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TASMANIAN SCALEFISH FISHERY ASSESSMENT - 2000

Compiled by J.M. Lyle and K. Hodgson

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

The SFAWG met on 14 December, 2000 to consider background documents and provide input into the assessments. The Working Group participants were:

Assoc. Prof. Malcolm Haddon	Chair
Dr Jeremy Lyle	Senior Research Scientist (TAFI)
Ms Kate Hodgson	Research Assistant (TAFI)
Mr Dennis Witt	Manager, Wild Fisheries (DPIWE)
Mr Sean Riley	Manager, Finfish (DPIWE)
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This series provides general fishery assessment reports by the Tasmanian Aquaculture and Fisheries Institute. The documents are not intended as definitive statements but rather as progress reports on the current status of ongoing assessments derived from research and monitoring programs.

Scalefish Fishery Assessment 2000

Summary

The Tasmanian scalefish fishery is a multi-species commercial fishery involving a wide variety of fishing methods. In addition, many scalefish species are 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. Catch history for the period 1990/91 – 1999/2000 is presented, with more detailed analyses of catch and effort by method for the period 1995/96 – 1999/2000. An important improvement in the analysis of catch and effort information has been the inclusion of Commonwealth logbook data for dual endorsed operators fishing in Tasmanian waters. These data were not available in the previous assessments.

Effort and catch rate (catch per unit effort - CPUE) information are presently only available for a five year period, the first three years being used as the reference period to define the trigger points. In this regard there are only two years of data available to assess fishery performance.

The most important developments in the fishery since 1997/98 have been the significant increases in dropline, spear, dip net and squid jig effort. For all but squid jig, 1999/2000 effort levels were between 10-40% higher than during the reference period (Table 1). Squid jig effort had increased around one hundred-fold over the reference period, reflecting increases in effort targeted at southern calamary and especially automatic jig effort targeted at arrow squid. It is noteworthy that these methods are available to all holders of scalefish licences. In terms of days fished, however, only dropline and jig effort exceeded reference levels, suggesting that for the other methods that exceeded the effort triggers, more gear or time per day was spent fishing.

By contrast, effort levels declined for methods regulated through limited entry (eg. purse seine, beach seine). Graball net effort also declined markedly, presumably reflecting the impact of new management arrangements that prescribe and limit the amount of gear that can be used by each scalefish licence category.

Table 1 Effort trigger point assessment by major fishing methods
Y triggered , N not triggered, , * 10-40% increase, ** > 40% increase

	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)	Y*	Y*
Handline	N	N
Troll	N	N
Fish trap	N	N
Spear	Y*	N
Dip net	Y*	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 CPUE data. Descriptions of these fisheries, including fishing methods, seasonality and spatial distribution of catches were provided in previous assessment reports and have been updated here.

Striped trumpeter

The 1999/2000 catch of striped trumpeter, while slightly lower than in 1998/99, was higher than catches taken during the reference period. Handline catches have continued to increase since 1995/96 while dropline and graball net catches fell slightly by comparison with 1998/99. Catch rates for dropline fishing rose whereas graball catch rates fell in the current year. By comparison, CPUE for handline fishing has remained relatively stable over recent years. Particularly strong recruitment of 1993 and 1994 cohorts appears to have contributed to the recent catch and catch rates for handline and dropline methods. The resource status is unknown, but indicators based on catch and effort are likely to be strongly influenced by recruitment variability.

The triggers for total catch and handline effort in striped trumpeter were exceeded in 1999/2000.

Banded morwong

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, falling further in 1999/2000 to 29 tonnes due primarily to a large decrease in effort and declines in CPUE. Declines in catch and effort were evident in most east coast fishing blocks.

Banded morwong are long-lived (up to 80 years) and productivity appears to be very low. In addition, the species demonstrate strong site attachment, suggesting that it 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 block and regional levels may be insensitive more localised changes in abundance.

The 1999/2000 catch was lower than the minimum reference level (1994/95 to 1997/98) and had declined by greater than 30% compared to 1998/99. As a consequence both catch triggers were exceeded. Furthermore, despite a decline in fishing effort, state-wide and regional (St Helens, Schouten and Maria) catch rates had declined to below 80% of the lowest reference level and therefore the catch rate trigger was also exceeded.

Catch and catch rate indicators demonstrate the impact of the fishery on the banded morwong population and suggest that the sustainability of the fishery, even at current levels of exploitation, is uncertain.

Sea garfish

Sea garfish catches declined slightly compared to 1998/99, due mainly to a fall in the dip net catch, but were within the reference catch range. Effort and catch rates in the dip net sector fell considerably but the fall in catch rates did not exceed the trigger level. Beach seine catch and effort has been relatively stable of the past three years while catch rates have increased in the past two years. Sea garfish are a schooling species and catch rates are not considered to be reliable nor sensitive parameters for indicating trends in abundance. Resource status is unknown.

No triggers were reached for sea garfish.

Wrasse

The development of live fish markets for wrasse has resulted in increased catches since the early 1990's. Two main species are involved, purple wrasse and blue-throat wrasse, though it is not possible to distinguish catches of either species from commercial catch returns. Overall catch declined from 89 tonnes in 1998/99 to 85 tonnes in 1999/2000, reflecting decreases in trap and handline catch and effort. CPUE decreased for all methods in 1999/2000.

Although wrasse are comparatively short-lived, attaining maturity well before they are recruited to the fishery, they demonstrate strong site attachment and therefore, assessment even at the smallest reporting scale (block level) may mask more localised changes in abundance. Resource status is unknown.

No triggers were exceeded for wrasse in 1999/2000.

Southern calamary

The total annual catch of southern calamary again exceeded the maximum obtained over the 1990-1997 period, although catch was slightly less compared to 1998/99. Jig effort continued to escalate, up by 25% from 1998/99 levels, following a six-fold increase in the previous year. Evidence suggests that the short-term closures of Great Oyster Bay in late 1999 were successful in providing some degree of protection to spawning squid. The closures may also have been partly responsible for the distinct shift in the dynamics of the fishery, with Mercury Passage contributing catch and effort comparable to that seen in Great Oyster Bay for the first time.

The resource status is unknown and the sustainability of current catch levels is uncertain. The fact 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 over-fishing.

Catch and effort (jig) triggers were exceeded for the second year.

Arrow squid

The 1999/2000 catch of over 430 tonnes of arrow squid is the highest reported catch of the species from Tasmanian waters and represented a five-fold increase in catch over the previous year. Increased squid jig effort, primarily by automated jig vessels accounted for the majority of increased catch. The catch was concentrated off south-eastern Tasmania and in particular in Storm Bay. Catch sampling revealed that the bulk of the catch was comprised of juvenile squid, much of which was utilised for the bait market.

The resource status of arrow squid is unknown and the sustainability of current catch levels is uncertain. The relationships between arrow squid populations from south-eastern Tasmania and those exploited in the Commonwealth fishery in Bass Strait is not known.

Catch and effort triggers were exceeded for the second year.

Other key species

Catch, effort and CPUE were also examined for blue warehou, Australian salmon, bastard trumpeter, flounder and jackass morwong. These parameters were within the reference criteria for Australian salmon and bastard trumpeter. The 1999/2000 catch of blue warehou, although within the reference range, fell by over 30% compared with the previous year, indicating that the catch trigger was reached. Flounder and jackass morwong catches were also lower than during the reference period, with a fall of over 30% in the catch of jackass morwong compared with 1998/99, indicating that catch triggers were reached for both species. Effort and CPUE triggers for blue warehou, flounder and jackass morwong were not exceeded.

Trigger point summary

Catch, effort and CPUE trigger point analysis for key species are summarised in Table 2. Details of effort triggers by methods for key species are detailed in Chapters 3-9.

Table 2 Summary trigger point assessment for key species –1999/2000.
Y triggered; N not triggered; arrows indicate direction of change; * catch history period for comparison is 1994/95 to 1997/98; ** catch history period for comparison is 1995/96 to 1997/98; # applies only to particular methods.

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

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1 Management Objectives and Strategies

The Scalefish Management Plan was introduced in 1998 (DPIF 1998) and 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 ‘trash’ or 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-method 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 gear in use include traps, Danish seine, otter trawl, dip nets, spears, etc. 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, finfish 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 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, 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 currently represent a significant portion of the total fishery production. 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, are 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 Tasmanian fishery in terms of both volume and value. In December 2000, OCS arrangements between Tasmania and the Commonwealth saw management responsibility for shark passed over to the Commonwealth. In January 2001 individual transferable quotas were introduced for these species. The Southern Shark Fishery Assessment Group (SSFAG) is responsible for school and gummy shark stock assessment.

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).

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 in terms of providing any effort and fishing method information. Limitations of the old catch returns have been discussed in some detail by Lennon (1998) and, in summary, they provide basic information about production levels but are of little value in providing a meaningful basis for effort and catch rate analysis.

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 1 degree blocks), details about effort and depths fished and form of the harvested product.

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 returns

Following the introduction of the Commonwealth non-trawl logbook (GN01) in late 1997, dual endorsed Tasmanian and Commonwealth (South East Non-Trawl and Southern Shark) operators generally commenced recording all of their catch and effort data, including fishing in State waters, in the Commonwealth logbook. These data were not available for the 1998 and 1999 assessments but are incorporated in the present update.

In addition, several dual endorsed squid vessels reported some or all of their state waters fishing activity in the Southern Squid Jig Fishery (SSJF) logbook and these data have also been incorporated in the analyses.

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.

Since Tasmania has assumed management responsibility for striped trumpeter, all catch and effort data for this species have been incorporated in the analyses, including fishing in Commonwealth waters.

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 2000. All catch returns available as at September 2000 have been incorporated in the analyses.

Catch returns for which effort was unrealistically high or low (either due to data entry error or misinterpretation of information requirements by fishers) have been excluded when calculating effort and catch rates but the catches have been included in catch reporting. Effort information for approximately 0.5% of all fishing operations (daily catch records) were considered unreliable.

When reporting annual data, a fishing year from July to June has been adopted. The primary justification being that this period better reflects the seasonality in the fisheries for most species, with catches (and effort) tending to be concentrated between late spring and early autumn.

In generating catch rate statistics the geometric mean of all valid individual records has been calculated. The geometric mean approach is recommended because catch rates tend to be log-normally distributed.

2.2.4 Recreational fishery

A national survey of recreational fishing is in progress and will provide catch and effort information for the recreational sector in 2000/01 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 available 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 2,000 tonnes in the early 1990s to between 1,100 – 1,500 tonnes in recent years. The 1999/2000 catch of 1145 tonnes represented a decline of just over 15% when compared with the previous year. Falls in blue warehou, Australian salmon and jack mackerel catches contributed significantly to the overall drop in scalefish production.

The decline in the reported catch of 'Commonwealth' species (as defined in Table 2.1) since 1997, principally blue eye trevalla, is a consequence of the introduction of the Commonwealth non-trawl logbook and the fact that fishing occurs in offshore Commonwealth waters. Tuna catches have also been reported in Commonwealth logbooks since the early 1990's and, as a consequence, actual catches in recent years are under-represented in the data. Catches of sharks (mainly school and gummy shark) have fluctuated between 1000 and1600 tonnes p.a. since 1990/91 but represent only the Tasmanian component of the Southern Shark Fishery and need to be considered in the context of the wider shark fishery. These data are incorporated as part of the shark stock assessments undertaken by SSFAG and are not considered further here.

The sharp rise in the cephalopod catch in 1999/2000, to almost 600 tonnes, was the result of increased arrow squid catches combined with relatively high catches of calamary and octopus.

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 have remained lower, fluctuating between about 300 - 475 tonnes. The 1999/2000 catch of 345 tonnes represented a decline of 10% compared with 1998/99 but was within the catch range for the reference years 1990/91 – 1997/98. The generally lower landings in recent years were due largely to a decline in the beach seine catch, itself a 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. For the past two years catches were maintained at around 25 tonnes p.a.

Catches of flounder have tended to range between 30 – 40 tonnes, the most recent data indicating a lower catch of around 20 tonnes, slightly below the minimum reported during the reference period.

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 1999/2000 catch of 35 tonnes represented a 25% reduction compared with the previous year. In contrast, striped trumpeter production levels have generally increased since the early 1990's, with annual catches for the past two years exceeding 100 tonnes.

Flathead, jackass morwong and whiting catches all declined between the early 1990's and 1995/96. Subsequent catches have remained relatively stable at levels of below 50 tonnes p.a. A reduction in inshore trawl (otter trawl and Danish seine) activity has largely contributed to these declines (Lyle and Jordan 1999).

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

The development of live fish markets for banded morwong and wrasse during the early 1990's resulted in marked increases in the catch 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 just 30 tonnes in 1999/2000.

Since the early 1990's, blue warehou catches have fluctuated widely, between around 100 – 300 tonnes, with the most recent catch of around 180 tonnes representing a decline of about 34% on the previous year. This species is also harvested in the Commonwealth managed South East Fishery (SEF) by both trawl and gillnet methods.

Arrow squid landings increased sharply from around 85 tonnes in 1998/99 to 434 tonnes in 1999/2000. Although the most recent calamary catch was slightly down on 1998/99, at 87 tonnes, it was still substantially higher than levels during the reference period.

Table 2.1 Annual catch (whole weight) by species for the period 1990/91 to 1999/2000 based on General Fishing Returns and Commonwealth (GN01, GN01A and SSJF) logbook returns.

	Catch (t)									
Species	*90/91*	*91/92*	*92/93*	*93/94*	*94/95*	*95/96*	*96/97*	*97/98*	*98/99*	*99/00*
Alfonsino	0	0	0.1	0	0.1	0.4	1.8	0.9	0	0.2
Anchovy	0	0	3.1	12.9	11.8	5.5	4.2	15.4	2.8	0.1
Atlantic Salmon	0	0	0	1.7	0.1	0	0.2	0	0	0
Australian Salmon	815.9	651.9	867.0	878.8	682.1	413.1	287.3	476.0	384.6	345.7
Barracouta	351.5	268.3	205.4	59.6	25.2	19.9	53.8	65.2	27.6	24.1
Boarfish	7.2	9.4	7.6	10.1	9.1	7.2	10.3	9.7	6.9	7.5
Bream	5.7	3.5	1.4	7.4	7.2	2.5	9.9	1.0	0	0.1
Cardinal fish	0.3	0	0	0	0	0	0	0	0	0
Cod, deep sea	0	0.9	4.6	2.4	1.8	2.2	4.3	0.5	0.1	0.8
Cod, bearded rock	0.6	0.4	0.9	2.4	0.6	4.7	6.5	1.9	2.0	2.1
Cod, red	0.1	0	1.3	1.3	0.5	0.5	1.5	0.5	0.8	1.0
Cod, unspec.	9.3	10.0	4.8	8.4	9.8	64.1	50.5	12.6	7.1	6.2
Dory, john	0.3	0	0	0.1	0.1	0.3	0.1	0	0	0.1
Dory, king	0.8	0	0	0	0	0	0.1	0	0	0
Dory, mirror	0	0	0.4	0	0	0	0.2	0.1	0	0
Dory, silver	0.4	0.5	0	0.4	0.5	0.1	0.3	0.5	0	0.1
Dory, unspec.	1.3	0.8	5.6	0.6	0.4	0.0	0.3	0.6	0.2	0
Eel	0.2	0.5	0.9	2.2	3.1	2.1	1.4	1.7	2.0	1.2
Flathead	165.3	118.1	98.8	121.4	91.1	57.8	51.7	62.9	50.5	60.5
Flounder	44.0	36.8	31.8	27.3	27.1	33.0	29.1	29.7	25.0	18.4
Garfish	80.9	80.1	82.3	82.9	69.3	56.1	91.6	83.0	101.7	90.9
Gurnard	18.6	18.4	13.2	13.1	9.8	9.9	8.5	6.4	2.7	3.8
Gurnard, red	0.1	0.2	1.0	0.6	1.9	0	0	0	0.3	0.9
Gurnard perch	0.1	0.2	1.0	1.0	1.0	0.4	0.1	0.9	1.4	3.5
Hardyheads	0	0	0	0	0	0.2	0.2	0.0	0.2	0.9
Herring, cale	0	0.3	0	0	1.1	1.1	0.5	1.7	0.3	0.2
Kingfish	1.3	0.2	2.8	0.1	0.3	1.1	0.3	0.1	1.3	0.3
Knifejaw	0.2	0	0.1	0.5	0.2	0	0.1	0.2	0.1	0
Latchet	13.9	10.0	6.5	12.4	11.9	6.1	3.3	1.9	1.3	2.3
Leatherjacket	12.2	14.0	13.1	23.3	27.7	14.5	12.5	13.3	12.9	16.5
Ling	5.1	13.6	30.0	41.6	33.2	20.4	23.5	84.1	5.2	3.0
Luderick	0.7	0.6	0.2	1.5	2.4	1.5	0.5	0.3	0.6	0.5
Mackeral, blue	3.0	2.1	0.3	8.5	5.7	1.1	1.9	0.9	3.1	0.6
Mackeral, jack	6.1	11.1	32.8	48.4	39.7	26.2	19.3	19.7	59.8	13.2
Marblefish	0.2	0.9	0.3	1.0	1.8	3.5	5.6	3.0	2.6	4.1
Mixed	99.7	66.1	61.0	52.9	15.0	16.9	19.3	10.6	8.1	7.0
Morwong, banded	7.0	6.9	39.2	145.5	105.8	86.7	78.7	76.3	43.1	29.4
Morwong, blue	0	0.3	0.3	0	0	0	0	0	0	0.4
Morwong, dusky	0.4	0	0	0.1	0.1	0	0	0	0	0
Morwong, grey	0	0.2	1.9	2.5	2.0	0	0.1	0.1	0.3	0
Morwong, jackass	136.9	111.9	83.2	117.6	63.1	27.2	24.4	34.1	18.1	12.4
Morwong, red	0	0	0	0	0	0	0	0	0	0
Morwong, unspec.	2.2	1.9	2.7	5.6	3.3	3.4	2.7	6.7	4.4	3.5
Mullet	31.2	22.2	26.2	19.5	23.8	10.8	11.2	16.1	14.5	21.0
Nannygai	0	0.3	0	1.1	1.1	0.3	1.0	0.2	0.3	0.1
Perch, magpie	1.2	3.2	0.3	5.7	2.7	1.8	1.4	0.6	1.6	0.7
Perch, ocean	1.7	0.2	4.1	4.6	1.3	4.6	13.9	4.3	2.5	4.0

Table 2.1 Continued

	Catch (t)									
Species	*90/91*	*91/92*	*92/93*	*93/94*	*94/95*	*95/96*	*96/97*	*97/98*	*98/99*	*99/00*
Pike, long-finned	0.1	0	0.1	0.3	0.2	0.3	3.1	3.9	9.4	16.1
Pike, short-finned	10.4	9.5	11.0	12.4	18.6	13.7	15.2	17.7	3.2	4.0
Pilchard	0.1	0	0.7	1.7	0.3	1.1	0	0	0	0
Rays bream	0	1.2	0.6	0.2	0.5	2.0	2.0	0.2	0	0
Redbait	0	0.7	0.8	0	0	0.1	0	0	4.0	0
Red mullet	0.4	0	0.2	0.3	0.1	0.2	0.1	0	0	0
Silverfish	0.4	0	0.2	0	0.3	0.0	0.4	0.1	0	0.1
Snapper	0	0	0	0	0.2	0.2	0.2	0.9	1.5	0.6
Stargazer	10.7	3.0	1.2	4.3	1.5	0.2	0	0.3	0.1	0.2
Sweep	1.5	1.4	0.8	0.8	2.0	1.1	0.5	0.6	0.4	0.3
Tailor	0	0	0	0	0	0	0.7	0	0	0.1
Trevalla, unspec.	1.1	20.9	10.0	0.8	1.4	0	0	3.5	0	1.8
Trevalla, white	0.6	0	0.1	0	0.2	0	0.1	0	0.9	0
Trevally, silver	15.0	12.2	2.5	5.9	15.5	5.9	4.5	7.8	8.0	3.7
Trevally, unspec.	5.6	1.4	9.5	2.4	6.1	0	0	0	0	0
Trout	0	0	0.5	0	0	0.4	0.8	3.6	1.1	0.1
Trumpeter, bastard	63.3	37.2	34.0	54.8	50.8	59.7	51.5	40.6	47.2	35.1
Trumpeter, striped	74.5	58.2	52.7	56.5	72.4	60.2	82.3	81.1	107.5	100.9
Trumpeter, unspec.	0.7	0	0	0.4	0.1	0.2	0.1	0.6	3.4	0.1
Warehou, blue	257.6	317.6	187.7	250.1	205.4	82.1	128.9	190.8	274.1	180.1
Warehou, spotted	0.7	0.4	4.2	8.8	3.4	14.6	15.6	4.8	0	0
Whiptail	0	0	0	0	0	0	0	0	0.1	0
Whiting	124.2	152.3	84.3	97.9	81.4	25.4	39.3	48.1	30.4	24.6
Whiting, King George	0.1	0.4	0.1	0.1	0.2	0.1	0.3	0.2	0.2	7.1
Wrasse	57.2	71.7	97.3	142.4	178	83.3	110.1	100.3	90.7	84.8
Other (unspec.)	0	0	0	0	0	0.8	0.5	2.6	0.5	0.3
Total scalefish	**2449.9**	**2154.1**	**2134.7**	**2367.1**	**1933.5**	**1258.9**	**1290.0**	**1551.8**	**1379.0**	**1147.5**
Cephalopods										
Calamary	8.2	7.5	5.8	9.7	12.6	33.0	19.0	26.6	94.4	87.0
Cuttlefish	0.5	0.7	0	1.1	0.8	0.2	0.3	0.2	0	0
Octopus	32.2	35.2	47.4	58.2	55.3	76.8	40.8	43.4	85.4	65.3
Squid, arrow	35.1	7.2	7	7.7	8.6	5.7	7.9	12.9	85.6	434.1
Total cephalopod	**75.9**	**50.6**	**60.2**	**76.7**	**77.3**	**115.7**	**67.9**	**83.0**	**265.4**	**586.4**
'Commonwealth' sp.										
Blue grenadier	3.6	0.1	3.2	5.2	4.2	8.9	12.3	1.7	0	0.1
Gemfish	3.4	1.7	1	0.4	0.9	5.0	6.1	2.9	0.1	0
Hapuka	7.2	4.9	19.1	21.4	16.0	2.7	1.7	4.7	0.1	0.1
Oreo	0.5	0	0.1	0	0	0.1	0	0	0	0
Trevalla, blue eye	206.6	296.5	261.2	288.7	347.7	436.4	575.8	138.5	14.0	2.9
Total 'Comm.' Sp.	**221.3**	**303.2**	**284.6**	**315.7**	**368.8**	**453.1**	**595.9**	**147.8**	**14.2**	**3.1**
Tuna										
Tuna, albacore	36.7	72.9	43.4	26.9	3.4	1.4	4.7	5.5	2.5	0.7
Tuna, skipjack	13.8	14.1	8.2	0.6	0.7	0.3	0.4	0.3	6.8	0.5
Tuna, southern bluefin	46.7	24.1	10.8	2.3	1.8	0.6	0.9	0	0	0.2
Tuna, unspec.	11.3	10.2	8.9	4.9	1.1	0.2	0.5	0.4	0.9	0.5
Total tuna	**108.4**	**121.3**	**71.3**	**34.7**	**7.0**	**2.4**	**6.5**	**6.3**	**10.2**	**1.9**
Sharks & Rays										
Shark	1472.7	1114.2	1671.3	1483.8	1427.4	1248.5	1026.5	1128.3	1094.1	1365.6
Skates & Rays	2.6	7.4	5.1	6.3	5.9	6.4	2.1	4.7	7.8	5.5
Total shark & ray	**1475.5**	**1121.6**	**1676.4**	**1490.1**	**1433.3**	**1254.9**	**1028.6**	**1133.0**	**1101.9**	**1371.1**

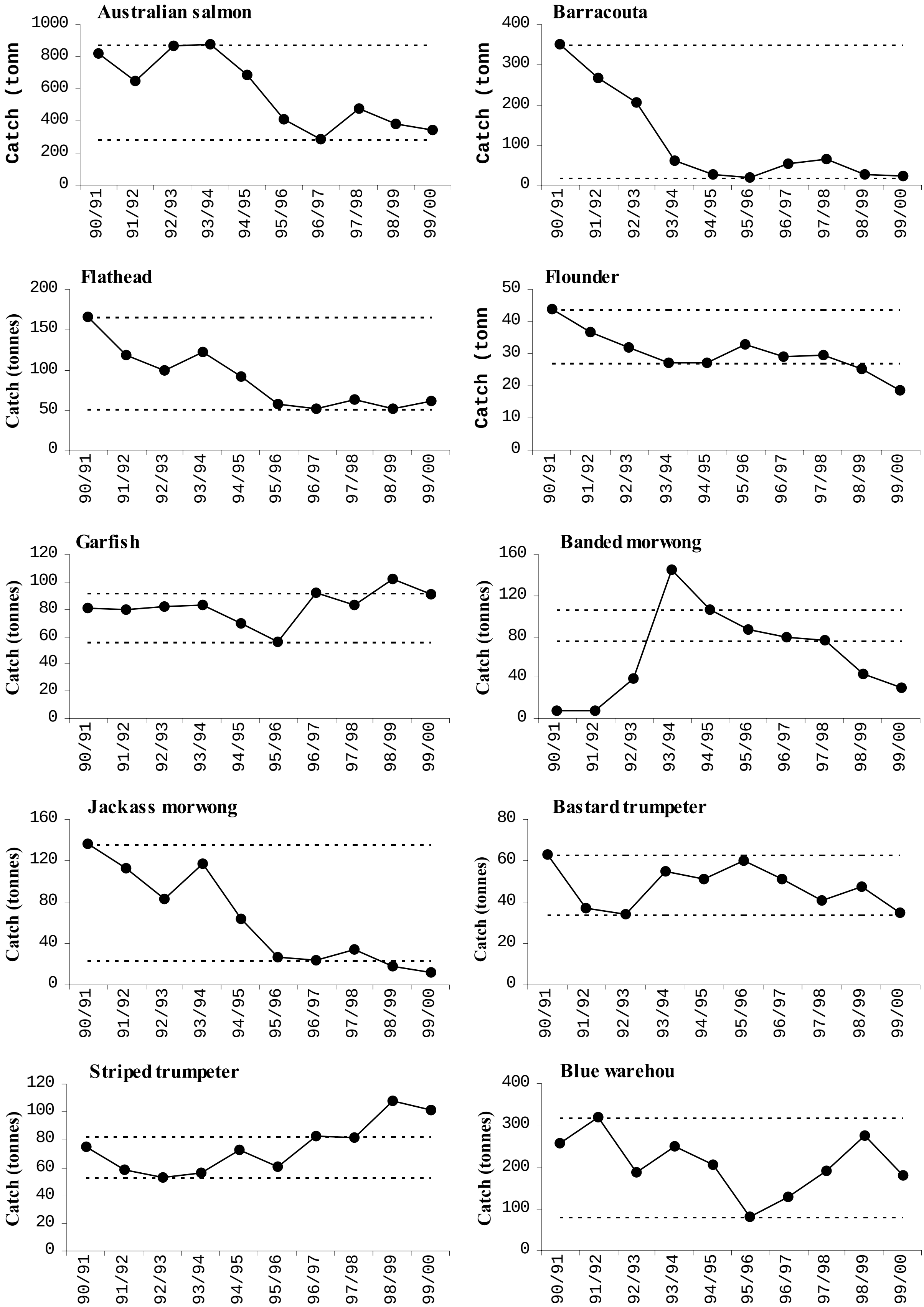

Fig. 2.1 Annual catches for key scalefish species 1990/91 to 1999/2000. Dotted lines indicate upper and lower catch levels for the catch reference period (1990/91-97/98 for all species except banded morwong [1994/95-97/98] and wrasse [1995/96-97/98]).

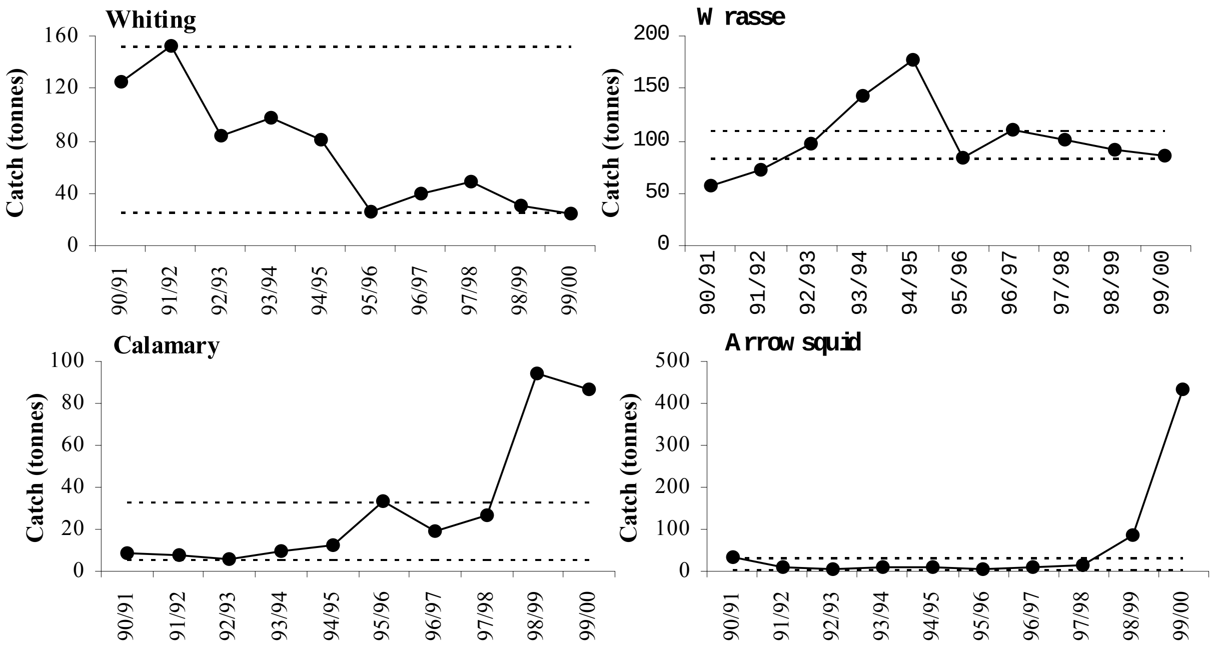

Fig. 2.1 Continued.

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 targeted 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%.

2.4.1 Method based effort

Method based effort triggers are intended more as indicators of fishery performance than as meaningful biological reference points. Specifically, the Scalefish Management Plan was developed to limit the potential for expansion of fishing effort by defining and limiting access in terms of gear allocation. The impact or performance of these management arrangements may, therefore, be assessed in terms of trends in fishing effort for the main fishing methods.

Catch and effort by the major fishing methods are presented in Table 2.2. Since a range of fishing methods are represented it has been necessary to express effort in units appropriate to the specific fishing method (Table 2.3). However, because it has become apparent that some operators have misinterpreted reporting requirements for effort, effort has also been expressed in terms of days fished.

Reporting of dropline catch and effort has been restricted to depths of less than 200 m to exclude fishing for blue eye trevalla (now managed by the Commonwealth). Since less than 1% of the striped trumpeter catch is reported from depths greater than 200 m, this restriction effectively encompasses the target dropline fishery for striped trumpeter. While catch and effort for shark net and bottom longline methods have been included in this analysis, these methods relate specifically to the shark fishery (with shark accounting for over 90% of the catch taken by each method), which is now managed by the Commonwealth.

Inferences about the status of the fishery and the impacts of recent management changes are limited due to the short time series of available data. In fact, since the new licensing arrangements only took effect part way through the 1998/99 fishing year (November 1998), less than two years of data under the new arrangements are available for this assessment.

Effort levels in 1999/2000 were higher than during the reference period for dropline, dip net, squid jig and spear methods whereas fish trap effort was within the reference range (Table 2.2)[1]. For the remaining key fishing methods, including graball and handline, current effort levels were lower than prior to the introduction of the management plan.

By comparison with 1998/99, current squid jig and spear effort (based on gear units) were only; effort for all other methods had in fact declined. A similar pattern was evident for days fished in all but beach seine, dropline and handline methods. For this group, more days were fished using these methods in 1999/2000 although overall less gear was used.

Despite this variability in effort, current catches for the key methods were within previous levels for all but dropline and squid jig methods. In both of these instances, catches exceeded reported levels since 1995/96.

In terms of the effort based criterion, 1999/2000 effort levels for dropline, dip net, squid jig and spear methods were at least 10% higher than the peak for the reference period (see Table 2.2). The effort increases were moderate (14-23%) for dropline, dip net and spear methods but were substantial (over a hundred-fold increase) for squid jigs, due largely to the activity of automatic jig vessels targeting arrow squid. Effort triggers were not exceeded for the remaining methods. In fact, beach seine, purse seine, graball, small mesh net and handline effort levels were substantially lower than for preceding four years. Most of these methods have been constrained in terms of access, through limited entry (beach seine, purse seine, small mesh net), or through gear restrictions (graball), under the scalefish management plan. By contrast, all operators are permitted to us handlines, however, one of the primary handline species, (live) wrasse, is itself subject to a limited entry fishery and handline effort targeted at wrasse has declined markedly in recent years.

Notwithstanding the above, there are concerns, especially from industry, 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 (available to all scalefish licence-holders).

[1] Shark net and longline methods have not been included in this comparison.

Table 2.2 Total annual catch and effort by major fishing methods for the period 1995/96-1999/2000.
Gear units of effort are defined in Table 2.3. * Five or fewer vessels involved, data not shown.

	Method	*Fishing year*	*Catch (kg)*	*Effort* Gear units#	*Days fished*
Seine	Beach seine	1995/96	469129	1086	567
		1996/97	364252	1358	697
		1997/98	520894	1206	585
		1998/99	448087	903	408
		1999/2000	403968	873	435
	Purse seine	1995/96	35182	417	187
		1996/97	30419	336	154
		1997/98	41786	319	157
		1998/99	77056	242	162
		1999/2000	31942	229	119
Gillnet	Graball	1995/96	346697	223284	5525
		1996/97	377218	235176	5266
		1997/98	455607	234863	5342
		1998/99	494684	166615	4824
		1999/2000	354460	154289	4234
	Small mesh net	1995/96	38575	11039	291
		1996/97	26847	8000	266
		1997/98	21770	7992	249
		1998/99	31144	7863	288
		1999/2000	22136	6014	206
	Shark net	1995/96	1073892	663541	2798
		1996/97	932328	817457	3191
		1997/98	1051181	1137866	4604
		1998/99	1025029	1207666	4920
		1999/2000	1246811	1278318	5228
Hook	Dropline (<200m)	1995/96	19866	433	159
		1996/97	30092	436	207
		1997/98	22676	480	207
		1998/99	29448	610	266
		1999/2000	31746	591	286
	Handline	1995/96	75956	17153	1659
		1996/97	94318	21538	1906
		1997/98	98927	21065	1731
		1998/99	92207	17536	1340
		1999/2000	98217	16605	1454
	Bottom longline	1995/96	204083	4648	577
		1996/97	121941	3918	482
		1997/98	96584	3452	486
		1998/99	102933	2314	572
		1999/2000	141415	4133	689

Table 2.2 Continued

	Method	Fishing year	Catch (kg)	Effort Gear units*	Effort Days fished
	Trolling	1995/96	19563	3497	358
		1996/97	62039	9755	600
		1997/98	76189	13520	692
		1998/99	46211	9500	484
		1999/2000	39933	6096	420
Trap	Fish trap	1995/96	41764	9829	1454
		1996/97	57144	10710	1799
		1997/98	49898	9873	1877
		1998/99	53571	10698	1583
		1999/2000	55855	10476	1628
Other	Squid jig	1995/96	8710	5006	97
		1996/97	5791	554	75
		1997/98	17489	7172	195
		1998/99	145098	171339	663
		1999/2000	488409	906491	1255
	Spear	1995/96	13991	1391	371
		1996/97	19236	1845	467
		1997/98	16806	1981	487
		1998/99	19307	1830	450
		1999/2000	19009	2257	486
	Dip net	1995/96	*	*	*
		1996/97	24151	1517	364
		1997/98	33271	1707	415
		1998/99	42641	2679	556
		1999/2000	24872	1973	427

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/trolling	Line hours
Fish trap	No. trap or pot lifts
Squid jig	Jig hours
Spear	Fisher hours
Dip net	Dip net hours

2.4.2 Species based effort

Individual species may be taken by a variety of methods, either as a target or non-targeted catch. Targeting is an important and relevant issue when considering effort; a fact that is highlighted in the species based performance indicators outlined in the Scalefish Management Plan. Although targeting has not been recorded in the General Fishing Returns, inferences can be made by considering the relative importance of a species in the catch[2]. Based on experience in other fisheries and field observations in this fishery, when a species is targeted it will, generally, account for a significant proportion of the catch. There will, however, be times when target species are either not caught or only represent a minor component of the catch. In such instances, the correct classification of fishing operations will be difficult and targeting may be incorrectly classified. Unless otherwise specified, the issue targeting has not been addressed in this report.

For the purposes of analysis, effort has only been assigned to a species when that species was reported in the catch (whether taken as a targeted species or as incidental catch). Effort for the key species or species groups by fishing method are presented in Chapters 3-9.

2.5 Catch rates

Catch rates of catch per unit effort (CPUE) is often used in fisheries assessment as an index of resource 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 period, 1995/96 to 1997/98. CPUE values by method for key species are discussed 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 1999/2000, suggesting an increase in recreational netting effort over the period (Table 2.5).

Table 2.5 Number of recreational gillnet licences issued by licensing year.

Licence type	*1995/96*	*1996/97*	*1997/98*	*1998/99*	*1999/2000*
Graball Net 1	5615	6290	6685	6709	7477
Graball Net 2	2612	2678	2683	2426	2652
Mullet Net	656	684	738	739	879
Total gillnet licences	**8883**	**9652**	**10106**	**9874**	**11008**

Results from a State-wide 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, resulting in a catch of over 560 tonnes for the same period. More recent statistics are not available.

Blue warehou dominated the recreational gillnet catch, representing about 45% of the total catch weight. Species of secondary importance included bastard trumpeter, Australian salmon, silver trevally and striped trumpeter. For several 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 fishery is also taken into account in stock assessment.

[2] During 1999 the General Fishing Return was modified to allow fishers to identify which species were being targeted, however, as yet not all operators have been issued with the revised logbook.

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 both exceeded 100 tonnes for the period December 1996 – April 1998, while catches of 10-30 tonnes were estimated for Australian salmon, cod, striped trumpeter and jackass morwong during the same period. These findings indicate that recreational catches of several key species are significant, probably exceed the commercial catch.

The 2000/01 national recreational fishing survey will provide for a more comprehensive assessment of recreational catch and effort.

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, five 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.

Catch and effort (at the fishing method and species levels) are influenced by a combination of factors which include fishers matching their fishing operations against 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, however, an urgent need to consider on-going monitoring of the recreational fishery, without which attempts to assess the status of species with significant recreational catches, will be either biased or incorrect.

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.

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 are taken by a variety of fishing methods including hooks and gillnets but are also taken in small quantities as a bycatch to demersal trawling on the shelf. 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, longline) and by large mesh gillnets (shark nets).

Responsibility for management of striped trumpeter in both inshore and offshore (from 3 – 200 nautical miles) waters was passed to the 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. 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 be vulnerable to additional targeting by operators participating in these fisheries. A bag and possession limit of five striped trumpeter has also been 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).

3.2 Stock Structure and Life-history

Striped trumpeter are distributed throughout southern Australia, from Sydney around to Kangaroo Island in South Australia, including Tasmania. The species is also found in New Zealand. They 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. A recent report of a striped trumpeter tagged off eastern Tasmania and recaptured off southern NSW provides some support for a common Australian stock.

Little is known of 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 throughout south-eastern 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.

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. Age composition, mortality rates and productivity have not been estimated.

There is some evidence for 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, through its size relative to the 1993 cohort is unknown.

Few biological parameters have been defined for striped trumpeter (see Appendix 3). The growth parameters defined are represented by 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 analysis of catch, effort and catch rate data and reporting on performance indicators (trigger points).

The 1998/99 catch was the highest on record, being particularly influenced by higher dropline, handline and graball catches, and therefore exceeded the catch trigger. The effort trigger for handline fishing was also exceeded but CPUE remained within previous levels.

3.4 Current Assessment

3.4.1 The Fishery

Striped trumpeter are taken by a range of fishing methods, but predominately hook and gillnet methods (Fig. 3.1). Handline and dropline fishing accounted for around 55% of the total 1999/2000 catch of 100 tonnes. 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 1999/2000, about 18% of the catch was taken by graball net.

Striped trumpeter are also caught on longlines and in shark nets as a by-product of fishing for school and gummy shark. In 1999/2000 these methods accounted 21% of the reported catch.

Striped trumpeter are taken commercially around the entire Tasmanian coastline, with the greatest portion of the catch being taken from shelf grounds along the length of the east and south-east coasts and off Flinders Island. Relatively small catches are taken from the north-west, west and south-west coasts. There are few indications of shifts in the distribution of catches, although there was evidence of increased west coast catches in 1998/99.

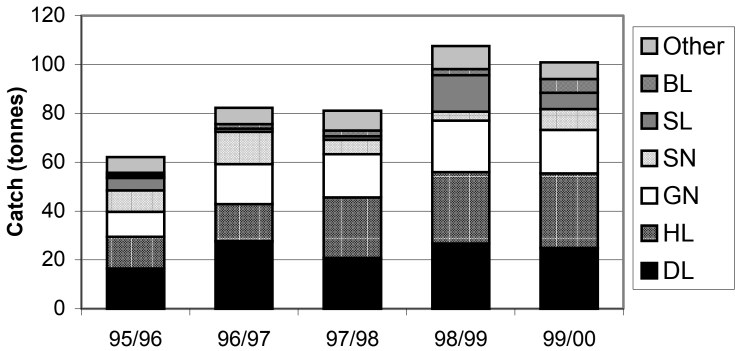

Figure 3.1. Annual catch of striped trumpeter by method. DL is dropline; HL is handline; GN is graball; SN is shark mesh net; SL is shark longline; BL is bottom longline.

3.4.2 Recent developments

Some limited monitoring of the offshore hook fishery for striped trumpeter in the south east was conducted in 1999/2000. The strong 1993 and to a lesser extent 1994 year-classes were apparent in the catches which has implications for the interpretation of trends in catch and CPUE in the fishery. While there are limited data to assess the relative strength of the subsequent year-classes, the movement of these two year-classes into the offshore hook fishery is likely to influence catches in this sector. Initially, small changes in CPUE (based on weight) can be expected, although increased numbers of fish will be landed. As these fish increase in size, CPUE should gradually rise assuming these cohorts continue to dominate catches.

The inclusion of Commonwealth catch data in this assessment represents an important development, providing a more comprehensive description of the fishery.

3.4.3 2000 Assessment

The 1999/2000 commercial catch of 100 tonnes was slightly down on the previous year but was still higher than annual Tasmanian catches during the reference years 1990/01 – 1997/98. However, if catches reported in Victorian logbooks, but taken in waters south of latitude 39° 12'S, are included (i.e. waters incorporated in the OCS agreement for striped trumpeter), then recent catches are of similar order to that reported in 1990/91 (Table 3.1).

The current assessment has been restricted to an examination of catch and effort trends for the primary fishing methods for striped trumpeter, 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 summarised in Table 3.2 and are represented graphically in Figs 3.1-3.3. Annual handline catches have increased steadily since 1995/96 from around 13 to over 30 tonnes in 1999/2000. This increase has been largely due to rising effort, with both targeted and total CPUE remaining relatively stable over the period. Dropline catches increased initially from around 15 tonnes and have been maintained at around 25 tonnes p.a. since 1996/97. Up until 1998/99, dropline effort had tended to increase each year while CPUE remained relatively stable, apart from a peak in targeted CPUE in 1996/97. In the most recent year, however, dropline effort fell by over 40% compared to that in 1998/99, but as this was offset by a sharp increase in CPUE, catches were maintained at similar levels. The presence of strong 1993 and 1994 year classes may have influenced the recent increase in CPUE. Limited catch sampling supports this observation.

Graball catches of striped trumpeter rose from 1995/96 to a peak in 1998/99, falling slightly in 1999/2000. Striped trumpeter are not usually targeted using gillnets but generally occur as a by-product of targeting other scalefish species. This clearly evident in the comparatively low levels of effort (and consequently the proportion of the catch) that met the targeting criteria (Fig 3.3). Although the most recent targeted and to a lesser extent total graball CPUE values were down on 1998/99, they were comparable with previous years.

In the 1999 assessment it was noted that size composition data for graball catches suggested that 1998/99 CPUE peak was influenced by the presence of relatively large numbers of 3 year-old fish (representing the 1996 year-class) (Jordan and Lyle 2000). As these fish grow they are expected to move into deeper water and thus become less vulnerable to graball nets. The decline in catch and CPUE in the most recent data is possibly indicative of this transition.

The striped trumpeter resource status is uncertain; recruitment variability is likely to be a major factor influencing abundance in the short to medium-term.

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Table 3.1 Annual catches of striped trumpeter (tonnes) south of latitude 39° 12'S based on Tasmanian, Victorian and Commonwealth logbook returns.

		Catch (tonnes)		
Year	*Tasmania*	*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	60.2			60.2
1996/97	80.3		2.0	82.3
1997/98	75.3		5.8	81.1
1998/99	98.6		8.9	107.5
1999/2000	86.2		14.7	100.9

Table 3.2 Catch, effort and CPUE by method for striped trumpeter based on General Fish Returns. For units of effort and CPUE refer to Table 2.3.

Method	*Year*	*Catch (tonnes)*	*Effort*	*CPUE*
Handline	1995/96	13.0	3487	2.86
	1996/97	15.1	3823	2.83
	1997/98	24.8	4180	3.93
	1998/99	29.3	5167	4.34
	1999/2000	30.5	5083	4.19
Dropline	1995/96	16.5	541	28.96
	1996/97	27.7	736	36.63
	1997/98	20.8	635	33.84
	1998/99	26.7	845	31.28
	1999/2000	24.8	469	45.84
Graball	1995/96	10.2	17113	0.74
	1996/97	16.4	23430	1.24
	1997/98	17.7	14892	1.39
	1998/99	21.1	15081	1.64
	1999/2000	17.8	20292	1.10

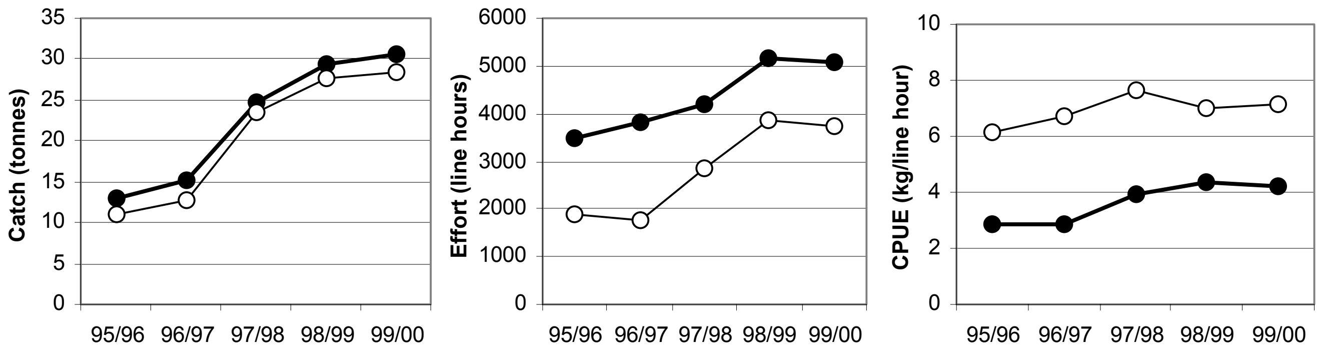

Figure 3.1 Annual handline catch, effort and catch per unit effort (CPUE) for striped trumpeter based on total (solid circle) and targeted (open circle) effort.

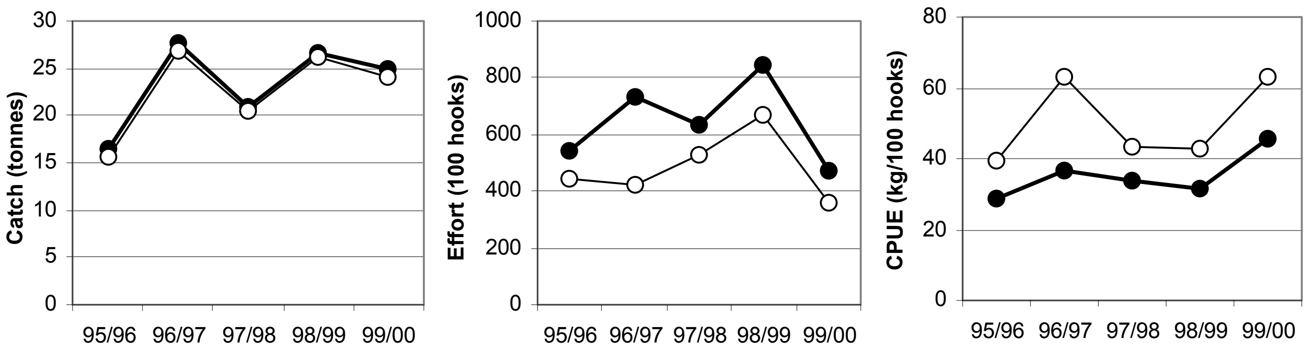

Figure 3.2. Annual dropline catch, effort and catch per unit effort (CPUE) for striped trumpeter based on total (solid circle) and targeted (open circle) effort.

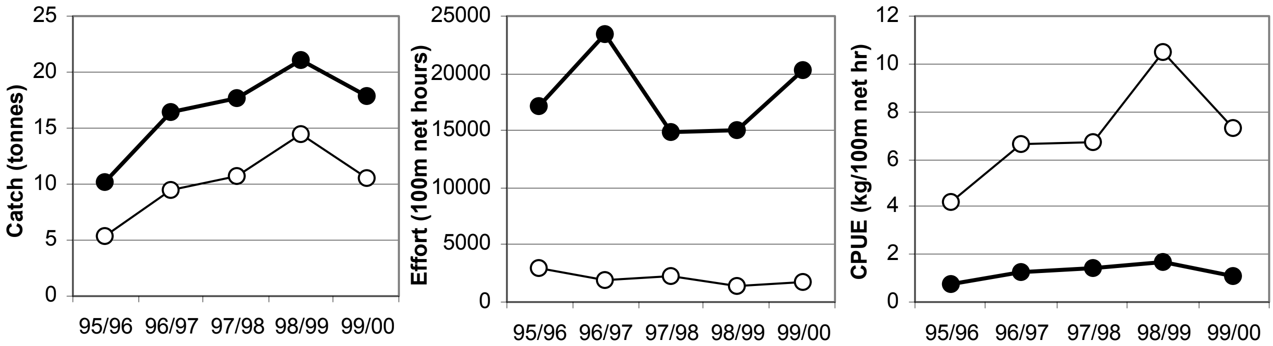

Fig. 3. Annual graball net catch, effort and catch per unit effort (CPUE) for striped trumpeter based on total (solid circle) and targeted (open circle) effort.

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 1999/2000 striped trumpeter catch of 100 tonnes was higher than Tasmanian catches taken during the reference period and, while lower than 1998/99, the decline was only small (<10%). On this basis the catch trigger (i) was exceeded. However, if the combined catch from waters over which Tasmania now has jurisdiction for striped trumpeter is considered, then the catch trigger was not reached (refer Table 3.1).

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 slightly lower than 1998/99 handline effort once again exceeded the effort trigger. By contrast, the marked decline in dropline effort in 1999/2000 meant that this trigger was not exceeded. Increased graball effort in the most recent year did not exceed the previous (1996/97) peak level.

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.

CPUE (total and targeted) values for each of the key methods were either higher or 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.*

Commercial and research catch sampling over several years indicates marked recruitment variability. The full significance of this phenomenon has yet to be fully evaluated.

3.6 Implications for Management

Trends in catch and CPUE in the fishery are likely to be influenced for some years by the strong 1993 and 1994 year-classes. There are also some indications of good recruitment for the 1996 year-class.

Superficially, stability in catches over the past decade could suggest that current catch levels are sustainable, however, there is evidence of strong recruitment variability which could produce marked variations in population size, especially if there is a prolonged period of poor recruitment. The lack of knowledge about the recruitment processes and the impacts of the recreational fishery represent major uncertainties. Clearly a more rigorous assessment than is possible through examination of commercial catch and effort data is required to assess the sustainability of the fishery.

The suitability of the legal minimum size limit of 35 cm in terms of yield-per-recruit is unknown, however, as this size limit is well below the size at maturity it is a risk prone strategy in terms of egg-per-recruit.

There are likely to be impacts on the fishery from the recently introduced 250 kg trip limit. It is unclear how future catch and effort will be affected but this limit may confound the interpretation of catch rate trends, especially if operators achieve the limit and cease fishing.

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 a need to define life history and population parameters for striped trumpeter (including growth and mortality, reproductive biology, movements, etc) and to conduct yield per recruit analysis to determine the appropriate legal minimum size. Given the paucity of information regarding the offshore fishery for striped trumpeter, basic size and age composition data are required for this component of the fishery to develop optimal harvest strategies.

Given evidence of considerable recruitment variability, there is also a need to conduct sampling of inshore reefs to assess relative abundance of pre-recruits. Such information would be valuable interpreting and even predicting both catch and catch rate trends for the various sectors of the industry.

4 Banded Morwong (*Cheilodactylus spectabilis*)

4.1 Management Background

The 'live fish' fishery for banded morwong began in 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 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, in an attempt to minimise wastage of fish at a time when they are most vulnerable to mortality in captivity. Spawning closures have been implemented each year since that time.

In addition to the closed season, management measures for 1996 included the introduction of an interim live fish endorsement on the fishing licence (personal) to take banded morwong and wrasse. Eligibility for an endorsement was based on a demonstrated history of taking one or both of 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 plan, a specific licence was introduced for the taking of banded morwong in State waters. The amount of gear able to be used to target this species was also restricted. To qualify for a fishing licence (banded morwong), applicants had to prove that they had caught at least two tonnes of banded morwong during the period 1 January 1993 to 31 May 1994. There are currently 29 fishing licences (banded morwong).

4.2 Stock Structure and Life-history

Banded morwong are a rocky reef species distributed from about Sydney (New South Wales) 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 in Tasmania. The relationships of populations throughout the range are unknown.

In Tasmanian waters, banded morwong are caught in a spawning condition between mid to late February and May, with the distribution of oocytes indicating they are serial spawners. Sexual maturity in females begins at between 30 and 32 cm FL, equivalent to 4 to 5 years of age (Murphy and Lyle 1999). Length at 50% maturity is 32 cm. 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 to within 5 km of the site of release (Murphy and Lyle 1999).

In Tasmania, growth in female banded morwong is relatively rapid for the first 5-6 years, until about 35 cm, and then slows dramatically (Murphy and Lyle 1999). In 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 exhibit strong year classes, providing evidence for variation in recruitment strength (Murphy and Lyle 1999).

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

4.3 Previous Assessments

Previous assessments have been limited to examination of trends in graball catch, effort and catch rates. Given evidence of population structuring at a small spatial scale, analyses have been conducted at regional as well as state-wide levels. Overall, catch and effort has declined steadily since 1995/96 with only a slight fall in CPUE. However, when regional catch rates were examined for only those fishers with a minimum of three years catch history over the period 1995/96 to 1998/99, the decline in CPUE was more pronounced in all areas apart from the Bruny region.

The 1998/99 catch of banded morwong was lower than previous catches during the reference period (1994/95 – 1997/98 in this case) and had declined by greater than 30% compared with 1997/98. Both catch triggers were, therefore, exceeded. State-wide, the catch rate trigger was not reached, however, at the regional level, CPUE triggers were exceeded in the Schouten and Maria Island regions.

While there were uncertainties in the interpretation of catch and catch rate trends, given the life history characteristics of the species, concern was expressed in relation to the impact that the fishery had had on the populations.

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. In addition to targeted fishing, both banded morwong are taken as a by-product in gillnets set on inshore rocky reefs and targeting trumpeters and blue warehou. Fishing operations are conducted over hard bottom, with nets fished primarily in the 10-20 m depth range.

The fishery is centred mainly along the east coast of Tasmania, between St Helens in the north and the Tasman Peninsula in the south, with the largest catches coming from around Bicheno. Smaller catches are made along the south coast and around Flinders Island. Apart from a general increase in fishing activity around St Helens up to 1997/98, there has been little evidence of any substantial shifts in the distribution of catches at the fishing block level over the past five years (refer Figs 4.2- 4.3).

4.4.2 Recent Developments

There has been no recent research or monitoring of the banded morwong fishery. However, a meeting of researchers, managers and industry was convened in December 2000 to discuss resource and management issues relevant to the banded morwong fishery. Industry confirmed that recent declines in catches were not market driven but rather were the result of reductions in actual fishing effort. 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 number of sets conducted each day. Many operators reported that increased interactions with seals had caused them to either curtail fishing on a given day or reduce the amount of net that was 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.

4.4.3 2000 Assessment

Since 1994/95[3] banded morwong catches have declined from over 100 tonnes falling to just 29 tonnes in 1999/2000 (Table 2.1, Fig. 2.1). In fact, the most recent year's catch represented a fall of about 32% compared with 1998/99.

This assessment has been restricted to examination of catch and effort trends for the graball nets, the method accounting for around 99% of the total catch of banded morwong. In an attempt to distinguish targeted fishing for banded morwong the following assumptions have been made. Fishing on a given day was assigned as targeted at banded morwong 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.

State-wide, the graball catch has declined each year since 1995/96, with a sharp falls in since 1997/98 (Table 4.1, Fig. 4.1). Banded morwong are primarily taken in operations targeted at the species, the levels of 'non-targeted' effort being comparatively low. Over the past two years there has been a marked drop in both total and targeted effort accompanied with falls in CPUE. Since 1995/96, CPUE has fallen by over 40% based on total fishing effort and by just under 10% based on targeted effort. These observations tend to support industry comments in that there is currently less effort targeted at the species and that targeted catch rates have declined only slightly.

[3] Note: the reported catch for 1993/94 is considered to be inaccurate due to over-reporting.

Since banded morwong appear to be site attached to individual reefs, analysis of data at the smallest spatial scale provides a more realistic indication of trends in the fishery. Catch, effort and CPUE for the major fishing regions are presented in Figs 4.2 and 4.3. The regions, based on fishing blocks, have been defined as St Helens (5H1), Bicheno (5H3), Schouten (6H1), Maria (6H3, 6G4) and Tasman Peninsula (7G2, 7H1). Between 1995/96 and 1997/98 the sharp fall in catches from the Bicheno region was to some extent offset by rising catches from around St Helens. Since then, however, catches in all regions have tended to decline, with the 1999/2000 catch for St Helens almost half that for the previous year. Effort levels in 1999/2000 were higher in the more southerly regions (Maria and Tasman Peninsula), lower for St Helens and generally stable for Bicheno and Schouten regions.

Regionally, catch rates have been highly variable both within and between years but there has been a general decline in CPUE for all regions since 1995/96, such that the most recent year's values were lower than for the reference period (1995/96 - 1997/98). CPUE data also indicate a general trend of increasing catch rates moving south to north along the east coast. This could imply that the more northern reefs support greater densities of banded morwong but it may also be influenced by the fact that the fishery developed initially in the south-east and this area has had a longer history of exploitation.

Catch and catch rate indicators suggest that the fishery has impacted on banded morwong populations and that the sustainability of the fishery, even at current levels of exploitation, is uncertain. These fishery dependent indicators may, however, be influenced by factors other than just fish abundance, for instance there have been recent management changes (licensing and size limits) and there are suggestions of shifts in the dynamics of the fishery which are not necessarily linked to fish availability. As a consequence, there is uncertainty surrounding the resource status. There is an urgent need to investigate possible biological indicators of stock condition; for example population age structure.

Table 4.1 Catch, effort and CPUE by method for banded morwong based on General Fish Returns. For units of effort and CPUE refer to Table 2.3.

Method	*Year*	*Catch (tonnes)*	*Effort*	*CPUE*
Graball	1995/96	86.2	69019	1.16
	1996/97	78.5	64524	1.09
	1997/98	75.8	78821	0.98
	1998/99	43.1	43993	0.95
	1999/2000	29.0	46237	0.66

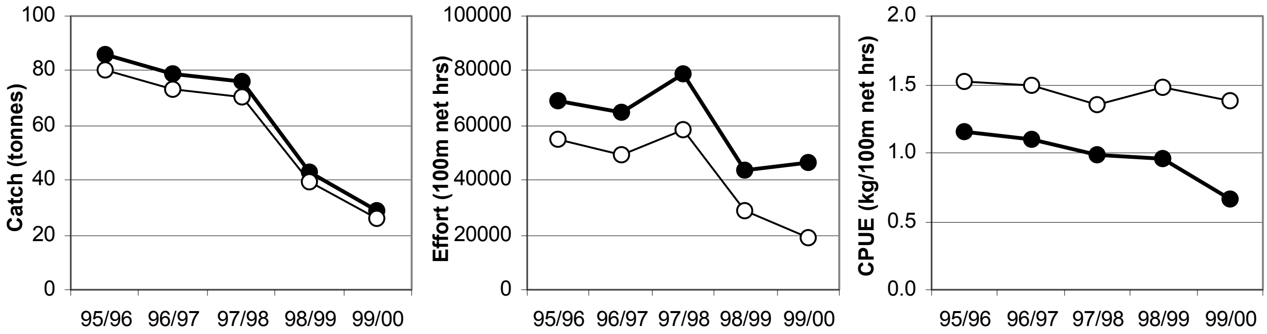

Fig. 4.1 Annual graball net catch, effort and catch per unit effort (CPUE) for banded morwong based on total (solid circle) and targeted (open circle) effort.

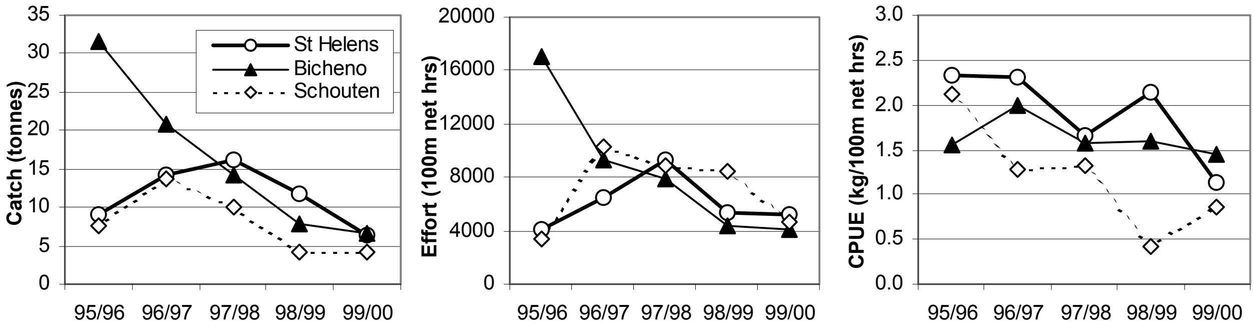

Fig. 4.2 Annual graball net catch, effort and CPUE for banded morwong by fishing regions - St Helens, Bicheno and Schouten.

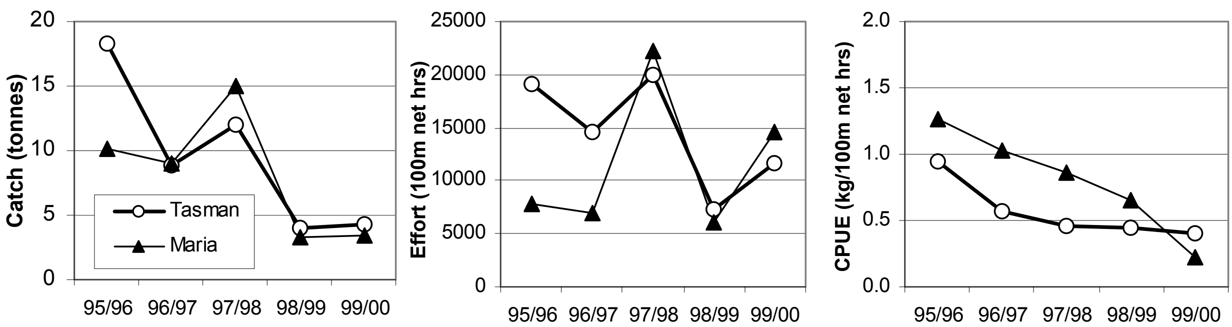

Fig. 4.3 Annual graball net catch, effort and CPUE for banded morwong by fishing regions - Maria and Tasman Peninsula.

4.5 Evaluation of Trigger Points

Total catch

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

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

Total catch of banded morwong for the period 1990/91 to 1997/98 ranged from 6.9 to 145.5 tonnes (Table 2.1). However, given the rapid increase in landings 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 is believed to have been significantly overstated. Therefore, for the purpose of trigger point assessment, catches for the period 1994/95 to 1997/98 have been adopted as the reference period.

The 1999/2000 catch of just 29 tonnes was outside of this range and was over 30% lower than in 1998/99, indicating that both catch triggers were exceeded. Significantly, catch triggers were also exceeded in 1998/99.

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.*

As fishing effort had decreased and in the key fishing regions in 1999/2000 and state-wide, 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.*

Based on targeted CPUE, the value for 1999/2000 was within the reference range. However, if total (combined targeted and non-targeted) CPUE is considered, then in the most recent year CPUE was just 67% of the lowest value for the reference period. At a regional level, total CPUE values for the St Helens, Schouten and Maria regions were below 80% of the lowest value for the reference period and therefore triggers had been reached in each of these regions.

Interpretation of the significance catch rates for banded morwong is complicated by the fact that the species can be targeted or taken as a by-product of fishing for other species, with targeted and total catch rates indicating different levels of change. However, it is significant that catch rates have declined despite substantial reductions in effort.

Change in size composition

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

ii. *monitoring of the size/age structure of a species indicates a significant change in the abundance of a year class (or year classes), with particular importance on pre-recruit year classes.*

No monitoring of the size or age structure of banded morwong populations has been conducted since 1997. There is considerable variability in the size composition of the catch between regions and seasons, which will strongly influence the spatial and temporal pattern of future commercial monitoring. The impact of changes in size limits will need to be taken into account in any future analysis.

4.6 Implications for Management

While catch rates have declined only slightly in the main fishing areas over the past five years, it is likely that they have been maintained to some extent through the fish down of accumulated (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.

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 five years there has been a trend towards increased mesh size (largely in response to size limit increases) that will have implications for the interpretation of catch and CPUE data from the commercial fleet. That is, catch rates will reflect changes in mesh size and size regulations in addition to abundance. For instance, modelling undertaken at the time of the new size limits were proposed suggested that there would be a slight decline in catch rates, assuming that there were no changes in mesh size or the size structure of the catch (Murphy and Lyle 1998). There is no empirical information to test the above.

The age structure of the banded morwong population indicates variations in the strength of recruitment, 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. As commercial monitoring of the banded morwong fishery concluded in mid-1997, on-board commercial catch sampling of the fishery is a high priority because of inferences that can be made about the effects that fishing is having on the size and sex structure of the population. However, given the considerable variability in the size composition of the catch between regions, future monitoring 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.

Changes to the minimum and maximum size limits for banded morwong were also introduced in the Scalefish Management Plan in late 1998. There is a need to assess the effect these changes have had on catch rates in order to interpret the trends. In 2001, population age structure at key sites will be investigated 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 stack 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 north-east coast, including Flinders Island. More recently the fishery has extended to the east and south-east coasts and, with the introduction of dip nets, catches have increasingly being 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, however, is 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 is endemic to Australian waters and is distributed from Eden in NSW to Kalbarri in Western Australia, including Bass Strait and Tasmanian waters (Gomon *et al*. 1994). 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.

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 beds may be of greater significance around areas such as Flinders Island where the majority of shallow water habitat consists of seagrass beds (principally *Posidonia australis* and *Amphibolis antarctica*). 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 south-western 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 the same rate.

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. Analysis was based on calendar rather than fishing year (July to June) since, historically at least, the major fishery for garfish occurred during the winter months[4].

With the exception of 1995, annual garfish catches have fluctuated between around 70-100 tonnes, without any consistent pattern or trend between years. Since 1995 beach seine catches generally increased but CPUE remained stable. It was noted, however, that stability in beach seine CPUE may not be a good indicator of stock abundance, since garfish are targeted in schools and thus catch rates are expected to remain relatively insensitive to changing population abundance (unless there are actual declines in school size). The growing importance of dip nets as a method for taking garfish was evident in previous assessments, with a sharp increase in dip net effort since 1995. Although dip net catch and CPUE for 1998 was within the reference range, the increase in effort exceeded the effort trigger. Since all holders of scalefish licences have access to dip nets and garfish can command premium prices there was concern about the potential for further expansion in this 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 (Fig 5.1). Other methods include purse seine and spears, with purse seine catches tending to rise slightly over the past two years. 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 north-east coast, including Flinders Island, and off the east and south-east coasts. Since 1996/97, annual catches from the north-east (blocks 3G4, 4G2, 4G4, 4H1, 4H3) have declined slightly from around 50 tonnes in 1996/97 to 42 tonnes in 1999/2000 (Fig. 5.2). Over the same period, east coast (blocks 6G4, 6H1, ES13, ES14, ES15, ES16) catches have fluctuated between 14 and 25 tonnes, without an obvious trend. By contrast, catches of garfish from the south-east,

[4] For the purposes of the current assessment, analysis has been undertaken on a fishing year basis.

including Norfolk and Frederick Henry Bays (blocks 7G1, 7G2, ES17, ES18, ES19), have increased steadily, from just 3 tonnes in 1995/96 to about 25 tonnes in 1999/2000. The majority of the catch from the north-east is taken by beach seine whereas 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 south-east coast catch.

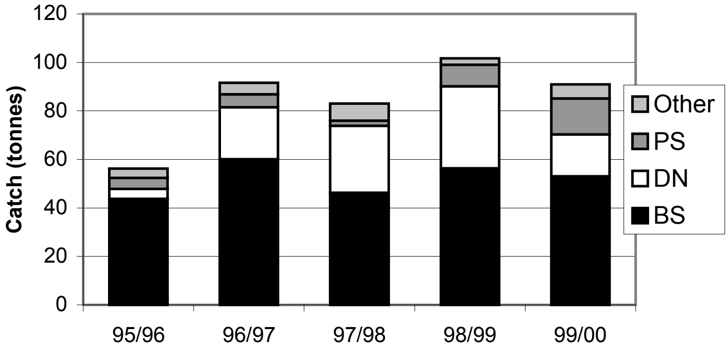

Fig. 5.1. Annual catch of sea garfish by method. BS is beach seine; DN is dip net; PS is purse seine.

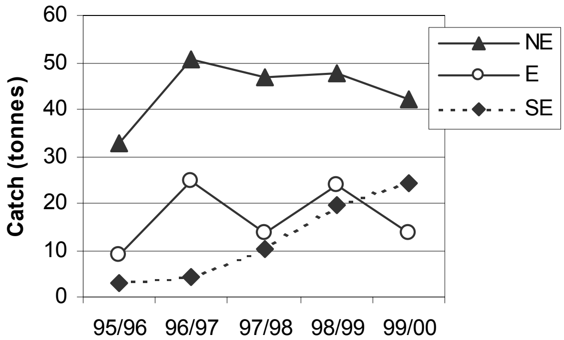

Fig. 5.2. Annual catch of sea garfish by major fishing regions. NE includes Flinders Island and the northeast coast of Tasmania, E is east coast including Great Oyster Bay and SE is southeast coast including the Tasman Peninsular, Norfolk and Frederick Henry Bays and Bruny Island.

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 and reproductive biology off southern Australia (incorporating Tasmania) is being finalised.

5.4.3 2000 Assessment

The 1999/2000 catch of 91 tonnes was slightly down 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 two years contributed to the maintenance of catch levels despite slight drops in effort. The trend for increased dip net catch and effort between 1995/96 and 1998/99 was reversed in 1999/2000, with the catch and effort falling by 49 and 29%, respectively (Table 5.1, Fig. 5.3). Dip net CPUE also declined by about 35%, to its lowest level on record.

The lack of consistency in catch rate trends for the two methods suggests a number of complicating factors in the interpretation of stock status. As a schooling species, CPUE for garfish is expected to be relatively insensitive to declines in abundance, perhaps more so for methods such as beach seining which target schools of fish. On the other hand, several industry members have expressed concerns about the effects of dip netting on the schooling behaviour of garfish. Specifically it has been suggested that intensive dip netting activity tends to cause schools to break up, which could have the effect of lowering CPUE (and opportunities to use beach seines to target the species).

Based on the available analysis, the stock status for sea garfish is uncertain.

Table 5.1 Total catch, effort and CPUE by the main garfish fishing methods.
* 5 or fewer vessels involved, data can not be shown.

Method	*Year*	*Catch (tonnes)*	*Effort*	*CPUE*
Beach seine	1995/96	43.8	731	36.2
	1996/97	60.1	1044	36.9
	1997/98	46.2	752	37.0
	1998/99	56.3	683	52.2
	1999/2000	53.0	657	52.4
Dip net	1995/96	*	*	8.9
	1996/97	21.4	1492	12.1
	1997/98	27.6	1650	13.0
	1998/99	33.8	2522	10.7
	1999/2000	17.2	1811	7.0

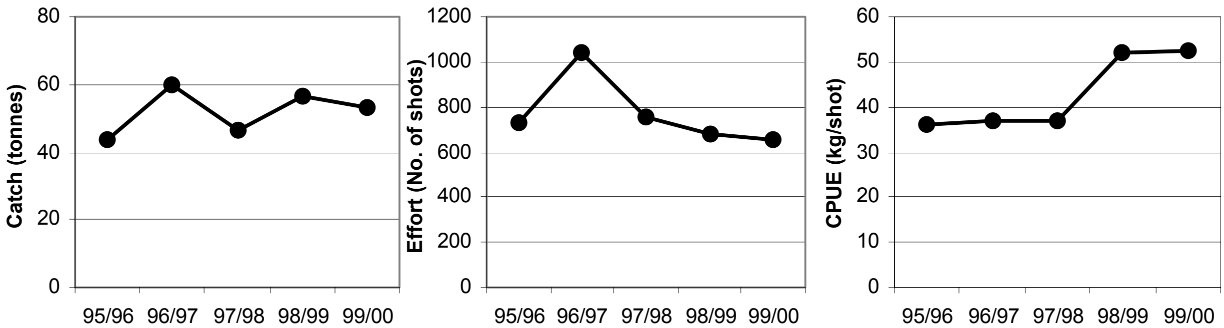

Fig. 5.3 Annual beach seine catch, effort and catch per unit effort (CPUE) of sea garfish.

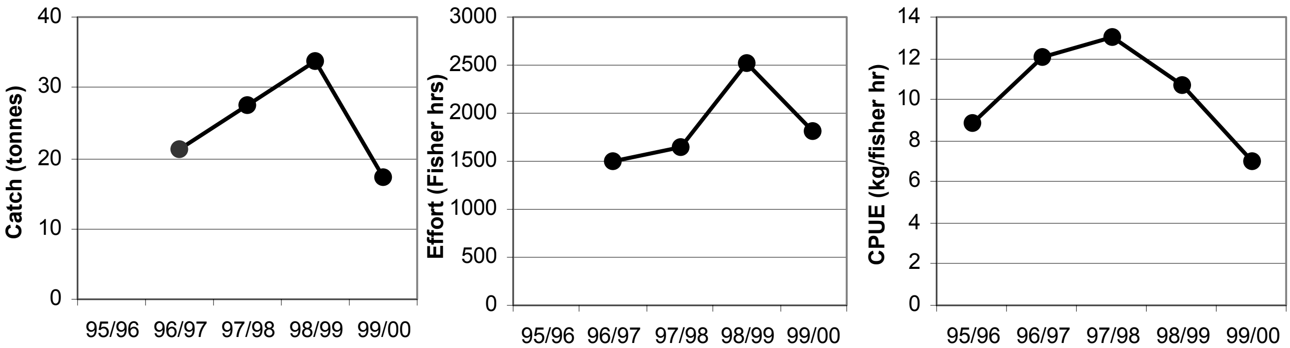

Fig. 5.4 Annual dip net catch, effort and catch per unit effort (CPUE) of sea garfish. Catch and effort is not shown where 5 or fewer vessels are involved.

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 1999/2000 was within the reference range and being about 10% lower than for the previous year 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 in 1999/2000 while dip net effort had fallen from a peak in 1998/99 to a level roughly equivalent to 10% greater than the peak during the reference period. On this basis, effort triggers were not 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.

Although the most recent dip net CPUE was lower than reported for the reference period, it was equivalent to about 80% of the lowest previous value (1995/96) and therefore the CPUE trigger was not exceeded. As noted above, however, 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 south-east and north-east 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. Such increases may result in over-exploitation. Very limited information is available on the stock structure of sea garfish and thus it is not possible to evaluate whether some form of regional management would be appropriate.

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

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.

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 able 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 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 access in the future. 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.

6.2 Stock Structure and Life-history

Eight species of wrasse occur in Tasmanian waters with purple wrasse (*Pseudolabrus fucicola*) and blue-throat wrasse (*P. tetricus*) the two main commercial species. Both species are distributed in south-east 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 set before sexual maturity is reached (Barrett 1995). In contrast, a small proportion of blue-throat wrasse between 27 and 32 cm change from female to male, accompanied by a colour change. Sex reversal 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 females for both species is about 15 cm, which corresponds to an age of around 2 to 3 years. This small size at maturity means fish may spawn for at least 4 to 5 years before reaching the lower size limit of 28 cm. 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 four years, with growth considerably slower in older fish (Barrett 1995). The maximum age for purple and blue-throat wrasse is about 17 and 10 years, respectively (Barrett 1995). Age composition, 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 and purple wrasse (see Appendix 6). The growth parameters defined are represented by few fish over 30 cm and are based on unvalidated age estimates.

6.3 Previous Assessments

Previous assessments have been restricted to analyses of trends in trap and handline catch, effort and catch rates since 1995/96. During this period there have been only minor changes in the annual catch of wrasse combined across all fishing gears, with catches ranging between 83 and 110 tonnes between 1995/96 and 1998/99.

Trap catch and effort peaked in 1996/97 and CPUE in 1998/99. Variability in catches between years were more in response to changes in effort rather than catch rates over this period. Similarly, the handline component of the fishery showed a peak in catch and effort in 1996/97, with CPUE peaking in 1998/99.

6.4 Current Assessment

6.4.1 The Fishery

Operators targeting the live fish market primarily take wrasse with fish traps and handlines. In 1999/2000, trap and handline fishing accounted for around 50% and 30% of the catch, respectively (Fig 6.1). Graball catches tend to of secondary importance, since few fish caught by this method are suitable for sale on the live fish market. Incidental catches are also regularly taken in rock lobster pots and a by variety of other methods.

Based on the reported form of the catches, the annual live wrasse catch has ranged between 55.2 tonnes (1999/2000) and 82.4 tonnes (1996/97) for the five years since 1995/96 (averaging 68% of the total catch weight in each year). Reported usage of wrasse as bait has ranged between 9.4 tonnes (1999/2000) and 12.8 tonnes (1995/96) over the same period (averaging 12% of the annual catch). 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.

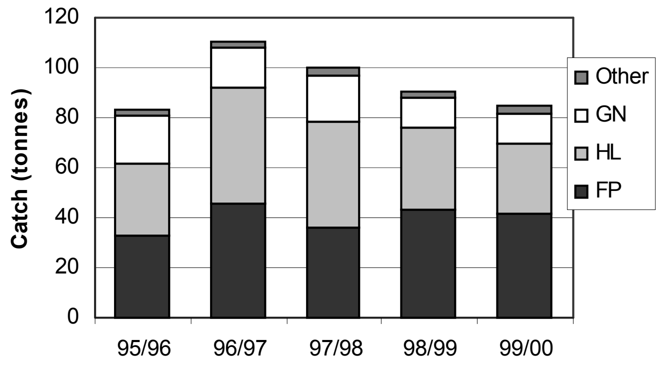

Fig. 6.1 Annual catch of wrasse by method. FP is fish trap; HL is handline; GN is graball net.

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 south-east 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 north-west coast (blocks 4D2, 4D4, 4E1, 4E2, 4E3, 4E4, 5D2). There is evidence that there has been a shift in the spatial distribution of catches since 1996/97, with east coast catches generally increasing, while south-east and north-east coast catches have declined. In 1999/2000 there was a sharp increase in east coast and a marked decline in the north-east coast production.

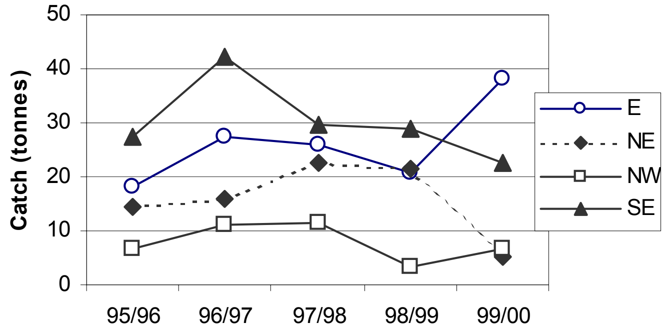

Fig 6.2 Annual catch or wrasse by fishing regions - E is east coast, NE is north east coast, including Flinders Island , NW is north west coast and SE is south-east coast (refer text).

6.4.2 Recent Developments

A project presently underway is examining aspects of age and growth of purple wrasse on the south and east coasts of Tasmania. Multiple mark recapture and selectivity experiments are being 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 2000 Assessment

There has been a small decrease in the annual catch combined across all fishing gears over the past year, with catches down from 91 to 85 tonnes (Table 2.1). This assessment is limited to examination of trends in fish trap, handline and graball catch, effort and CPUE for the period 1995/96 to 1999/2000 (Table 6.1).

Fish traps are the primary fishing method and catch, effort and CPUE have remained relatively stable over the past five years (Table 6.1, Fig. 6.3). By contrast, handline catch and effort have declined steadily since 1996/97 although CPUE has remained stable over this period (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. However, notwithstanding this, graball CPUE remained stable between 1995/96 and 1998/99 but declined by around 40% in 1999/2000 (Table 6.1).

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 analysis of data at the block level will be relatively insensitive to changes in abundance at the level at which the fishery impacts on the fish populations, that is at the individual reef level. Further, analysis of data at the block level does not overcome the species problem.

The stock status of wrasse is uncertain.

Table 6.1 Wrasse catch, effort and CPUE for the main wrasse fishing methods.
For effort units refer to Table 2.3.

Method	*Year*	*Catch (tonnes)*	*Effort*	CPUE
Fish trap	1995/96	32.6	7813	3.59
	1996/97	45.5	10329	3.94
	1997/98	36.3	9386	3.61
	1998/99	43.5	10159	4.00
	1999/2000	42.0	9988	3.80
Hand line	1995/96	29.2	7626	3.08
	1996/97	46.9	13209	3.16
	1997/98	42.2	10648	3.19
	1998/99	32.4	6737	3.69
	1999/2000	27.5	6139	3.60
Graball	1995/96	19.3	30655	0.69
	1996/97	16.0	27219	0.68
	1997/98	19.2	45492	0.69
	1998/99	12.7	30116	0.71
	1999/2000	12.2	52469	0.42

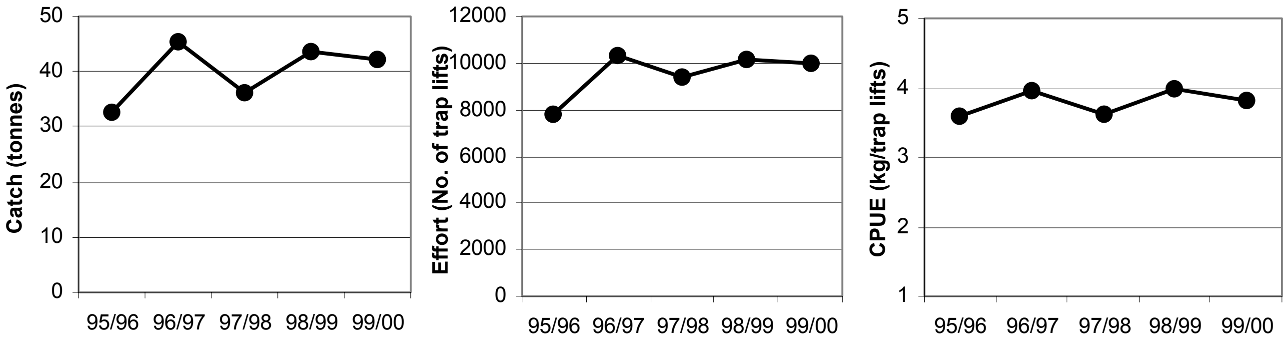

Fig. 6.3 Annual fish trap catch, effort and catch per unit effort (CPUE) of wrasse in Tasmania.

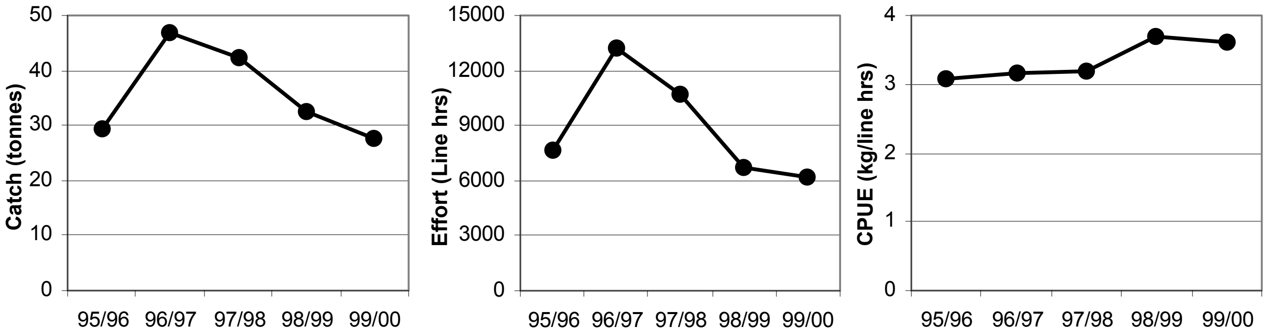

Fig. 6.4 Annual handline catch, effort and catch per unit effort (CPUE) of wrasse in Tasmania.

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 1999/2000 catch was within the reference range and varied less than 30% from the 1998/99 level (refer Table 2.1), no catch triggers were exceeded for wrasse.

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.*

Fishing effort peaked in both the handline and trap fisheries in 1996/97 indicating that effort triggers were not reached for either method based on 1999/2000 data (Table 6.1). Although in 1999/2000 graball effort exceeded the previous peak (1997/98) by about 15%, this does not necessary indicate an increase in gillnet effort targeted at wrasse, an observation supported by consistency in catch levels over the past two years.

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.*

Minimum CPUE levels occurred in the trap and handline components of the fishery in 1995/96 (Table 6.1). As the most recent annual CPUE values for fish trap and handline methods were within or higher than the reference range, this trigger was not reached. The sharp fall in graball CPUE is not considered a reliable indicator since the species occur largely as an incidental catch using this method.

Although no CPUE triggers were reached for the trap and handline gears, 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.

Wrasse are currently managed and reported in catch returns as a species group, rather than at the individual species level. This clearly has implications for stock assessment, producing uncertainty in the interpretation of fishery indicators.

There is a need to assess 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 legal minimum and maximum size limits.

Commercial monitoring of the wrasse fishery is 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. Alternatively, commercial fishers could be encouraged to provide information on the species breakdown and greater spatial resolution in relation to their catches.

7 Southern calamary (*Sepioteuthis australis*)

7.1 Management Background

Annual catches of southern calamary rose dramatically in 1998/99 from historic levels of generally below 20 tonnes 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 may be introduced in the future. In addition, temporary 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.

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.

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% are either immature or in developing stages of maturity. Minimum recorded age and size at maturity for females is 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 spawning occurs 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 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 macro-algae. 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 remain over the spawning grounds for 20-30 days. The location of individuals between about 20-80 days of age is unknown, however at 80-150 days juveniles are found in deep 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 1999 assessment was restricted to an analysis of trends in catch, effort and catch rates for squid jig and purse seine methods. There was a large increase in the total catch of southern calamary in 1998/99, due almost exclusively to increased squid jig effort, which resulted in both catch and effort triggers being exceeded for this species. Catches from Great Oyster Bay, Mercury Passage and Tasman Peninsula regions combined contributed around 80% of the total and consequently trends in catch, effort and CPUE were also analysed at the regional level. Jig effort was found to have increased markedly in 1998/99, largely due to targeted fishing over seagrass beds in the eastern Great Oyster Bay and Mercury Passage regions, with the effort trigger greatly exceeded for this gear type.

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 and purse seine the primary methods, accounting for around 73% of the catch in 1999/2000(Fig.7.1). Both purse seine and jig fishing are conducted close to shore, almost exclusively in depths of <10 m. Jigs are used 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.

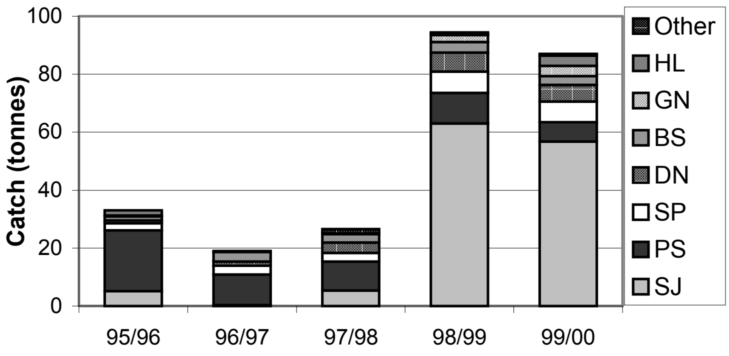

Figure 7.1. Annual catch of southern calamary by method. SJ is squid jig; PS is purse seine; SP is spear; DN is dip net; BS is beach seine; GN is graball net; HL is handline.

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, an follow-up study was initiated to further examine these population parameters, with research sampling conducted on a more intensive temporal basis. The size composition and sex ratio of the commercial catch from both jig and purse seine gears are being 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 temporary 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*. 2001). 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*. 2001).

Recent research has also examined levels of mortality occurring within the egg mops 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.

7.4.3 2000 Assessment

There has been a considerable change in the annual catch of southern calamary combined across all fishing gears over the past five years, ranging from 19 tonnes in 1996/97 to 87 tonnes in 1999/2000, with a peak of 94 tonnes in 1998/99 (Table 2.1). The higher catches of 1998/99 and 1999/2000 have been almost exclusively due to increased squid jig effort (Table 7.1).

This assessment is restricted to an examination of trends in catch, effort and catch rates since 1995/96 and as squid jig and purse seine are the primary fishing methods, analysis has been restricted to these methods. It should be noted, however, that as five or fewer vessels were involved in the use of purse seines between 1996/97 and 1998/99, catch and effort data have not been reported.

State-wide, jig effort increased again in 1999/2000, up by 18% from the 1998/99 peak. There was, however, a 30% decrease in CPUE compared to 1998/99 that resulted in a 10% fall in the jig catch (Table 7.1). Purse seine CPUE, which had remained relatively stable over the previous four-year period, declined by almost 40% in 1999/2000.

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 and ES14), Mercury Passage (6H3, 6G4 and ES16) and Tasman Peninsula (7G2). Collectively these regions accounted for 82% of both the overall squid jig catch and effort in 1999/2000. Whereas in previous years catch and effort was concentrated in Great Oyster Bay, in 1999/2000 catch and effort levels were generally similar for Great Oyster Bay and Mercury Passage (Fig.7.2). This general shift in the fishery reflected a combination of reduced activity in Great Oyster Bay and increased fishing in the Mercury Passage. This shift was probably at least partly a response to the short-term fishing closures imposed during 1999 in Great Oyster Bay. Although CPUE in each of the three regions declined in 1999/2000, levels were comparable or slightly higher that those for the period 1995/96 to 1997/98.

Interestingly, in 1999/2000 around 3.4 tonnes of calamary was coded as handline catch, representing a ten-fold increase when compared to the previous three years. As the majority of this was probably taken using jigs this effectively would represent a further increase to both catch and effort for this gear type.

The resource status of southern calamary is unknown and the sustainability of current catch levels is uncertain. The fact 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 units of effort and CPUE refer to Table 2.3. * 5 or fewer vessels involved, data can not be shown.

Method	*Year*	*Catch (tonnes)*	*Effort*	*CPUE*
Squid jig	1995/96	5.1	360	10.0
	1996/97	0.3	127	2.6
	1997/98	5.3	1407	5.0
	1998/99	63.0	6592	8.9
	1999/2000	56.7	7799	6.2
Purse seine	1995/96	21.0	322	31.1
	1996/97	*	*	28.6
	1997/98	*	*	29.8
	1998/99	*	*	31.6
	1999/2000	6.8	199	20.0

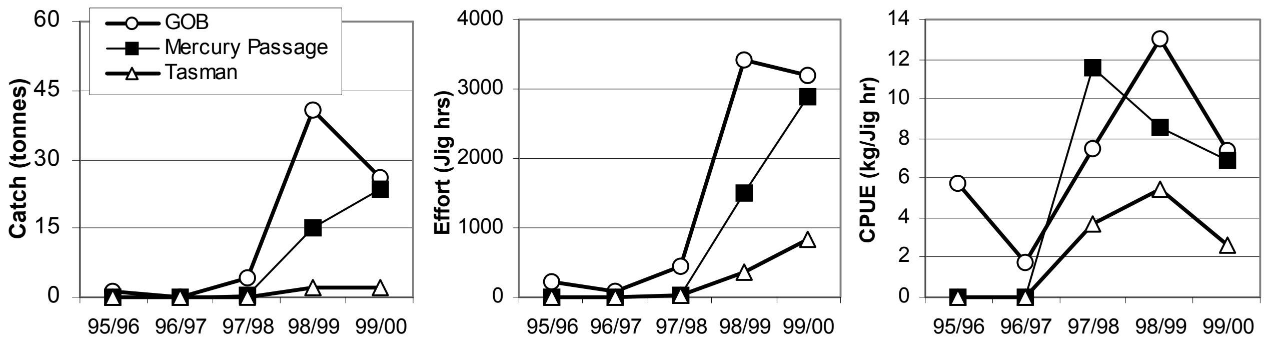

Fig. 7.2 Annual squid jig catch, effort and catch per unit effort (CPUE) of southern calamary in Tasmania.

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 1999/2000 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 second year running. However, although the current catch was lower than in 1998/99, the decline of about 8% did not exceed the second catch trigger.

Fishing effort

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

Purse seine fishing effort has remained relatively stable over the past four years indicating this effort trigger has not been reached. By contrast, jig effort increased again in 1999/2000 by at least 18%, and possibly up to 25% 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 1999/2000 jig CPUE was within the reference period range, it was about 30% lower than for the previous year, with declines occurring in each of the major fishing regions. Purse seine catch rates also declined by about 40%, to a level equivalent to 70% of the lowest value from the 1995-97 period. As such this trigger point has been exceeded for purse seine. However, it is unclear how the recent changes to the licensing arrangements for purse seines (i.e. limited entry) have impacted on the use of this method to target calamary.

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 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 all 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 have yet to be evaluated.

7.6 Implications for Management

All holders of scalefish fishing licences are entitled to use squid jigs and, therefore, given growing interest in this species, there is potential for further expansion in effort. 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.

The 1999 closures were implemented as an emergency measure when little information was available on the temporal and spatial predictability of spawning activities. Although it was evident that the 1999 closures were successful in providing some protection to spawning animals, 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 the arrow squid fishery 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 in 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 scalefish management plan all scalefish and rock lobster licence-holders are 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 where 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 will be considered in the review of the scalefish management plan, scheduled to take effect in late 2001.

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 are a single genetic stock.

Arrow squid aggregate near the sea bed 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

There have been no previous assessments of arrow squid apart from reporting of catch levels.

8.4 Current Assessment

8.4.1 The Fishery

The Tasmanian arrow squid fishery targets schools forming around the coast from October through to March. The fishery saw a dramatic expansion of effort in the jig sector in 1998/99 and again in 1999/2000, with annual catches increasing from less than about 10 tonnes during the 1990's to 86 tonnes in 1998/99 and 430 tonnes in 1999/2000 (Table 2.1).

The majority (about 80%) of the 1998/99 and 1999/2000 catches were taken between December and January and predominately from Storm Bay. Overall, 90% of the 1999/2000 catch was taken from Storm Bay (blocks 7G1, 7G2, 7G3). Smaller quantities were taken from Bass Strait, east of the Tamar River, and off the east coast, mainly south of the Freycinet Peninsula. Industry reports suggest that catch and effort in the Bass Strait region was unusually low in 1999/2000 because of the presence of large quantities of barracouta which caused excessive damage and losses to fishing gear.

The Tasmanian fleet consists of a small number of the 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.

Logistically, the fleet is limited in its area of operation since the catch is either stored on ice or in brine and spoils quickly. It is necessary therefore to fish in close proximity to the processing and storage facilities. Partly for this reason, catches in the past two seasons have been concentrated in Storm Bay and to a lesser extent off the east and north coasts of Tasmania.

8.4.2 Recent developments

Limited catch sampling was undertaken during the 1999/2000 season as part of research being undertaken by the University of Tasmania's Institute of Antarctic and Southern Ocean Studies (IASOS) (B McGrath and G Jackson) and as part of an Australian Maritime College project (R Mitchell).

The size composition of samples of arrow squid showed a trend of growth over the 1999/2000 season. The average size increased from 223 mm ML in December 1999 to 299 mm in February 2000. Sex and maturity information indicated that virtually all of the females and over 75% of males caught were immature in December and January. Fifty five percent of females and 11% of males caught in February were mature. The sex ratio was roughly 50:50 in December but by January and February females dominated the catches (70 - 100%).

These data indicate that the majority of arrow squid caught at the height of the season (December and January) were small and had not reached maturity. Industry reports suggest that a large proportion of the Tasmanian catch was not of size suitable for processing into squid tubes for human consumption but was processed for (longline) bait.

8.4.3 2000 Assessment

There has been a dramatic expansion in the arrow squid fishery over the past two years, with catches reaching about 430 tonnes in 1999/2000 (Table 2.1). The higher catches have been almost exclusively due to increases in squid jig effort compared to earlier years and, in particular, due to the operation of automatic squid vessels[5] (Fig. 8.1). In 1999/2000, the automated jig sector, some 11 vessels, alone accounted for 86% of the total catch.

Given the recent expansion of the fishery, examination of catch, effort and CPUE trends will not be meaningful. It would appear that arrow squid occur seasonally in coastal waters and, based on the 1999/2000 season, are largely represented by juveniles. 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

[5] 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).

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 south-eastern Tasmania and those exploited in the Commonwealth fishery in Bass Strait is not known.

Table 8.1 Catch, effort and CPUE by key fishing methods for arrow squid.
For units of effort and CPUE refer to Table 2.3. * 5 or fewer vessels involved, data can not be shown.

Method	*Year*	*Catch (tonnes)*	*Effort*	*CPUE*
Squid jig	1995/96	3.5	4563	0.23
	1996/97	5.4	405	2.10
	1997/98	12.0	6484	2.71
	1998/99	25.7	3822	4.96
	1999/2000	57.0	21537	3.05
Auto jig	1998/99	*	*	0.15
	1999/2000	373.0	875191	0.27

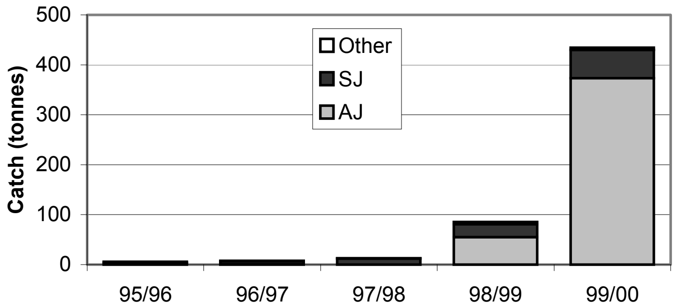

Fig. 8.1. Annual catch of arrow squid by method. SJ is squid jig; AJ is automated jig system.

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 1999/2000 catch of 430 tonnes was the highest on record for Tasmania, representing a five-fold increase over the 1998/99 catch. Both catch triggers were, therefore, 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.*

Jig effort increased again dramatically in 1999/2000, exceeding effort trigger level for the second year in a row.

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 through the use of lights to the fishing vessel. Notwithstanding this, jig CPUE was within the reference range of values while the automated jig CPUE was almost twice that for 1998/99. On this basis, the catch rate trigger was 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 1999/2000 season 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.

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 size of the stock available to the jig fishery. Some variation in effort may also be due to fluctuations in the performance of other south-east Australian fisheries which has the effect of forcing fishers to look to alternative species such as squid. Very little is known about the population dynamics of arrow squid in Australian waters at this stage.

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. 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.

A significant body of latent effort in the Tasmanian arrow squid fishery exists 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 is an urgent need to address the issue of access by large-scale operators to the fishery. This was undertaken as an interim measure for the 2000/01 season but should be resolved within the context of the scalefish management plan review in 2001.

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 Scalefish Fishery Research Advisory Group. 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.

Research into the life history and stock structure of arrow squid off southern Australia is being undertaken by IASOS. A post-graduate study within TAFI to examine the dynamics of arrow squid in Tasmanian waters has also been proposed.

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.

The beach seine catch of Australian salmon has declined steadily since 1997/98, reflecting a general decrease in effort (Table 9.1). While there was no consistent trend in CPUE, beach seines are generally used to target schooling fish and therefore catch rates are unlikely to be a reliable indicator of stock abundance. The graball catch increased slightly in 1999/2000, due largely to an increase in graball effort. No catch, effort or CPUE triggers were exceeded for Australian salmon.

The 1999/2000 graball catch of bastard trumpeter declined by about 27% compared with the previous year, despite a 14% increase in effort (Table 9.1). Although the most recent CPUE value was the lowest since 1995/96, it was still within 80% of the previous lowest level (1997/98) and therefore did not exceed the trigger. Bastard trumpeter, like the related striped trumpeter, are known to exhibit strong recruitment variability which may 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 availability and thus catch rates.

The most recent graball catch for blue warehou catch fell by over 30% when compared to the previous year, to a level equivalent to that for 1997/98 (Table 9.1). In doing so the catch trigger relating to rate of change in annual catches was exceeded. There was a slight decline in effort and CPUE in 1999/2000 but neither effort nor CPUE triggers were reached. Blue warehou occur seasonally in Tasmanian inshore waters, this area representing the southern most extent of the species distribution. In addition, the availability of blue warehou in inshore waters appears to be influenced by prevailing oceanographic conditions. Combined, these factors result in marked inter-annual variability in catches as demonstrated in Table 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 graball catch of flounder fell by over 50% in 1999/2000, due largely to a drop in effort of similar magnitude (Table 9.1). CPUE has, however, increased steadily since 1995/96. The spear catch was very similar to 1998/99 and although spear CPUE was at the lowest level for the five year period, the CPUE trigger was not reached. As the combined catch (all methods) of flounder was lower than the reference period the catch trigger has been activated (refer Table 2.1).

Both catch triggers were exceeded for jackass morwong, with 1999/2000 catches the lowest since 1990/91, representing a decline of greater than 30% over the previous year’s catch (refer Table 2.1). Jackass morwong are taken by a variety of methods, the most significant being graball nets. It is apparent from Table 9.1 that the sharp decline in graball catch was due to a marked fall in effort, CPUE being slightly higher in 1999/2000 compared to 1998/99. Effort and CPUE triggers were not, therefore, reached. As for blue warehou, the species is taken by trawl in Commonwealth waters, where catches are significantly greater than those taken from State waters.

Table 9.1 Catch, effort and CPUE by method for key species for the period 1995/96 to 1999/2000.
For units of effort and CPUE refer to Table 2.3.

Species	*Method*	*Year*	*Catch (tonnes)*	*Effort*	*CPUE*
Australian Salmon	Beach seine	1995/96	387.7	221	211.97
		1996/97	253.8	238	119.17
		1997/98	437.6	359	184.01
		1998/99	352.0	150	244.39
		1999/2000	309.6	143	145.37
	Graball	1995/96	12.9	11245	0.90
		1996/97	14.1	10983	1.37
		1997/98	16.3	8137	1.94
		1998/99	11.0	7169	1.70
		1999/2000	13.5	9957	1.15
Bastard trumpeter	Graball	1995/96	59.1	76964	0.86
		1996/97	50.0	80315	0.73
		1997/98	39.5	58352	0.68
		1998/99	45.9	61018	0.75
		1999/2000	33.5	69718	0.63
Blue warehou	Graball	1995/96	50.5	42047	0.76
		1996/97	111.6	86524	1.04
		1997/98	177.5	118622	1.36
		1998/99	257.5	97122	2.03
		1999/2000	170.7	93295	1.65
Flounder	Graball	1995/96	18.6	71138	0.23
		1996/97	11.8	47577	0.24
		1997/98	13.8	34872	0.31
		1998/99	12.1	24833	0.34
		1999/2000	5.7	13926	0.37
	Spear	1995/96	8.7	1204	6.15
		1996/97	15.2	1696	7.31
		1997/98	13.3	1864	5.87
		1998/99	10.7	1547	5.54
		1999/2000	11.0	1771	5.27
Jackass Morwong	Graball	1995/96	17.5	13474	1.29
		1996/97	11.4	11758	1.37
		1997/98	14.6	23994	0.77
		1998/99	10.8	10632	1.01
		1999/2000	6.9	6026	1.12

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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), such that if a catch of a species is reported as gilled and gutted then the equivalent whole weight can be estimated by applying a standard *conversion factor*[6].

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

ii) Area restriction

Unless otherwise stated, only catch and effort data reported in fishing blocks adjacent to land have been used in the analyses:

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.

In addition, catches from estuary blocks have been included (refer Fig A1).

iii) Duplicate records

Duplicate records (fisher, date and gear) were detected in the database. Where the records appeared to be exact duplicates, one was deleted. Where they appeared to be separate records, the catch was added together to form a single record but the effort was not doubled. The exception to this approach related to shark net and shark longline methods since fishers were required to report such activity on a shot by shot rather than daily basis.

iv) Effort Problems

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

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, however the effort was not included in effort summaries, nor was the record used in calculating CPUE.

v) 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.

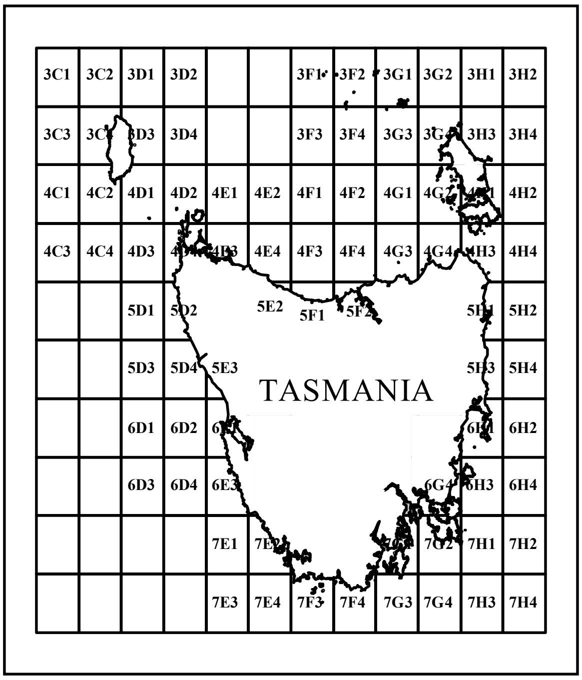

Fig. A1 Block numbers for fishing blocks used in calculation of catch figures.

Commonwealth logbook data:

Commonwealth logbook data from Australian Fisheries Management Authority was included in this year's analyses so that the report now reflects 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 (as above) *and* the maximum depth of the fishing operation was less than 200 m. This condition was applied to all records *except* where striped trumpeter was caught. All records that included catches of this species were included for analysis.
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.