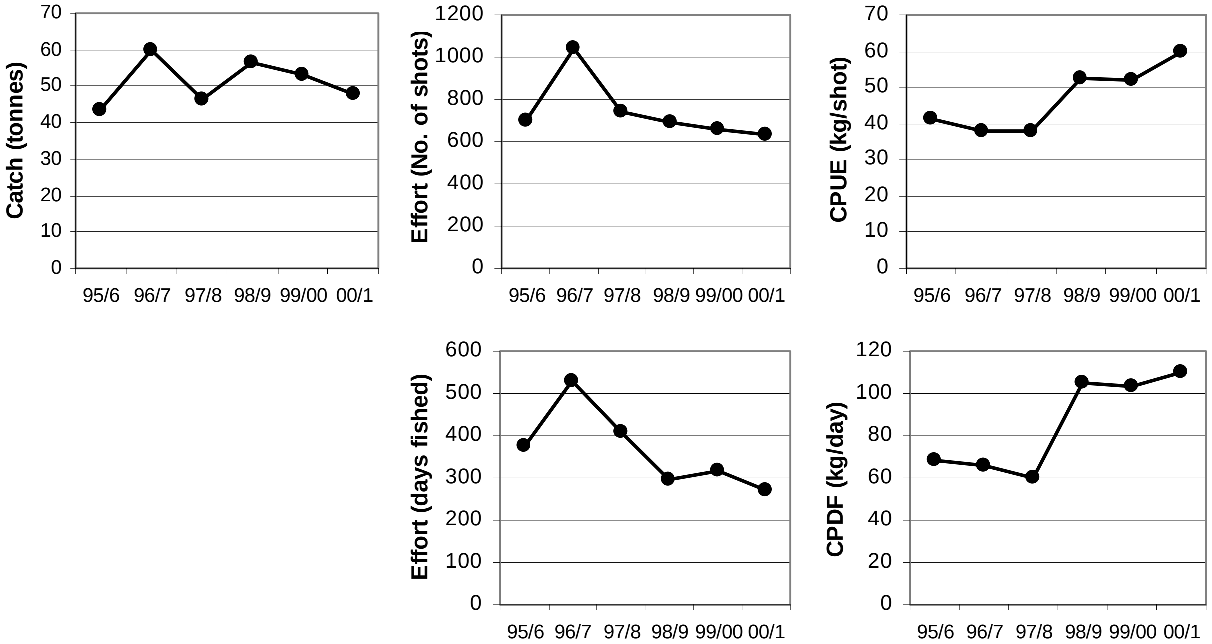


Fig. 5.3. Annual beach seine catch, effort, CPUE (catch per unit effort), days fished, and CPDF (catch per day fished) of sea garfish.

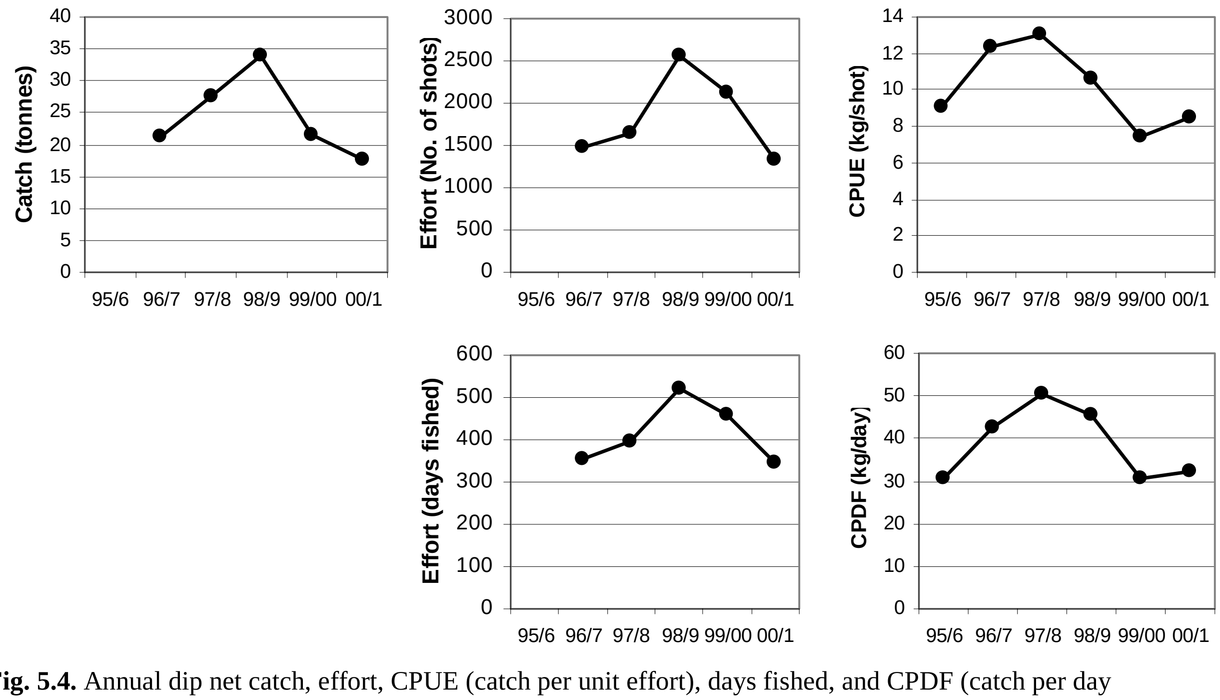


Fig. 5.4. Annual dip net catch, effort, CPUE (catch per unit effort), days fished, and CPDF (catch per day fished) of sea garfish.

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 2000/01 was within the reference range and only about 20% lower than for the previous year. 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 fishing effort was at its lowest level since 1995/96 while dipnet effort had fallen to slightly below that for 1996/97. Effort triggers were not, therefore, exceeded for 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.

Dipnet catch rates were roughly equivalent to the lowest previous value (1995/96) whereas beach seine catch rates were the highest on record. Although the catch rate trigger was not exceeded it is emphasised that as a schooling species CPUE may not be a suitable indicator of stock abundance for garfish.

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.*

There are considerable differences in the size, and possibly age structure, of sea garfish in the commercial fishery between southeast and northeast regions. The significance of these differences have yet to be assessed. Size/age compositions have not been followed through time and no pre-recruit surveys have been conducted.

5.6 Implications for Management

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

Very 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 dipnet fishing on the schooling behaviour of garfish, including possible impacts on spawning success. There is no objective information available to test these concerns.

Seagrass is important to the life history of sea garfish and therefore the distribution and health of seagrass beds is an important issue for the garfish stock. Recent reports of large reductions in the size of seagrass beds around Tasmania are of concern.

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 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 this species. As a result, there was a dramatic increase in fishing effort directed at the species. 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.

In November 2001 the size limits for wrasse were revised, from a slot size of 28-43 cm to a minimum size of 30 cm, with no maximum size. It should be noted that any impacts of these latest changes would not be reflected in the current assessment.

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 two 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[3]. 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.

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). The maximum age for purple and blue-throat wrasse is about 20 and 10 years, respectively (Barrett 1995, Ewing unpubl. data). Mortality rates and productivity have not been estimated.

While male blue-throat wrasse are territorial, females are home ranging and sedentary on inshore rocky reefs, showing strong site attachment (Barrett 1995).

Few biological parameters have been defined for blue-throat wrasse, however validated age estimates have been generated for purple wrasse (see Appendix 6) from samples collected on the east and southeast coasts, where purples are dominant in the fishery. Research is currently underway to estimate the relative proportions of the two species and to establish the degree of variation in growth rates of wrasse in landings from various areas around the state.

6.3 Previous Assessments

Previous assessments have been restricted to analyses of trends in trap, handline and graball catch, effort and catch rates. During this period there have been only minor changes in the annual catch of wrasse combined across all fishing gears, with catches ranging between about 85 and 110 tonnes between 1995/96 and 1999/00.

General stability in catch rates for trap and handline methods has been a feature of the fishery with variability in catches between years largely a function of changes in effort. It was noted however, that stability at the state-wide level may mask more localised effects of fishing which coupled with the fact that two species are involved lead to some uncertainty about the 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 2000/01, trap and handline fishing accounted for almost 90% of the catch (Fig 6.1). Graball catches tend to of secondary importance, since few fish caught by this method are

[3] 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.

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 the reported form of the catches, the annual live wrasse catch has ranged between 55 tonnes (1999/00) and 82 tonnes (1996/97) for the six years since 1995/96 (averaging 65 tonnes p.a. weight in each year). 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 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.

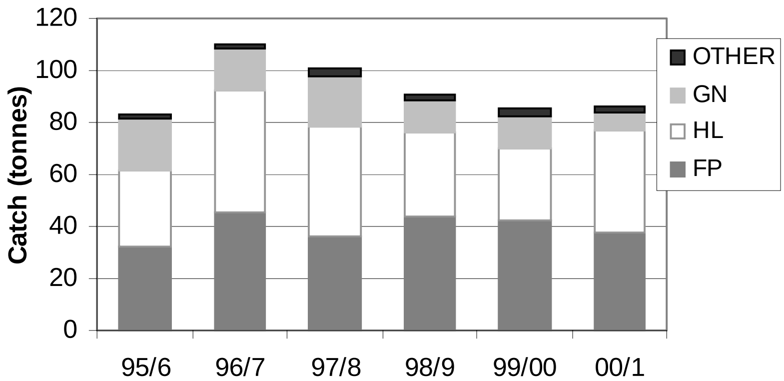


Fig. 6.1. Annual catch of wrasse by method. FP is fish trap; HL is handline; GN is graball.

Wrasse are taken commercially around the entire Tasmanian coastline, with the greatest portion of the catch taken from the east coast (blocks 5H1, 5H3, 6G4, 6H1, 6H3, ES13, ES14, ES15, ES16) and southeast coast (blocks 7F3, 7F4, 7G1, 7G2, 7G3, 7H1) (Fig 6.2). Moderate catches have also been taken from the north-east (including around Flinders Island) (blocks 3F1, 3F2, 3G1, 3G2, 3G3, 3G4, 3H3, 4G2, 4G4, 4H1, 4H3). Relatively small catches are taken from the northwest coast (blocks 4D2, 4D4, 4E1, 4E2, 4E3, 4E4, 5D2). There has been a shift in the distribution of catches since 1997/98, with east coast catches generally increasing and southeast catches falling. Compared with 1999/00, catches in the most recent year declined in the east and southeast while there were moderate increases in the northeast and northwest.

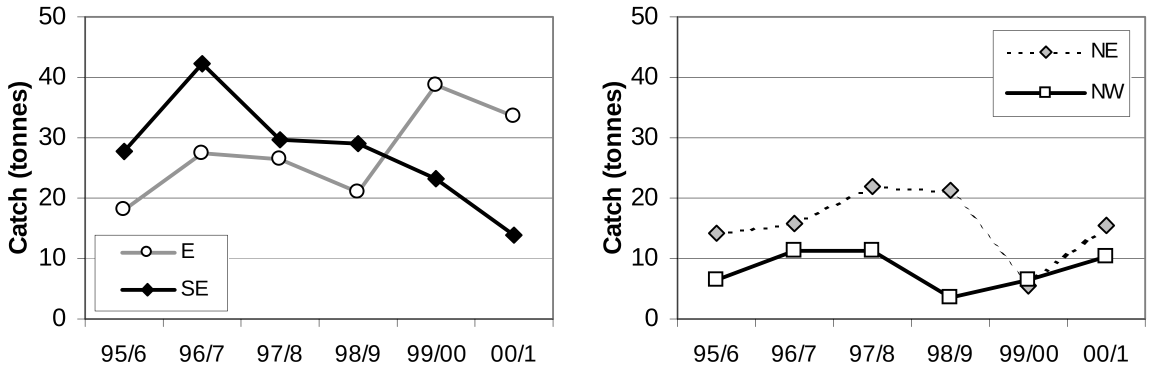


Fig 6.2 Annual catch or wrasse by fishing regions - E is east coast, SE is south-east coast, NE is north east coast, including Flinders Island and NW is north west coast (refer text).

6.4.2 Recent Developments

A project examining aspects of age and growth of purple wrasse on the south and east coasts of Tasmania is currently being finalised. Multiple mark recapture and selectivity experiments have been undertaken at sites on the east coast to provide an assessment of possible methods for estimating population abundance and size/age structure in these species. Analysis of data from this research is, however, incomplete and not available for this report.

6.4.3 2001 Assessment

The annual catch combined across all fishing gears over the past year of 86 tonnes was virtually unchanged compared with 1999/00 (Table 2.1). As noted above, however, there have been spatial shifts in the fishery, with falls in production in the southeast and east offset by increases in the northeast and northwest.

This current assessment is limited to examination of trends in fish trap, handline and graball catch, effort and CPUE for the period 1995/96 to 2000/01 (Table 6.1). Fish trap catch, effort and CPUE have remained relatively stable over the past six years (Table 6.1, Fig. 6.3). By contrast, handline catch and effort have fluctuated, increasing initially until 1996/97, falling to 1999/00 and then rising again in the current year. Despite this variability, catch rates exhibited no obvious pattern (Table 6.1, Fig. 6.4). Since wrasse are not usually targeted using gillnets, graball catch and effort data are unlikely to be useful in indicating trends in abundance. Notwithstanding this, graball catch rates have shown marked variability of the past two years although daily catches have remained relatively stable (Table 6.1, Fig. 6.5).

General stability in CPUE at the state-wide level for the major fishing methods may not be a reliable indicator of stock status since this is a multi-species fishery and there is evidence that individual reefs contain relatively discrete populations in terms of their age structure and population dynamics. Broad-scale or even regional analysis of data will 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. As a consequence, there is uncertainty regarding the status of the individual wrasse species though key fishery indicators do not indicate significant fishery impacts.

Table 6.1. Catalogue, 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	37.4	9354	3.28	1303	19.8
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	39.5	8468	3.35	991	24.2
Graball	1995/96	19.3	32222	0.65	1266	9.9
	1996/97	16.0	29024	0.63	1106	10.3
	1997/98	18.8	45815	0.66	1222	10.2
	1998/99	12.8	30202	0.69	904	9.3
	1999/00	12.5	53960	0.44	918	9.1
	2000/01	6.9	10620	0.92	505	10.3

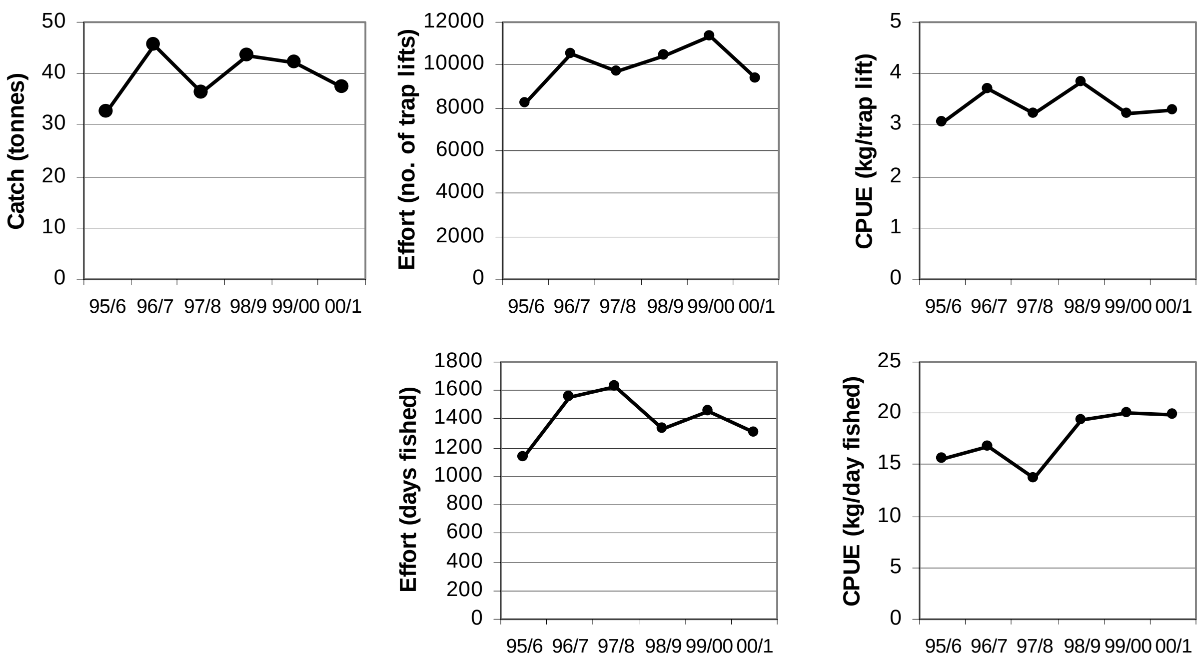


Fig. 6.3. Annual fish trap catch, effort, CPUE (catch per unit effort), days fished, and CPDF (catch per day fished) of wrasse.

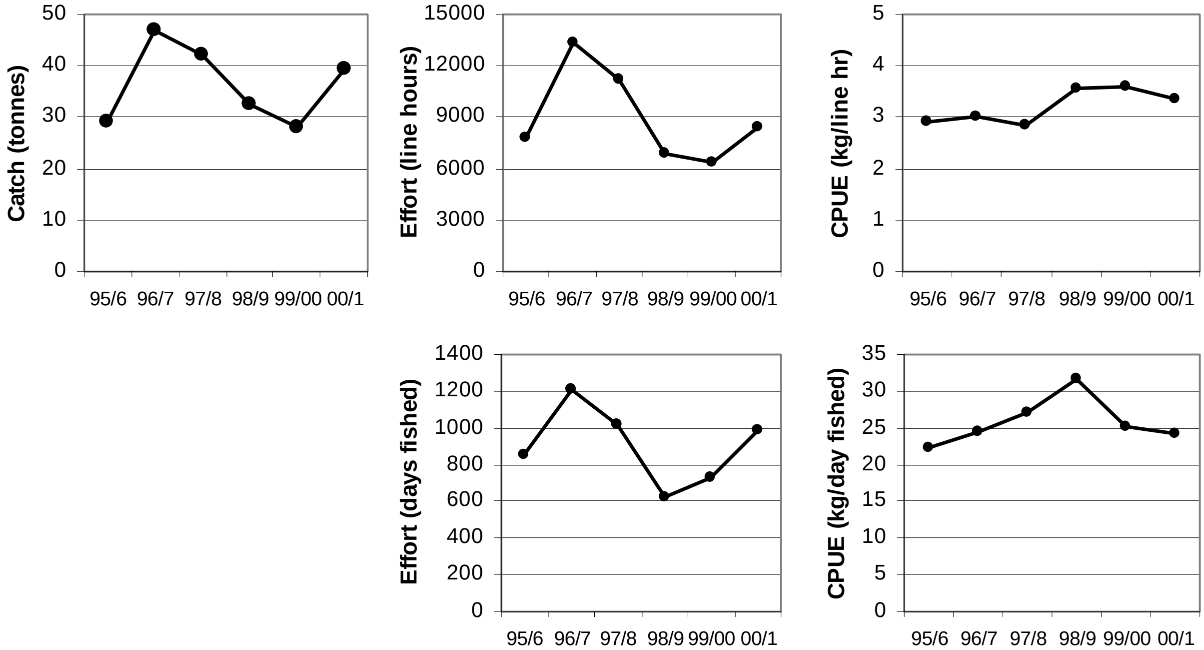


Fig 6.4. Annual handline catch, effort, CPUE (catch per unit effort), days fished, and CPDF (catch per day fished) of wrasse.

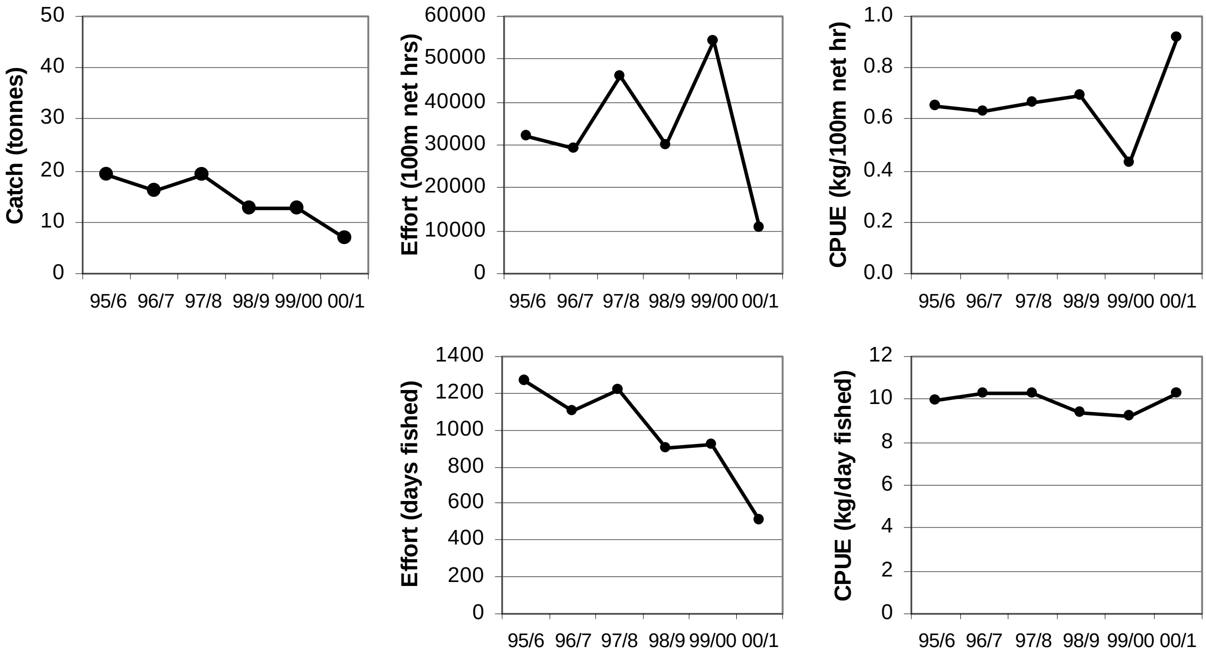


Fig. 6.5. Annual graball catch, effort, CPUE (catch per unit effort), days fished, and CPDF (catch per day fished) of wrasse.

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 little value in 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 2000/00 catch was within the reference range and was virtually equivalent to the 1999/00 catch, 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.

Since current effort for the primary methods, handline and trap, were within reference values and gillnet effort was below the reference range, effort triggers were not exceeded for any of the methods (Table 6.1).

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, trap and graball were either within reference values or slightly higher and therefore the CPUE trigger was not exceeded. However, these observations should be treated with some caution since the analysis is based on the entire State and not at spatial scales appropriate to the life history of the species.

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.*

During 1998, limited commercial monitoring of the trap fishery found fish within the legal size range made up about 48% of the catch. There is likely to be considerable variability in the size composition of the catch between regions and species, reflecting possible small-scale differences in growth and/or recruitment. Examination of such aspects is the subject to current research projects.

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 individual species level. This clearly has implications for stock assessment, producing uncertainty in the interpretation of fishery indicators. This is especially the case because the two species involved have such different life history strategies. Management of these species would be improved if the two species were separated 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 define population parameters for purple and blue-throat wrasse (including growth and mortality) and to conduct yield per recruit analysis to determine the appropriate size limits.

Although revised size limits did not take effect until after the 2000/01 fishing year, 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. Commercial monitoring of the wrasse fishery is also required because of inferences that can be made about changes in species, size and sex structure of populations, parameters that are likely to provide more suitable biological reference points for this fishery. Commercial fishers are also being encouraged to provide information on the species composition of catches.

7 Southern calamary (*Sepioteuthis australis*)

7.1 Management Background

Annual catches of southern calamary rose dramatically in 1998/99 from historic levels of 20 tonnes and under to almost 100 tonnes, prompting the warning by the Minister for Primary Industries, Water and Environment during August 1999. The Minister announced that management arrangements for southern calamary were under review and restrictions on catch, effort and numbers of operators accessing the resource maybe introduced in the future. In addition, short-term closures of Great Oyster Bay were implemented during October and December 1999 to protect egg production. Similar closures were also implemented in 2000 and 2001.

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.

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 and 3.6 kg and 538 mm dorsal mantle length (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 unpublished data). 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 (Steer unpublished data.).

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.

The range of biological parameters that have been defined for southern calamary in Tasmania are presented in Appendix 7.

7.3 Previous Assessments

The 2000 assessment was restricted to an analysis of trends in catch, effort and catch rates for squid jig and purse seine methods. Although there had been an increase in jig effort (to a historically high level) in 1999/00, a decline in catch rates resulted in an overall drop in catches compared to the previous year. There was further evidence of a shift in the fishery from Great Oyster Bay to Mercury Passage, possibly linked to the impact of the short-term closures in Great Oyster Bay. Catch and effort (squid jig) triggers were exceeded. Although jig catch rates had declined by about 30% in comparison with 1998/99 they were still within reference values.

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 61% of the catch in 2000/01 (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.

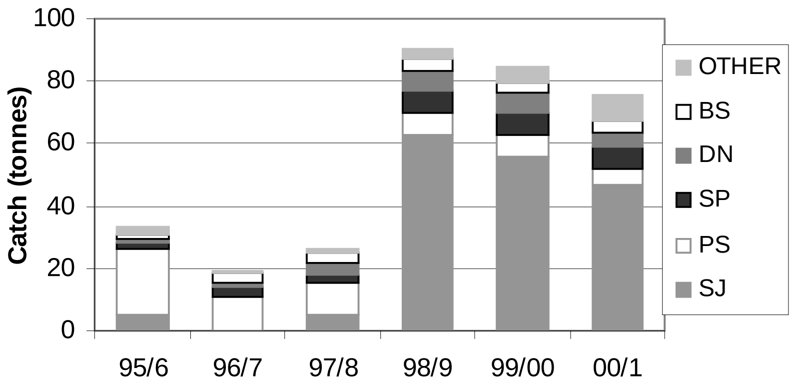


Fig. 7.1. Annual catch of southern calamary by method. SJ is squid jig; PS is purse seine; SP is spear; DN is dip net; BS is beach seine.

7.4.2 Recent Developments

A recent study of the fishery and biology of southern calamary examined aspects of reproductive biology, early life history, size composition and age and growth in Great Oyster Bay (Pecl 2001). In October 1999, a follow-up study was initiated to further examine these population parameters, with research sampling conducted on a more intensive temporal and spatial basis. The size composition and sex ratio of the commercial catch from both jig and purse seine gears were monitored on a monthly basis to determine biological and population characteristics as a function of season, region and fishing method. This research has shown that while overall the size composition of the commercial catch is comparable to that obtained during 1995/96 and 1996/97, the biological characteristics are extremely variable both between and within regions.

A closure to protect spawning squid in Great Oyster Bay was implemented over 2 two-week periods in late October to early December of 1999, with 2 weeks of commercial access allowed in between the closures. During the first of the two closures, densities of eggs on the seagrass increased six-fold suggesting that the either the closure provided protection to the spawning aggregations or promoted an increase in spawning activities (Moltschaniwskyj *et al*. 2002). An increase in egg densities did not occur over the monitored sites during the second closure, however, the reproductive condition of the females had declined by this time. A similar system of closures in Great Oyster Bay was implemented between October and December 2000, with egg densities again monitored during open and closed periods. Results of this research have yet to be fully synthesised.

Although Great Oyster Bay continued to be an important focus for fishing activity, evidence from regional effort data suggested that the closures have encouraged fishers to target areas outside of this region (Moltschaniwskyj *et al*. 2002).

Recent research has also examined levels of mortality occurring within the egg masses laid in Great Oyster Bay. This has shown that mortality of individual eggs can be significant, sometimes as high as 20%, and is also highly variable temporally. Work is currently progressing to establish relationships between egg mortality rates and environmental parameters such as temperature.

A research and management forum (August 2001) involving industry provided general support to the use of short-term staggered closures in Great Oyster Bay to allow spawning to occur over an extended period and thus accommodate temporal variability of spawning by adults and mortality of the eggs. The need to take a precautionary approach to future development (and management) of the fishery, given the biology of the species, was also generally recognised.

During the 2001/2002 fishing season, fishers began reporting the presence of discoloured squid with spongy tissues, lesions over most of the body, and a distinct rotting odour. Based on information obtained from the fishers, Great Oyster Bay, Mercury Passage and Port Arthur appeared to be the areas most affected, with an estimated 10-30% of the catch unsaleable. In January 2002 four squid with these characteristics were captured from Mercury Passage and Great Oyster Bay and sent to the Fish Health Unit for analysis of muscle and skin tissues. These tests revealed evidence of parasites and disease, although it was unclear if this was a function of a primary or secondary infection. Generally, squid typically form body lesions as part of the senecesence process, and it is possible that microbes may subsequently enter the tissues via the lesions. It should be noted however, that southern calamary have in the past been very rarely caught with evidence of skin lesions, and it is likely that the parasites and microbes were a primary infection. The last reported incidence of infected squid was in February 2002, with recent catches in all areas apparently free of infection at the time of the current assessment.

7.4.3 2001 Assessment

Over the past three years a significant fishery for southern calamary has developed in Tasmania, with catches expanding rapidly from less than about 30 tonnes p.a. prior to 1998/99 to between 76-90 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 76 tonnes represents about a 10% decline over the catch for 1999/00, but is still substantially higher than catches during the reference period.

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 and effort data have not been reported.

Statewide, jig effort (gear units) increased again in 2000/01, up by 16% from the 1999/00 peak. There was, however, a fall in the number of days fished, suggesting that, on average, operators spent more time (jig hours) fishing each day in the most recent year (Table 7.1). Jig catch rates fell for the second year running but remained within reference values. By contrast, purse seine catch rates remained relatively stable over the past two years but at a level outside (below) reference values. In any case, the shift in the fishery away from purse seines 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 key fishing regions, namely Great Oyster Bay (blocks 6H1, ES13 & ES14), Mercury Passage (6H3, 6G4 & ES16) and Tasman Peninsula (7G2). Collectively these regions accounted for 70% of the 2000/01 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 two years, with similar catch levels currently reported for the two regions (Fig.7.2). This shift can be attributed to increased fishing in Mercury Passage, at least partly a response to the short-term fishing closures imposed during 1999 and 2000 in Great Oyster Bay. Catch rates, based on gear units and daily catches, have declined in each of the two regions over the past 2-3 years and were very similar in magnitude in 2000/01. In comparison to peak levels, the 2000/01 jig catch rates (gear units) were down to just 33% and 41% for Great Oyster Bay and Mercury Passage, respectively. Although relatively small, Tasmania Peninsula catches rose slightly over the past three years, reflecting increased effort and fluctuating (not declining) catch rates. Interestingly, by 2000/01 catch rates for the more productive regions, Great Oyster Bay and Mercury Passage, had fallen to a level comparable to that for Tasman Peninsula.

Around 7.7 tonnes of calamary was reported as handline catch in 2000/01, representing more than a two-fold increase when compared to the previous year. As the majority of this was probably taken using jigs it effectively represents a further increase in effort for this gear type.

The resource status of southern calamary is unknown and the sustainability of current catch levels is 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 can not be shown.

Method	*Year*	*Catch (tonnes)*	*Effort (gear units)* +	*CPUE (kg/gear unit)* +	*Effort (Days)*	*CPUE (kg/day)*
Squid jig	1995/96	*	*	10.0	*	77.1
	1996/97	0.3	127	2.6	18	16.7
	1997/98	5.3	687	5.6	114	29.5
	1998/99	62.9	6571	9.0	498	81.9
	1999/00	55.8	7458	6.2	713	51.5
	2000/01	46.5	8683	4.3	647	46.6
Purse seine	1995/96	21.0	322	31.1	139	63.6
	1996/97	*	*	28.6	*	51.7
	1997/98	*	*	29.8	*	54.0
	1998/99	*	*	27.0	*	37.8
	1999/00	6.9	203	20.3	95	39.3
	2000/01	*	*	21.4	*	36.9

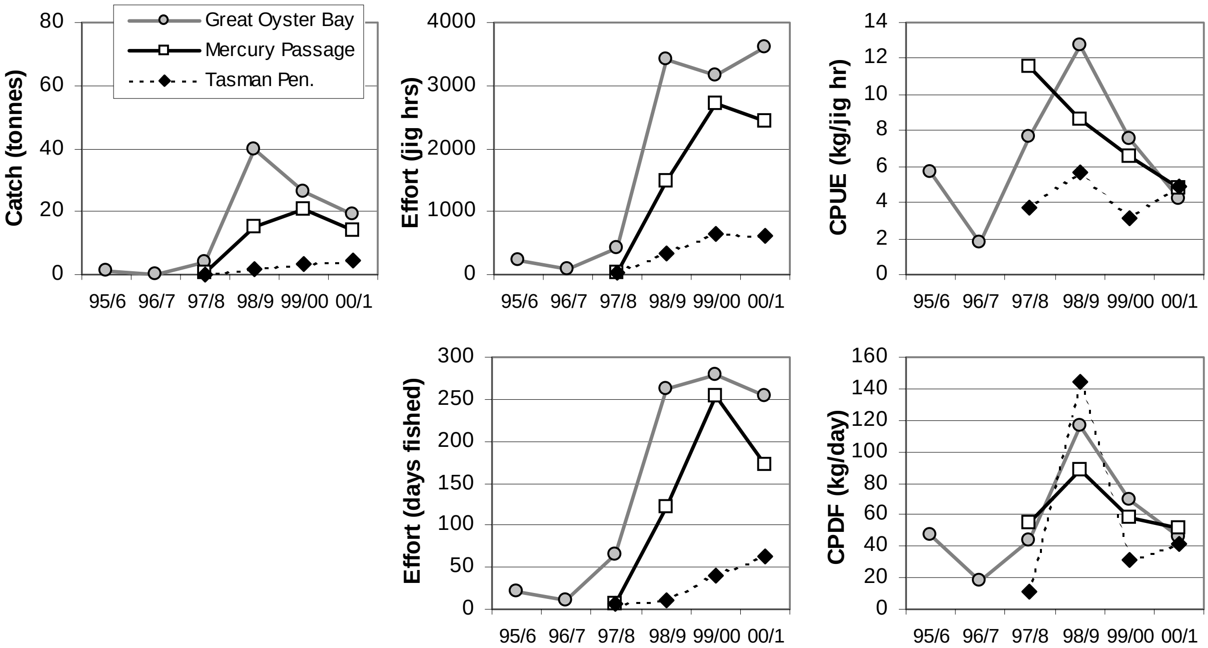


Fig. 7.2. Annual squid jig catch, effort and CPUE by major fishing region for southern calamary.

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 2000/01 catch of southern calamary was clearly in excess of catches for the period 1990/91 to 1997/98, indicating that the catch trigger was exceeded for the third year running. Although the catch was lower than 1999/00, the decline of about 10% did not exceed the second catch trigger. The fishery appears to be at least fully developed. If the decline in catch from that taken in 1999/00 is repeated in 2001/02 there would be cause for concern that the fishing mortality imposed on the stock is having a detrimental effect.

As noted above, 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.

Purse seine fishing effort has remained relatively stable over the past six years indicating this effort trigger has not been reached. By contrast, jig effort increased again in 2000/01 by 16%, and possibly even more if effort reported as 'handline' is combined with the jig effort. Current jig effort is substantially higher than the reference period and therefore the effort trigger has been exceeded for the second 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.*

Although overall 2000/01 jig CPUE was within the reference period range, it was about 30% lower than for the previous year, with declines occurring in two (Great Oyster Bay and Mercury Passage) of the major fishing regions. Purse seine catch rates remained relatively stable but were around 75% of the lowest value for the 1995-97 period. As such this trigger point was exceeded for purse seine.

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. The influence on catch rates of the seasonal closure of Great Oyster Bay is uncertain, however the fact that declines were also experienced in other areas is of concern and warrants closer scrutiny.

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 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.

There is little information available on the stock structure of southern calamary, which is required before the appropriate size of spatial management regions can be developed.

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.

Spawning season closures in Great Oyster Bay have been shown to provide some protection to spawning animals and current research may allow the timing of future closures to be made on a biological basis that offers maximum protection to spawning aggregations.

Seagrass is important to the life history of southern calamary and therefore the distribution and health of seagrass beds is an important issue for the species. Recent reports of large reductions in the size of seagrass beds around Tasmania are of concern.

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.

8 Arrow squid (*Nototodarus gouldi)*

8.1 Management Background

Arrow squid were first targeted in Tasmania in the early 1970's by fishers operating in the Derwent estuary. At this time, around 30 fishers landed over 150 tonnes over a two-month period. However, prior to this unusual occurrence, the only catches of arrow squid were taken as a by-catch to otter trawling, Danish seining and trolling.

In the late 1970's to early 1980's, Japanese, Korean and Taiwanese fishing interests targeted arrow squid in waters off South Australia, Victoria and Tasmania using vessels geared up with automatic squid jigging machines and fish attraction lamps.

A domestic arrow squid fishery developed in the late 1980's in Commonwealth waters using automatic squid jigging gear developed by the Japanese. This fishery has expanded to include around 40 active participants in the Southern Squid Jig Fishery. These fishers predominantly target arrow squid in western Bass Strait, where catches steadily increased to around 2,000 tonnes by 1997 and then declined to around 400 tonnes in 1998.

The South East Fishery and Great Australian Bight Trawl Fisheries also take arrow squid as a by-catch of trawling in Commonwealth waters. Annual catches have remained relatively consistent around 400 - 600 tonnes since 1986.

Under the initial Tasmanian scalefish management plan, all scalefish and rock lobster licence-holders were entitled to use an unrestricted number of squid jigs. Until recently, the Tasmanian arrow squid fishery was based around diversified fishers periodically targeting arrow squid using squid jigs by hand or semi-automatic fishing devices. The fishery expanded rapidly between November 1999 and February 2000 when approximately 400 tonnes of arrow squid were taken in State waters (mainly Storm Bay) by vessels using automatic squid jigging gear. Most of these vessels also participate in the Southern Squid Jig Fishery.

In April 2000, the Tasmanian Minister for Primary Industries, Water and Environment issued a press statement warning fishers against investing in automatic squid jigging gear and fish attraction lamps. The Minister also made fishers aware that management arrangements for this fishing sector would be reviewed, and that catches taken after the press release date might not be taken into account in any determination of future access to the resource. In November 2000, the Minister advised that State waters would be closed temporarily (between December 2000 and February 2001) to large-scale automatic jig operators, unless otherwise authorised by permit. About 15 arrow squid permits were issued.

Long-term management of the arrow squid fishery was addressed as part of the 2001 review of the management plan with the introduction of a fishing licence (automatic squid jig). Eligibility was based on catch history (minimum of 5 tonnes of arrow squid between 1 January 1995 and 30 April 2000) or investment (demonstrated financial commitment of at least $20,000 in automatic squid fishing gear in the period 1 June 1999 and 30 April 2000) criteria. A total of 17 automatic jig licences have been issued. Furthermore, under the reviewed management plan, holders of scalefish C licences (but excluding those who also hold beach seine or purse seine licences) are restricted to a combined possession limit of 30 calamary and arrow squid.

8.2 Stock Structure and Life-history

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 along with the related species, *N. sloanii*. Arrow squid are an oceanic squid but are commonly found schooling in shallow coastal and estuarine waters at certain times of the year (Winstanley *et al.* 1983). Stock structure within Australian waters is not known at present and it is unclear whether the Australian and New Zealand populations form a single genetic stock.

Arrow squid aggregate near the seabed during the day and disperse through the water column at night to feed (Winstanley *et al*. 1983, O'Sullivan and Cullen 1983). Their diet consists mainly of planktonic crustaceans, fish and other squids (O'Sullivan 1980). The main predators of arrow squid are seals, dolphins, tuna and benthic and bathypelagic fishes including school shark (Coleman and Hobday 1982).

As a general group, squid are fast growing, short-lived animals. Arrow squid are thought to live for up to 12 months. Females grow larger than males and reach 1.4 kg and 370 mm ML, males reach 1.0 kg and 330 mm (Harrison 1980).

Based on length frequency information, early research on arrow squid in Tasmania suggested that there were at least three separate broods or cohorts a year. These were termed the winter, spring and summer broods (Harrison 1980). More recent work based on ageing using statoliths has revealed that growth rates are highly variable in response to ecological parameters, such as temperature and productivity, and that length is not a reliable indicator of age.

Males store sperm in spermatophoric packages that are transferred to the female using a single modified arm called a hectocotylis. Females are mated before they mature and store the sperm packets in buccal pouches around the mouth. Eggs are fertilised as they emerge from the ovary and are transferred to a gelatinous mucous ball produced by the female (Harrison 1980). It is not known whether the egg mass is free floating or attached to the substrate. Naturally spawned egg masses for arrow squid have not been identified and studied. Based on studies of other oceanic species, it is thought that fertilised eggs develop and hatch in 1 to 2 months, depending on water temperature.

8.3 Previous assessments

The only previous assessments are restricted to the examination of catch, effort and catch rate trends for the jig sector and a 2001 fishery status report (Willcox *et al*. 2001).

The expansion of the fishery in 1998/99 and again in 1999/00 triggered catch and effort performance indicators. The primary management responses have been to limit the use of automatic squid jigs through the introduction of automatic squid jig licences and the introduction of trip limits for holders of scalefish C licences.

8.4 Current Assessment

8.4.1 The Fishery

The Tasmanian fishery targets schools of arrow squid that form in coastal waters between October and March. The recent expansion in the fishery was attributed to a dramatic increase in squid jig effort in 1998/99, and in particular automatic jig effort. Annual catches increased from less than 10 tonnes during the 1990's to 80 tonnes in 1998/99. In the following year 480 tonnes were taken, 75% of which was caught using automatic jigs. In 2000/01 there was a sharp drop in catches with just 40 tonnes caught (Fig. 8.1). The introduction of automatic jig vessels into the fishery has had a profound impact on catches, particularly in the 1999/00 season (Fig. 8.1).

The Tasmanian fleet consists of a small number of large commercial automated jig vessels (with four to eight jig machines), most of which also participate in the Commonwealth squid fishery, and a large number of smaller, diversified operators. Some of these diversified operators have recently invested in a small number of automated jig machines (one or two) and lights. Others have constructed semi-automated systems whilst, at the most basic level, hand operated lines with one or more jigs attached are used. Smaller operators tend to have success fishing during the day in shallow water while automatic jig boats fishing at night have the highest catches in waters ranging from 20 to 100 m. Thus the capacity to harvest large quantities of arrow squid in Tasmanian waters now exists and catches are primarily limited by availability.

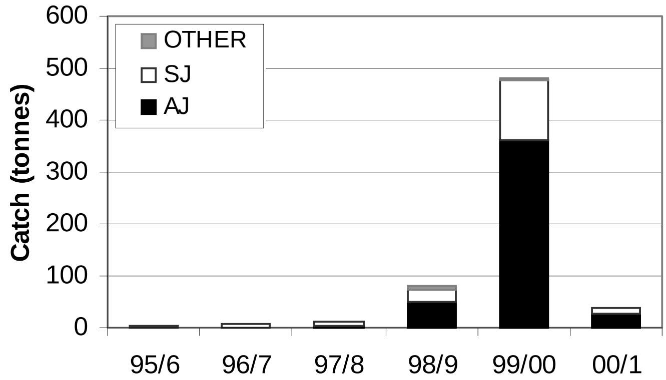


Fig. 8.1. Annual catch of arrow squid by method. SJ is squid jig; AJ is automated jig system.

8.4.2 Recent developments

Biological sampling of commercial catches commenced in 1999/00 and continued through 2000/01. In addition to strong inter-annual variability in the availability of squid (as evidenced by catches), the biological characteristics of the catch differed between and within seasons (Willcox *et al*. 2001). In both years, catches early in the season consisted of small, immature individuals, with some evidence of modal progression in size during the season. In 1999/00, the proportion of mature females increased as the season progressed (to February) whereas as the proportion of mature females declined over time in 2000/01. In 2000/01 this was a consequence of both an influx of small animals in late December, possibly a second cohort, and the gradual disappearance of larger mature animals. Interestingly, this bi-modality in the size structure was not evident in 1999/00. Highly plastic growth rates prevent forming simple links between size and age.

8.4.3 2001 Assessment

There was a dramatic expansion in the arrow squid fishery over the past three years, with catches peaking at about 480 tonnes in 1999/00 (Table 2.1). The increased catches have been almost exclusively due to targeted squid jig effort, in particular the operation of automatic squid vessels[4] (Fig. 8.1, Table 8.1).

Given the recent expansion in the fishery, catch, effort and CPUE trends will not be very informative. Arrow squid occur seasonally in coastal waters and availability is highly variable between years, as evidenced by the tenfold fall in catch in 2000/01 despite the significant commitment in fishing effort (Table 8.1). Daily catches for automatic jig operators were very poor (< 20% of 1999/00 levels) though overall catch rates (gear units) were slightly higher than those for the previous year. This apparent contradiction suggests that only limited time was actually spent fishing each day, presumably as operators searched for viable concentrations of squid.

The impact of taking large quantities of juvenile squid out of the population on subsequent spawning success is unknown. There are, however, indications that not only is the availability of arrow squid highly variable between years but the size (and maturity) of squid varies between and within seasons. The effects of taking large quantities of squid over a short period of time and from a very limited area (Storm Bay) on the squid population and more broadly on the general ecosystem is not known.

The resource status of arrow squid is unknown and the sustainability of current catch levels is uncertain. The fact that arrow squid probably 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. The relationships between arrow squid populations from southeastern Tasmania and those exploited in the Commonwealth fishery in Bass Strait is not known. By contrast to the Tasmanian fishery, Commonwealth jig and trawl catches in 2000/01 (approximately 2,600 tonnes) were the second highest on record (AFMA 2002).

[4] Automated jig systems have been defined as operations using more than 100 jigs (mostly >200 jigs), whereas jig operations refer to operators using hand operated or semi-automated systems involving less than 100 jigs (mostly < 60 jigs).

Table 8.1 Catch, effort and CPUE key fishing methods for arrow squid.

+ For gear units refer to Table 2.3. * 5 or fewer vessels involved, data can not be shown.

Method	*Year*	*Catch (tonnes)*	*Effort (gear units)* +	*CPUE (kg/gear unit)* +	*Effort (Days)*	*CPUE (kg/day)*
Squid jig	1995/96	3.5	7579	0.25	46	17.8
	1996/97	6.1	10342	0.81	50	25.7
	1997/98	9.5	3444	3.26	71	80.5
	1998/99	25.3	3565	5.14	95	127.6
	1999/00	116.1	165745	1.85	284	291.4
	2000/01	11.5	7310	2.38	63	100.3
Auto jig	1996/97	*	*	0.04	5	36.8
	1997/98	*	*	0.52	8	190.8
	1998/99	*	*	0.17	64	293.5
	1999/00	360.4	792511	0.29	309	700.0
	2000/01	27.5	271100	0.05	105	122.2

8.5 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 2000/01 catch of about 40 tonnes was slightly higher than reference catch levels but represented a 90% reduction over the previous year and therefore both catch triggers were exceeded. It should be expected that for a species such as arrow squid, availability will vary naturally between and with seasons and therefore catch triggers have little meaning, particularly if considered in isolation of the wider fishery (i.e. inclusive of catches from the Commonwealth fishery).

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.

Although automatic jig effort was substantially lower in 2000/01, it was still significantly greater than reference levels and therefore the effort trigger was exceeded for the third year running. By contrast, non-automatic jig effort remained within reference levels.

With the advent of automatic jig operations, industry now has the capacity to harvest large quantities of squid when available and can be expected to be responsive to changes in squid availability, with fishing activity concentrated where and when squid abundance is high.

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.*

Jig CPUE is unlikely to be a very reliable indicator of abundance since arrow squid are a schooling species and are generally attracted to the fishing vessel through the use of lights. Notwithstanding this, both jig CPUE measures were within the reference range of values and the catch rate triggers were not reached.

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.*

Catch sampling for 1999/00 and 2000/01 seasons indicated that the bulk of the catch was comprised of small and immature individuals. The impact of taking large quantities of juvenile squid on the population is not known but if there is an effect it will be a negative one. There were marked differences in size structure of catches between seasons, the significance of which remains unclear.

8.6 Implications for Management

The sporadic nature of the arrow squid fishery in south-east Australia has been due in part, to economic viability, as dictated by world supply and demand for squid, and to fluctuations in the quantity of fish available to the jig fishery. Some variation in effort may also be due to fluctuations in the performance of other southeast Australian fisheries that have the effect of forcing fishers to look to alternative species such as squid.

A significant body of latent effort exists in the Tasmanian arrow squid fishery in the form of Commonwealth automated jig boats that are increasingly looking to maximise the length of their fishing season. Arrow squid become available to the jig fishery in Tasmania as early as November as opposed to February in Bass Strait. By fishing in Tasmanian waters, Commonwealth operators can increase the length of the season by up to 4 months. There was, therefore, an urgent need to address the issue of access by large-scale operators to the fishery and this has been addressed within the context of the 2001 scalefish management plan review.

A number of characteristics particular to squid populations make management of such fisheries particularly difficult. The short life span means that essentially a new population has to be managed each year, although it should be noted that recruitment over-fishing is a possibility if too many juvenile squid are taken. Also, the extreme plasticity of growth in squid means that the more traditional use of length frequency relationships in management and assessment techniques are not valid. Ageing of individuals is a much more powerful tool for determining population dynamics. The implications of harvesting large quantities of immature squid from a relatively small area (principally Storm Bay) on potential yield and stock status are unknown but some degree of caution would be prudent. Very little is known about the population dynamics and stock structure of arrow squid in Australian waters at this stage.

Given the existence of squid fisheries in waters adjacent to Tasmania it would also be prudent to consider management of the Tasmanian fishery in the context of the wider fishery off southern Australia.

8.7 Research Needs

The need for research into arrow squid, in particular in relation to monitoring size/age structure and reproductive condition as a means of supporting management, was identified as a high research priority by the 1999 - 2004 Tasmanian Fisheries and Aquaculture Strategic Research Plan. Very little is known about the ecology and population dynamics of arrow squid populations around Tasmania. Various studies have been conducted since the early 1970's and data obtained from these studies have shown a high degree of variability in the distribution and abundance of the species between years. Recent ageing work on squids has revealed that the more traditional use of length frequency analysis may not be an appropriate way to model the populations. Establishing environmental linkages between the distribution and abundance of arrow squid in the context of the overall squid fishery may greatly assist with understanding the dynamics of the populations and explain the inter-annual variability in availability.

The Institute of Antarctic and Southern Ocean Studies are undertaking research into the life history and stock structure of arrow squid off southern Australia.

9 Other key scalefish species

Catch, effort and CPUE for the main fishing methods for Australian salmon, bastard trumpeter, blue warehou, flounder and jackass morwong are presented in Table 9.1. Reference should also be made to Table 2.1 and Fig. 2.1 for recent catch history trends.

Although the total catch of Australian salmon in 2000/01 was more than 30% higher than in the previous year (exceeding the rate of change catch trigger) it was within reference levels (Fig. 2.1). Considering beach seine catches, the general decline since 1997/98 was reversed in the most recent year with 450 tonnes taken, reflecting increased effort (number of sets) rather than increased number of days fished (Table 9.1). In should be noted that catch rates, which were lower than reference levels, are influenced by the extremely skewed nature of the data. That is, the vast majority of catches were relatively small but the total catch was influenced by a very small number of very large catches. In this respect even the geometric mean approach to calculating catch rates may provide a biased estimate and, in any case, if searching time is not included, catch rates are probably not a sensitive indicator for a schooling species such as Australian salmon.

Bastard trumpeter catches declined further in 2000/01 to below reference levels (Fig. 2.1), mainly as a consequence of reduced graball effort (Table 9.1). Catch rates did not exceed trigger levels, though daily catches were very close to the reference year that had the lowest rate. Bastard trumpeter, like the related striped trumpeter, exhibit strong recruitment variability that can result in short-term variability in catch rates. 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.

The blue warehou catch fell sharply in 2000/01 to less than the minimum level for the reference period, triggering both catch performance indicators (Fig 2.1). Since 1995/96, graball catches rose to a peak of almost 260 tonnes in 1998/99 and subsequently fell to just 30 tonnes in the 2000/01. 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 catches in 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 needs to be considered in the context of the overall fishery. Recent analyses of fishery dependent indicators for the South East Fishery (trawl and non-trawl) suggest that there has been a significant decline in blue warehou abundance in recent years.

Flounder catches have declined steadily since 1995/95 and are currently below the minimum reference level, at just 10 tonnes (Fig. 2.1). Industry members noted that while there had been a decline in resource availability there have also been changes in the markets for the species, which have impacted on the amount of effort targeted at the species. Consistent with this observation, has been the general reduction in graball and spear effort, with spear catch rates consistent with reference values but daily catches for graball nets lower than trigger values (Table 9.1).

The performance indicator for catch was triggered for jackass morwong, with the 2000/01 catch the lowest since 1990/91 (Fig. 2.1). Jackass morwong are taken by a variety of methods, the most important being graball net. It is apparent from Table 9.1 that the decline in graball catch was due to a reduction in effort, with catch rates comparable to reference years. As for blue warehou, jackass morwong are taken by trawl methods in Commonwealth waters, where catches are significantly greater than those in State waters. Interestingly, trawl catch rates in 2000 were the lowest since 1990, though the resource implications for this decline remains poorly understood.

Table 9.1 Catch, effort and CPUE by method for key species for the period 1995/96 to 2000/01.
[+] For gear units refer to Table 2.3.

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	454.0	247	129.94	102	189.7
Bastard trumpeter	Graball	1995/96	59.4	76986	0.87	2408	13.9
		1996/97	50.3	80101	0.74	2074	12.3
		1997/98	39.6	58508	0.69	1825	11.5
		1998/99	46.1	60421	0.78	1860	12.0
		1999/00	34.4	70974	0.67	1808	11.2
		2000/01	24.8	38768	0.88	1274	10.8
Blue warehou	Graball	1995/96	50.6	42045	0.77	786	25.4
		1996/97	111.9	86533	1.06	1340	32.0
		1997/98	176.3	118660	1.36	1801	41.5
		1998/99	257.2	98122	2.07	2126	50.0
		1999/00	173.5	94437	1.68	1762	45.2
		2000/01	29.3	18266	1.07	553	22.9
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	4.1	11112	0.22	215	8.8
	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	6.13	146	22.9
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	8.5	5944	1.18	309	14.8

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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*[5].

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

ii) Effort Problems

Records where effort (based on gear units, refer to Table 2.3) was zero or null, or appeared to be recorded incorrectly (that is implausible), were flagged. The catch was included in catch summaries but the records were not included in gear unit effort and catch rate calculations. These records were, however, used in calculating days fished and daily catches.

iii) Vessel restrictions

In all analyses of catch and effort, catches from six vessels (four Victorian based and two Tasmanian based) have been excluded. These vessels were known to have fished consistently in Commonwealth waters and their catches of species such as blue warehou and ling tended to significantly distort catch trends. In fact, all four Victorian vessels and one of the Tasmanian vessels ceased reporting on the General Fishing Returns in 1994. With the introduction of the South East Fishery Non-Trawl logbook (GN01) in 1997, the remaining Tasmanian vessel ceased reporting fishing activity in the Tasmanian logbook.

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

Commonwealth logbook data:

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

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.

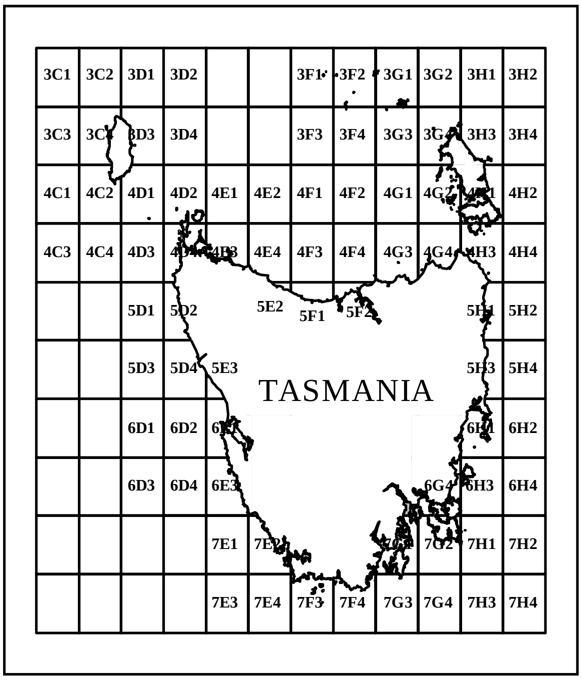

Fig. A1 Block numbers for fishing blocks used in calculation of catch figures.

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.

Appendix 3. Biological parameters for striped trumpeter in Tasmania.

	Growth			Longevity	Mortality		Reproduction		Recruitment Inshore Fishery		Length-Weight		
	L_{inf}	K	t_0	A_{max}	Z	M	Age	Size	Age	Size	a	b	Author
Females	72.9	0.89	-1.258		-	-					0.034	2.77	unpubl.
Males	72.9	0.89	-1.258		-	-					0.034	2.77	
Females							5	43.8					Hutchinson (1993)
Males							8	53.4					
Females									5				Murphy and Lyle (in prep)
Males													

Appendix 4. Biological parameters for banded morwong in Tasmania

	Growth			Longevity	Mortality		Reproduction 50% mature		Recruitment		Length-Weight		
	L_{inf}	K	t_0	A_{max}	Z	M	Age	Size	Age	Size	a	b	Author
Females	43.2	0.098	-11.3	77	0.02-0.04	0.059	4-5	32.4			0.0318	2.91	Murphy & Lyle (1999)
Males	51.2	0.161	-2.7	65	0.06-0.07	0.071					0.0309	2.91	
Females - non spawning											0.0371	2.847	
Females - spawning											0.0329	2.902	
Males											0.0301	2.912	
Females - Bicheno	43.2	0.113	-10.0										
Females Tasman	43.1	0.082	-13.7										
Males - Bicheno	50.9	0.178	-2.5								0.0318	2.901	
Males - Tasman	51.6	0.149	-2.8								0.0309	2.901	

Appendix 5. Biological parameters for sea garfish in Tasmania

	Growth			Longevity	Mortality		Reproduction 50% mature		Recruitment		Length-Weight		
	L_{inf}	K	t_0	A_{max}	Z	M	Age	Size	Age	Size	a	b	Author
Females	34.3	0.54	0.23						2	~25 cm			Jordan *et al.* (1998)
Males									2	~25 cm			
Females	37.3	0.62					2				3.08	3.85	St Hill (1996)
Males	36.4	0.59					3				3.05	3.45	

Appendix 6. Biological parameters for purple and blue-throat wrasse in Tasmania

	Growth			Longevity	Mortality		Reproduction 50% mature		Recruitment		Length-Weight		
	L_{inf}	K	t_0	A_{max}	Z	M	Age	Size	Age	Size	a	b	Author
Purple													
Males/Females	39.9	0.12	2.36	16			2	~15					Barrett (1995)
Males/Females									7	28	0.05	2.71	unpubl.
Blue-throat													
Males/Females	36.1	0.20	-0.35	9			2	~15					Barrett (1995)
Males							5-9	27-32					
Males/Females									6-7	28	0.05	2.71	unpubl.

Appendix 7. Biological parameters for southern calamary in Tasmania

	Growth			Longevity	Reproduction (minimum age & size)			Recruitment			Length-Weight		
	Maximum Length (ML)	Maximum Weight (g)	% BW day^{-1}	Maximum Age (days)	Age (days)	Length	Weight	Age	Length	Weight	a	b	Author
Females	398	2008	4-8%	263	117	147	120	90-120 days	100-110 mm	60-120g	0.00042	2.56	Pecl (2000)
Males	530	3600		275	92	114	63				0.00049	2.50	Pecl (2000)

ML: Dorsal mantle length in mm, %BW day^{-1}: increase in percentage body weight per day.