Fisheries management paper

Management of the South Coast Purse Seine Fishery

Fisheries management paper No. 99

Fisheries Western Australia

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SUMMARY

Since 1989, when dedicated research commenced on the pilchard stocks of the south coast, the advice has been consistent in the call for precautionary management. Caution was necessary because of the uncertainty over stock discrimination, the schooling behaviour of the pilchard which makes them vulnerable to overfishing by net, and the natural fluctuations in the stocks due to environmental conditions.

Although research advise that the stock of pilchards is one genetic breeding stock with separate adult populations in each of the zones, there will always be variability in the stock available in the fishery and in each zone. Management needs to account for this variability and provide flexibility so that both the stock and the commercial industry are sustainable.

This paper has presented a strategy for moving the management of the small pelagics fishery off the south coast to management of the whole fishery, which facilitates a more biologically sound and economically stable fishery.

It involves the abolition of the pool quotas, moving all units to an equal value, and a biological objective that sets the minimum breeding stock level for each zone and for the total fishery.

Instead of individual allocations being restricted to catch within a particular zone, the TAC may be taken across a number of zones according to the level of the available breeding stock. For 1997/98, this results in the reallocation of fishing effort from Albany to Esperance. Despite this re-allocation, the exploitation rates for both Esperance and the total fishery are within safe limits, although the exploitation rate for Albany is still 10 per cent higher than that advised by the research scientists.

Taking the whole south coast stock, the exploitation rate is sustainable. However, the adult stock in the Albany zone will continue to be severely reduced under the proposed zonal TAC for 1997/98.

This flexible system provides a method of spreading effort across the total fishery and is responsive to recruitment variations in each zone. The chance of local depletion is reduced and economic stability increased.

For 1997/98, the TACs will be 3030.5 tonnes for Zones 1 & 2, 2552 tonnes for Zone 3 and 2777.5 tonnes for Zone 4.

PROCESS

The strategy developed in this paper was presented to industry at a meeting in Albany on Wednesday, 5 March 1997. At that meeting scientists and managers addressed the proposed direction of management for 1997/98 and beyond, and were available to answer any questions.

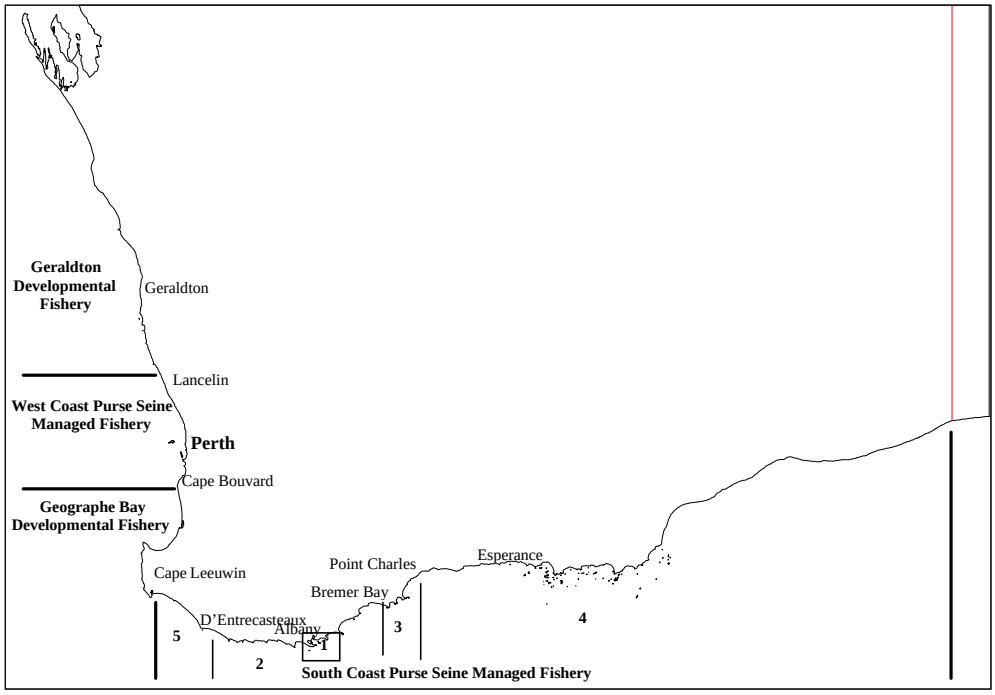
Industry had the opportunity to take a draft of this paper and consider the proposal and the implications for them as individual fishermen or processors, and for the fishery as a whole. Departmental officers were available in Albany on the morning of Monday, 10 March to field any further questions arising from consideration of the draft. A meeting of the MAC was held that afternoon in Albany to discuss the proposed management strategy and to put recommendations to the Minister.

The Minister agreed to provide his decision within a week of the industry and MAC meetings, so that amendments to the management plan could be prepared prior to the commencement of the next licensing period (1 April 1997).

DESCRIPTION OF THE FISHERY

The South Coast Purse Seine Fishery covers the taking of small pelagic fish by purse seine in all waters between Cape Leeuwin and the South Australian Border. Although a small pelagic fishery, the target species is pilchards. The fishery is divided into five zones and there are 33 managed fishery licences.

Figure 1 Western Australian Purse Seine Fisheries



Albany - Zones 1 and 2

There are two zones in this fishery. The Albany zone extends from Point D'Entrecasteaux to Cape Knob with King George Sound being a zone within this area. There are 15 licensees holding 444 units in King George Sound (Zone 1) and six licensees holding 107 units of entitlement in the outer zone (Zone 2, see Table 1).

Since the introduction of individual transferable quotas (ITQs) in 1991, the Albany unit value stayed at 10 tonnes/unit until it was changed to seven tonnes/unit in 1995/96 following three years of poor recruitment. This was increased to eight tonnes/unit for the 1996/97 season following preliminary indications recruitment was improving, with reasonable numbers of one year-old fish present in inshore waters in 1995.

Bremer Bay - Zone 3

The boundaries of this fishery are from Cape Knob to Point Charles. There are seven licensees holding 206 units of entitlement in the fishery (see Table 1).

The Bremer Bay unit value was reduced from 10 tonnes/unit, which was the initial value in 1991, to 8.5 tonnes/unit in 1995 due to concerns arising from a lack of recruitment. Following an acceptable level of recruitment in the region in 1995 the unit value was increased to 10 tonnes/unit for the 1996/97 season. There are an additional 50 units of "pool" quota that are available to licensees who have taken all their permanent allocation.

Esperance - Zone 4

The boundaries of this zone are from Point Charles to the South Australian Border. A development fishery for pilchards operated until early 1996 when the Minister approved management arrangements placing the area within the South Coast Purse Seine Managed Fishery. Prior to 1 April 1996 Albany fishermen were allowed to fish the zone. On 1 April when the zone became part of the managed fishery, five licensees were allocated 113 units at 10 tonnes/unit in the fishery.

This zone also has a 'pool'quota of 67 units that can be allocated to licensees in a similar way to that which applies to the Bremer Bay 'pool' quota.

Augusta - Zone 5

The boundaries of this zone are from Cape Leeuwin to Point D'Entrecasteaux. Like Zone 4 a development fishery operated until the zone became part of the managed fishery on 1 April 1996. However, unlike Zone 4 there were no entitlements issued in the zone with access being restricted to licence holders in the other zones with any fish being taken in the zone being deducted from TAC held in the other zones. The remoteness of the area, minimal docking facilities, and lack of suitable onshore freezing capacity has meant that little fishing has taken place in this zone. Plankton surveys over time have provided little evidence of significant stocks in this zone.

Table 1: Managed Fishery Licensees and entitlements in each zone

	Zone 1	Zone 2	Zone 3	Zone 4
Units	444	107	206	113
Licensees	23	6	7	5
Range of units held by individual licensees	8-37	9-34	8-51	20-28

Some licensees hold entitlements to more than one zone; however, licensees of Zone 3 do not hold entitlements to any other zone. Table 2 summarises the holdings.

Table 2: Licensees' unit holdings by zone

Zone 1	Zone 1 &2	Zone 1&4	Zone 3	Zone 4
15	6	2	7	3

LEGISLATION

The following legislation currently applies to the use of purse seine nets to take pilchards and other small pelagic fish off the south coast.

- *Net Hauling Restrictions Notice 1991* that prohibit persons from using fishing net drum, a puretic power block or other similar device for hauling a fishing net unless suitably endorsed.

- *Fishery Notice No 312* that relates to use of purse seine nets.

- *The Pilchard Fishing (Professional) Restrictions Notice 1992* prohibiting the taking of pilchard in Western Australian waters.

- *The South Coast Purse Seine Managed Fishery Management Plan 1994* (as amended).

All of the south coast came under one management plan in 1996 with 5 zones (Figure 1) extending from Cape Leeuwin to the South Australian border. Prior to that date each zone was managed as a separate fishery.

BIOLOGICAL SYNOPSIS OF THE PILCHARD (*SARDINOPS SAGAX*) IN WESTERN AUSTRALIA

The biology of pilchards in Australia has previously been described in detail by Fletcher (1990), using material collated from various studies up until 1990. Since this time, research on pilchards in Australia has concentrated on those off the southern coast of Western Australia (Fletcher, 1991; Fletcher, 1992; Fletcher & Tregonning, 1992; Fletcher et al. 1994; Fletcher, 1995; Fletcher & Blight, 1996; Fletcher et al., 1996a; Fletcher et al., 1996b; Fletcher & Hayes, in preparation). Besides these published studies there has also been a continuous program of intensive monitoring of commercial catches in WA since 1988/89.

Age and growth

Pilchards are a relatively short-lived, pelagic, schooling species. In WA, pilchards live to an age of eight years and attain a maximum size of approximately 200 mm fork length (FL). Sexual maturity is reached at two years of age, corresponding to a size of approximately 120 mm (FL).

Typical of most small schooling fish, pilchards have a relatively high natural mortality rate, which may account for natural losses as high as 35 per cent in a single year. Therefore, without replacement through recruitment, a population of pilchards will decline relatively quickly, even in the absence of fishing, due to natural mortality.

Schooling Behaviour

Pilchards younger than two years do not appear to school to the same degree as mature fish. Thus, while juvenile pilchards certainly school, the size and density of schools appear to increase markedly once the fish mature. This behaviour renders them vulnerable to exploitation with purse seines.

With schooling fish, catch rates remain high even when overall stock abundance is low.

Spawning

The period of spawning by pilchards on the south coast is different between the three fishing regions of Albany, Bremer Bay and Esperance. The main spawning season in Esperance is during April/May and at Bremer Bay is during June/July. In contrast, Albany has two major spawning periods each year, one during winter (July) and another during summer (December/January).

The occurrence of Day 1 eggs (eggs spawned the previous night) indicates that spawning occurs predominantly in inshore waters at the Albany region but at Esperance occurs across much of the continental shelf and can be most intense towards the edge of the continental shelf. The situation at Bremer Bay is intermediate with spawning predominantly occurring within the inshore half of the shelf. Another point to note is that spawning at Albany can extend further offshore during summer when the influence of the Leeuwin Current is much weaker or virtually absent. The stronger flow of the current during winter is probably responsible for restricting winter spawning at Albany to the inshore waters, landward of the main flow of the Leeuwin Current.

Fate of eggs and larvae

The distribution of pilchard eggs following spawning is dependent upon movements of water in which they may occur. Likewise, pilchard larvae initially are very weak swimmers and are thus also distributed by the water mass in which they occur. However, water movements may vary seasonally and annually in scale, strength and direction.

The dominant current along the south coast is the Leeuwin Current. This current has been shown to move pilchard eggs spawned in the Albany region during winter towards Bremer Bay and Esperance, with the distance travelled by eggs and larvae being significantly correlated to the strength of the current, as measured by sea level at Fremantle. The rate of this transport can be quite fast, with the result that larvae resulting from Albany-spawned eggs may occur up to 160 km to the east of Albany, with movements greater than 100 km possible in a matter of days. However, this rate of transport can vary and in some years the

observed distance transported was 80 km, while in another year, the Leeuwin Current was so weak no clear trend of an easterly movement was detected during the winter spawning period.

Smaller scale westerly transport of eggs sometimes occurs during summer. This transport indicates that there is mixing of pilchards between Albany, Bremer Bay and Esperance at the egg and larval stages, which therefore suggests that genetic differences between pilchards from these regions are extremely unlikely.

This conclusion is supported by research on the genetics of *Sardinops* within Australia and from around the world which has found "considerable genetic similarity" within Australian pilchards (Dixon et al., 1993; Okazaki et al., 1996). Hence, the south coast pilchards can be considered as belonging to one breeding stock. This is not unexpected since little interchange between populations is needed to produce one genetic stock. Even though other evidence indicates that adults in Albany, Bremer Bay and Esperance largely remain separate, the stock in each region has some potential to contribute to the other through their egg, larval and juvenile stages

The variable distances and directions of egg/larval transport also have implications on recruitment. With such variability, the contribution to overall recruitment from spawning in each region is also likely to be variable, depending on the early fate of larval stages (e.g. their location upon becoming juveniles). Nonetheless, the contributions from the Albany region to the south coast fishery as a whole, are probably more important because of the dominant influence of the Leeuwin Current which transports eggs and larvae eastward towards Bremer Bay and Esperance.

The detection of such transport along the coast is limited to the egg and larval stages which could be captured with plankton nets. Larvae eventually reach a size where their swimming ability has improved to the point where they become difficult, and then impossible, to catch using plankton nets. Thus, pilchard larvae longer than 20 mm are relatively rare in the plankton samples, and none longer than 30 mm are caught.

Juveniles

The two main methods of sampling for research on pilchards in WA have been (1) plankton sampling with small conical nets of either 0.5 or 0.3 mm mesh, and (2) obtaining adult samples from the commercial catch. Since plankton sampling rarely catches pilchards longer than 20 mm and the commercial catch typically consists of maturing and mature schooling fish longer than 120 mm (two year olds), there is little information on the pilchards in the size range of 20 - 120 mm. This problem is reduced to a certain extent by the occasional catch of pilchards around one year old with lengths of 70 - 100 mm. However, these small fish are in most cases only caught incidentally, are small enough to go through the commercial mesh and are not targeted by the commercial fishers.

Thus, the ecology of pilchards up to two years of age is not well understood. In particular, there is no strong evidence from which the location of nursery areas could be determined. Furthermore, there is in fact no evidence that specific nursery areas even exist, although observations by fishers along the south coast of WA appear to indicate that juvenile pilchards

are 'recruiting' from east of Esperance. Without knowledge of where pilchards are located up until they reach two years of age it is difficult to estimate the abundance of juveniles until they become vulnerable to fishing and are taken by commercial fishers.

Recruitment

The commercial catch of pilchards in WA normally consists of fish aged from two to eight years. The four and five year-old fish are the most abundant in the catches. Since no fishery-independent methods of estimating recruitment for the WA pilchard fisheries are currently available, the two year-olds in the catch are used as an indicator of recruitment success. While it is acknowledged that two year-old pilchards are not targeted by the south coast purse seiners, sufficient numbers have been obtained in commercial catches, (ie mixed in with older fish which dominate catches), to provide a useful index of recruitment. Thus, even though two year-olds typically contribute only a small fraction of the overall catch, their numbers have been sufficient to be significantly correlated to the abundance of three year-old fish caught in the following year. The abundance of these three year-old fish are likewise significantly correlated to four year-olds in the year after that. Thus, the catch of two year-old pilchards in a particular year can be 'followed' through the fishery in subsequent years. This provides strong evidence that two year-old pilchards which are found in the samples from the commercial catch do in fact represent recruitment and can be used as an index of recruitment.

Recruitment of pilchards, as with other small pelagic fish, can be extremely variable. Poor recruitment has been suggested to be at least partly the cause of past declines in the both the Japanese and North American pilchard fisheries. In particular, the North American pilchard collapsed from a spawning biomass of nearly four million tonnes to around 5000 tonnes (Wolf, 1992). Annual catches likewise declined from as high as 800,000 tonnes to less than 100 tonnes. These data, from several decades of monitoring and research, clearly indicate that populations of pilchards can undergo extremely large changes. Furthermore, periods of high or low abundance may persist for "sustained periods" (Lluch-Belda et al., 1992).

With the large data sets available for pilchard fisheries overseas suggesting that pilchard populations can be expected to be extremely variable in size, it is not particularly surprising that pilchards off the south coast of WA have undergone large fluctuations in spawning biomass. The level of annual recruitment has in fact varied by a factor of 30 since the start of the research on pilchards in the Albany region in 1988/89. In the case of the King George Sound/Albany pilchard fishery, poor recruitment between 1993 and 1995 has resulted in the decline in spawning biomass.

It is still unclear both in the WA pilchard fishery and in the pilchard fisheries overseas what factors are responsible for the large variability in recruitment. Therefore, although historical data can be used to examine the problem of variable recruitment, there is presently no means of predicting future upward or downward trends in recruitment or spawning biomass beyond one year. Using numbers of two year-old fish from commercial catches in WA provides us with the only means of assessing whether the biomass can be expected to increase or decrease in the following year due to good, average or poor recruitment. However, even if an increase or decrease cannot be predicted beyond one year in advance, the effects of various fishing or

recruitment scenarios on a certain level of biomass can be modelled a further two to three years ahead.

The simulation model for the Albany fishery and fishery-independent estimates of spawning biomass

The recruitment index (based on the number of two year-olds caught) is used in a variable recruitment simulation model, together with estimates of the biomass of fish three years and older, to predict biomass in the following year. This simulation model also incorporates information on the age and growth of pilchards as well as natural and fishing mortality. An inherent weakness in this type of model is that the data used are obtained from the fishery itself. Because of this, fishery-independent estimates of spawning biomass are obtained using the daily egg production method. This technique relates the numbers of pilchard eggs found in plankton samples to the numbers of eggs produced by spawning females, and then adds in data on the average weight and sex ratio of adult pilchards to give an estimate of spawning biomass in tonnes.

Data from the plankton survey in July 1995 indicated that the spawning biomass for the Albany region was about 17,600 t, which closely matched the estimate of 18,000 t derived from the simulation model for the fishery. This provides evidence that the model has been providing reasonable estimates of biomass in the Albany region.

The pilchard mortality event of 1995

The pilchard mortality event of early 1995 began in South Australia and then spread to both the east and west. Pilchard mortalities eventually occurred over the entire distribution of the species in Australia. In WA, this event moved west from the South Australian border to Cape Leeuwin and then north to Carnarvon. A herpes virus of unknown origin was the most likely cause of the pilchard deaths and only affected adult pilchards. Similar species whose range overlaps that of pilchards, such as maray (big-eye mulies) and scaly mackerel, were not affected.

Counts of dead pilchards were made both at sea and along shorelines. In combination with results from surveys of spawning biomass off the south coast before and after the mortality event, these results indicated that approximately 10-15 per cent of pilchard stocks in WA were killed. Although the deaths of pilchards due to the herpes virus appear to have ceased entirely, 10-15 per cent of the stocks represents thousands of tonnes which were lost over a very short period. The short term effects of this loss of stock did not have a major impact on the pilchard fisheries, which resumed fishing operations a few weeks after the mortality event had passed.

Summary of the data on stock delineation for WA pilchards.

Background and summary

A large amount of work has been devoted to the determination of the stock structure of pilchards in Australia, particularly in WA. These studies have provided a plethora of data,

not all of which are consistent, but a general picture has emerged whereby separation can be seen at a number of different levels.

Spawning times

There is ample evidence of variations in timing of spawning amongst locations to support the notion of some functional separation amongst stocks. In the eastern region of WA and into the Great Australian Bight (GAB), the main time for spawning by pilchards is in the April to July period. At Bremer Bay, there is also only one main spawning period per year, in June - July; whilst at Albany there are two periods of spawning, one in July and another in December/January. There are also two periods of spawning on the west coast of WA, one in August and one in February-March.

Age structure

Variations in the overall rates of mortality amongst areas with different levels of fishing have also provided information on the level of population separation. In WA, catch-at-age curves for Albany and Bremer Bay have been determined for the past six years using the otolith weight method. A number of years are also available for Esperance and Fremantle.

At Albany, the total mortality rate is relatively high which correlates with the long history of heavy fishing exploitation that has occurred in this region. At Bremer Bay, where exploitation has been much lower, the mortality estimated from catch-at-age curves is also lower, whilst at Esperance, where exploitation has only just begun, the curves appear to merely reflect natural mortality. If there was total free mixing of the adult stock along the south coast all the curves would be similar, or they would alter randomly among years. This is clearly not the case, suggesting that there is not a large degree of mixing of adults along the south coast of WA. There is, however, some evidence that the three south coast locations are linked in terms of variations in the level of juvenile recruitment.

Plankton

Plankton surveys have been completed in summer and winter on the south coast of WA for the years 1991-1995. These studies have confirmed that there are a number of discrete spawning areas which are consistent in space and time but the products of these are often mixed due to transport by the Leeuwin Current.

Samples have also been taken along the lower west coast during 1993-95 in which there has always been a large gap between south coast spawning areas and west coast spawning areas. There has also been surprisingly little evidence of movement of spawning material from the west coast to the south coast despite the presence of the strong, southwards flowing Leeuwin Current.

Morphological studies

Two studies (Blackburn, 1951; Syahailatua, 1992) have used morphological (body structure) features as a method of assessing stock structure of Australian pilchards. Both found significant differences amongst regions. Blackburn (1951) distinguished 3 regions; an eastern group (NSW), a south eastern group (Vic) and a south western group (southern WA). Syahailatua (1992) extended these findings to add a western group (West Coast, WA) and

confirmed that pilchards from all other south coast WA locations were morphologically similar.

Electrophoresis

Dixon et al. (1993) completed an allozyme study of the genetic structure of pilchards throughout Australia and concluded that there were " a series of contiguous quasi-independent pilchard sub populations". They delineated a western, south western, south eastern and eastern populations; the boundaries of which possibly shift in response with variations in environmental conditions, particularly the Leeuwin Current. However, this separation was not shown to be complete. A further study has found “considerable genetic similarity” within Australian pilchards (Okazaki et al., 1996).

Minor and trace elements

Results of the relatively new technique of examining the minor and trace elemental composition of otoliths as a method of stock delineation were, for pilchards, initially promising, showing clear separation amongst sites on the south coast but with no separation between west coast sites. Repeated sampling on the south coast showed, however, that the level of temporal variation was similar to the level of spatial variation. However, there do appear to be at least two south coast stocks, the position of which may vary with time and there is some overlapping at least on a minor scale at times.

$O_{16/18}$ Isotope Analyses

Further sampling of pilchard otoliths from different locations revealed very clear differences in isotope ratios amongst sites which were sustained over a full year of sampling (Edmonds and Fletcher, 1997). Otoliths from west coast pilchards had ratios consistent with them having lived in water on average 1.5^{o}C warmer than south coast pilchards. Those from Esperance were also about 0.5^{o}C cooler than Albany and Bremer Bay pilchards both of which are consistent with the average difference in temperatures among sites. These data support the notion that there is little movement between the south and west coasts by adult pilchards, and that there is even restricted movement along the south coast of adults.

Conclusions

In WA there appear to be two separate spawning stocks, the west coast and south coast, with recruits functionally separated. Along the south coast there also appears to be a finer level of separation of adults with at least two and probably three adult stocks along this region. The position of these stocks is variable and there is evidence for major flow between areas during the juvenile phases (less than three years of age), but only minor movement as adults. By contrast, none of the data collected on the west coast have indicated any finer level of stock separation, consequently this area is treated as one stock in all respects.

HISTORY OF MANAGEMENT OF THE FISHERY

Fishing for pilchards in the Albany region commenced around 1963/64 using drop nets from the wharf in Princess Royal Harbour. The fishery developed slowly and methods changed little until the late 1970s when purse seining took over as the main method. By 1980/81, 80 per cent of the total catch was taken using purse seine nets.

The introduction of ITQs in the Southern Bluefin Tuna Fishery in 1983 and development of the pet food market in 1984 resulted in extra boats entering the pilchard fishery in the mid 1980s. The number of boats operating in the King George Sound Pilchard Fishery increased from 13 in early 1984 to 25 by the end of 1985. During this time the catch more than doubled from 1596 tonnes in 1983/84 to 3517 tonnes in 1984/85.

The expansion of the Fishery prompted the setting up of a working group during 1986 to review management arrangements in the King George Sound Pilchard Fishery. The Chairman's report was released in November 1986.

Many of the Working Group recommendations were included in the King George Sound Purse Seine Limited Entry Fishery Notice which was gazetted in 1988.

The working group recommendations were primarily aimed at curtailing fishing effort in King George Sound. This was achieved by creating different categories of licences.

'A Class' licences were issued to those vessels which had remained active and had caught the minimum of 50 tonnes of pilchards in the three year period prior to 30 April 1985. 'A Class' licensees were permitted year round access to King George Sound. These licensees were provided 'permanent' access to the Fishery but were only permitted to transfer their licence to 'B Class' licensees and all vessels had to be owner operated. However, by 1989 'A Class' licences became fully transferable.

'B Class' licences were given to those vessels which had not caught the minimum of 50 tonnes of pilchard in the 3 year period prior to 30 April 1985. 'B Class' licensees were permitted access to King George Sound on a seasonal basis. These licences were non-transferable with continued access to be reviewed in 1989. In December 1989 a decision was made to extend the seasonal access for 'B Class'licensees in King George Sound until 1990.

'C Class' access permitted a licence holder to operate in the Albany Development Zone outside of King George Sound.

In 1989 a total allowable catch (TAC) of 8,500 tonnes was introduced for the Albany Zone including catch taken from King George Sound.

A development strategy commenced on the South Coast on 1 March 1990 with 13 vessels permitted in the Esperance Zone, seven in Bremer Bay, 31 for Albany and three for Augusta. Performance criteria were established for all those given developmental fishery endorsements.

The 31 Albany vessels included the 17 'A Class' vessels and eight 'B Class' vessels. The seven Bremer Bay vessels held 'C Class' licences.

The formation of the Purse Seine Management Advisory Committee in 1990 (the MAC) resulted in a number of recommendations on the future management of the Fishery being presented to the Minister. The major change was the introduction of ITQs into the Albany and Bremer Bay Fisheries.

After preparation of a Management Paper and consultation with the MAC and industry two separate Notices were gazetted in 1991 for the Albany and Bremer Bay Fisheries, ie:

(1) the *Albany Purse Seine Limited Entry Fishery Notice*; and
(2) the *Bremer Bay Purse Seine Limited Entry Fishery Notice*.

The allocation of ITQs was made by issuing base transferable ITQs of 200 tonnes to all Albany and Bremer Bay licence holders. Extra quota was provided to all fishermen who had taken in excess of 400 tonnes over the 1989 and 1990 calendar years in proportion to the amount of excess tonnage. All quota allocations were in units of 10 tonnes. Future TAC adjustment was to occur by varying the unit value.

Twenty five 'A Class' and 'B Class' licence holders were issued with ITQs in the Albany Fishery: unit holdings ranged from 20-28. 'A Class' licensees were permitted access to Zone 1, however, 'B Class' licensees were only allocated 8 units in the Zone 1 King George Sound (KGS) fishery. The balance of their units had to be taken outside of KGS. Nine 'C Class' licences were issued with ITQs in the Bremer Bay fishery. Unit holdings ranged from 20-31 units. In addition, approval was given for an extra allocation of 590 tonnes of non-transferable pool quota to be divided equally between the nine licensees as an incentive for 'C Class' vessels to transfer their operation to Bremer Bay.

As a consequence of the new management arrangements, the TAC for the 1991/92 licensing period was 6110 tonne for Albany and 2655 tonnes (including 65 tonnes pool quota allocation to each licensee) for Bremer Bay.

In 1991, after performance criteria was enforced in the Purse Seine Development Fishery, all of the development fishery endorsements issued in 1990 were extinguished for the Augusta Zone and only one fishermen was permitted continued access by endorsement to the Esperance Zone. However, to permit continued development of the Esperance and Augusta Development Zones, the Minister determined that all licensees from the Albany and Bremer Fisheries would be permitted to fish in the Esperance and Augusta Developmental Fisheries.

In 1994 the Albany and Bremer Bay Limited Entry Fishery Notices were revoked and both Fisheries came under the one Management Plan with the gazettal *of South Coast Purse Seine Management Limited Entry Fishery Notice 1994*. Managed fishery licensees continued to access the Esperance Zone and Augusta Zones until entry criteria were introduced by amendment to the plan in 1996 for Esperance. Augusta became part of the management plan without entry criteria.

The entry criteria for Esperance was that the boat was used to take a minimum of 50 tonnes of small pelagic fish from the Esperance Zone during the period 1 March 1992 to 31 December 1993. This resulted in five licensees being issued with Managed Fishery Licences permitting them to fish in the Esperance Zone. Licensees were issued with a minimum 20 units if they fulfilled the minimum entry criteria and additional units if they had taken over 200 tonnes during the criteria period.

CATCH HISTORY

A summary of catches from this fishery are shown at Table 3 and graphically in Figure 2.

Albany Zones

The pilchard fishery off southern Western Australia expanded from a drop net fishery of 28 tonnes in 1965 to a rapidly developing fishery of 4,324 tonnes in 1985. The fishery continued to expand until the catch peaked at 8,332 tonnes in 1988 with 32 boats operating. In response to poor recruitment into the fishery and falling catch rates, management measures were introduced that have seen the fleet reduced to 23 boats and the TAC reduced to 3,850 tonnes in 1995. Some 23 boats took a total TAC of 4,408 tonnes in 1996.

Bremer Bay Zone

The development of this fishery was restricted until a suitable processing plant was built at Bremer Bay in about 1989. With the establishment of the processing plant, the small fishery grew from 1,167 tonnes in 1989 to about 2200-2600 tonnes last year. The 1996, the TAC of 2,560 tonnes was taken by seven licensees.

Esperance Zone

Target fishing of pilchards by purse seine was first recorded in the Esperance zone in 1989. The expansion of the Esperance fishery proceeded slowly and was interrupted due to fishermen having to develop suitable fishing techniques, limited knowledge of the fish behaviour and lack of onshore freezing facilities. Only one fisherman fished regularly in the developmental zone up to 1991. As freezing capacity was expanded in 1993 the catch increased accordingly (see Table 3). The fishery remained essentially a developmental fishery until the area became part of the South Coast Purse Seine Managed Fishery in 1996.

Figure 2 Catch of pilchards from the South Coast Purse Seine Fishery

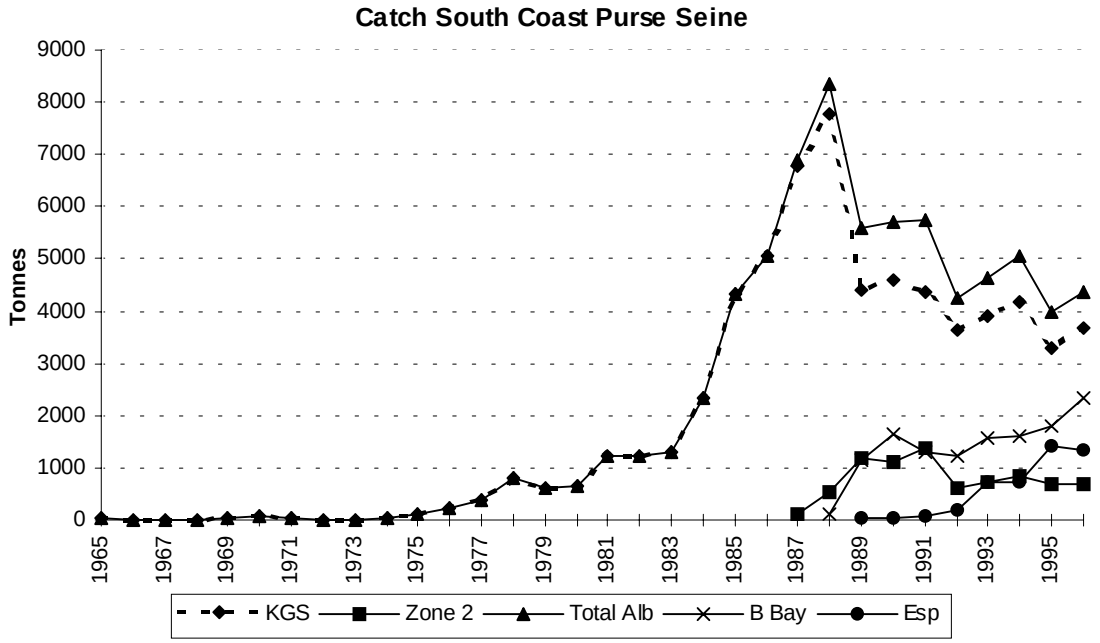


Table 3: History of Catches from the South Coast Purse Seine Fishery by Calendar Year (catch in tonnes)

Year	King George Sound	Outer zone	Total Albany	Bremer Bay	Esperance
1965	28		28		
1966	7		7		
1967	14		14		
1968	5		5		
1969	56		56		
1970	92		92		
1971	20		20		
1972	19		19		
1973	1		1		
1974	31		31		
1975	106		106		
1976	236		236		
1977	389		389		
1978	810		810		
1979	613		613		
1980	641		641		
1981	1211		1211		
1982	1215		1215		
1983	1293		1293		
1984	2343		2343		
1985	4324		4324		
1986	5065		5065		

Year	King George Sound	Outer zone	Total Albany	Bremer Bay	Esperance
1987	6783	114	6897		
1988	7791	541	8332	103	
1989	4400	1176	5576	1167	42
1990	4612	1111	5723	1628	28
1991	4365	1368	5733	1320	91
1992	3642	613	4255	1226	173
1993	3905	732	4637	1575	721
1994	4180	859	5039	1610	725
1995	3310	678	3988	1803	1415
1996	3673	695	4368	2338	1330

RATIONALE FOR MANAGEMENT

The purse-seine fishery in King George Sound was declared a limited entry fishery in April 1988. In his first advice to the managers, Dr Rick Fletcher stressed that “there is a strong need for conservatism in the management of pelagic fish stocks”.

In early 1989, the then Minister called for proposals from people interested in developing a purse seine fishery outside the existing developed fisheries of Cockburn Sound and King George Sound. A committee established to evaluate these proposals reported in May 1989 that: “Failures have been common in these types of fisheries.....therefore a level of caution is required in their management”.

The inaugural Pilchard Fishery MAC was formed in July 1990. In the November 1990, a Discussion Paper entitled ‘A Review of the Management Arrangements in the King George Sound Purse Seine Fishery for Pilchard’ noted “The long-term prognosis for the fishery if current levels of effort are maintained varies from a declining level of catch, to the stabilisation of the catch at present levels”. This conclusion arose because information available to Dr Fletcher at this time suggested “that there is at least local depletion of pilchards occurring in the King George Sound region due to the high level of effort being exerted.” A point of agreement common to the majority of Albany fishermen at this time, as presented in the Discussion Paper was that “fishing effort levels must be reduced in King George Sound in order to enhance the economic viability and sustainability of the resource”.

Research advice to the third MAC meeting in December 1990 stated that for the Albany zone, either:

(a) the stock is part of a larger south coast stock in which case, effort could be maintained at the levels of 1989 and 1990, which should result in a catch of between 5,000 to 5,500 tonnes; or

(b) the stock is a separate stock off Albany in which case catches should be reduced immediately to 3,000 - 4,000 tonnes, which would represent a reduction in effort of approximately 50per cent.

Given the uncertainty over stock definition, the MAC did not recommended a drop in TAC.

In a media statement released on 8 March 1991, announcing new management rules for the south coast pilchard fishery, the then Fisheries Minister Gordon Hill announced that intensive research over the last three years had indicated that Albany, Bremer Bay and Esperance had separate stocks of pilchards. "Research on the Albany pilchard stock has shown that it is under greater fishing pressure that it can sustain. As a result, the new management arrangements will shift fishing effort from the highly exploited areas, particularly King George Sound and adjacent areas," he said.

In his Report to the 7th Purse Seine MAC meeting in March 1993, Dr Fletcher stated that the catch of pilchards off Albany in 1992 was just 4,200 tonnes which is the lowest since 1984. This was almost 2,000 tonnes below the TAC for the zone. Scientists attributed this low catch to a weak year-class moving through the fishery. Industry attributed the catch to unfavourable fishing conditions (constant winds and record rains).

In a 'position statement' on the south coast pilchard fishery issued by the South Coast Licensed Fishermen's Association in March 1993, it was concluded that "the significant decline in the apparent abundance of pilchard stocks in the Albany zone in the last two years is of major concern and with research indicating the presence of a single spawning stock of pilchard on the south coast, to allow *any* increase in fishing effort would be irresponsible."

In his report to the South Coast Pilchard Fishery Working Group Meeting No 2 (December 1993), Dr Fletcher stated "it now appears that the catch rate for the fishery in this region will fluctuate on an annual basis dependent upon the relative size of the three and four year old cohorts moving through the fishery". Further, in relation to the stock structure he noted the following. "When the data for all sources are combined it is clear that the separation of pilchards occurs at a number of different levels. Thus there are at least two separate populations, a west coast and a south coast population. For the south coast population, there are a number of stocks which, while basically separate as adults, mix freely in the eggs to juvenile stages. Consequently, for management purposes, fishing in one area will, in the short term, only affect local catch rates. Recruitment, however, is probably a function of the total size of the population, i.e. all stocks combined."

Subsequently the Chairman's Summary noted that "the catch data from each of the fisheries supports both the biomass figures and the current management of treating each fishery as a separate adult stock. While there is almost certainly some mixing of eggs and larvae and it appears that the juveniles may move along the coast, once the adults have attained sexual maturity, they stay in the same general area."

At a meeting of the MAC in February 1994, consideration was given to the research report presented at the 2nd Working Group meeting and recommendations on TACs made to the Minister. As a result the TAC for Albany remained at 5,500 tonnes out of a total fishery TAC of 10,600 tonnes.

The Chairman's Summary of the Purse Seine fishery MAC Meeting of 29 September 1994 states: "The catch rate for pilchards in the Albany zone is relatively high. This is reflected in the high rate of total mortality observed for this region which is approximately 80 per cent per year... Consequently, because the number of two and three year old fish caught this year have been relatively small, this suggests that catch rates during the next two years will decline. The predicted catch may also decline, dependent upon the level of effort expended."

In his Report to the Purse Seine MAC Meeting 23 - 24 February 1995, Dr Fletcher stated of the Albany Fishery "it should be pointed out that the preliminary prognosis for 1996 is even worse that 1995 given that 1994 has the poorest catch of two year olds so far recorded." The subsequent Chairman's Summary stated of the Albany Fishery: "Due consideration was given to research advice which indicated that should a normal TAC be caught in the ensuing season, such a take would have no affect on the strength of recruitment for 1995. However, if the 1995 recruitment was consistent with the anticipated decline, the viability of the fishery would be in doubt. The reality could be that the fishery would need to close after 1995 if recruitment was too low to sustain the fishery. However, if 1995 recruitment went against the trend of decline, the future of the fishery in the short term, remained assured."

On 17 March 1995, industry met to consider management options and to make recommendations to the MAC, meeting later that day. The South Coast Licensed Professional Fishermen's Association tabled a submission that any future reductions should be borne by all zones and that latent effort (including the pool quota) should be removed before any cuts in quota were taken. The larger industry meeting noted its concern at the financial implications of quota cuts in 1995/96, but realised that regardless of any increase in recruitment levels in 1995, it was likely that quota reductions would be necessary in 1996/97. It was noted that this schedule gave fishermen time to restructure and refinance.

At the MAC meeting on 17 March 1995, three options for TACs were examined.

1. Leave TACs as industry suggested (5,500 tonnes in Albany) - this would likely result in the need for a TAC of 2,000 tonnes in 1996.
2. Decrease Albany TAC to 3,000 tonnes - this would cause financial hardship.
3. Decrease Albany TAC to about 3,000 tonnes but review recruitment in April and September with view to adjusting if possible.

The MAC recommended a TAC of about 3,500 tonnes for Albany, with the rationale that the 1996 TAC would remain at a similar level and provide some stability.

In April 1995 the Minister announced that the TAC for Albany would be set at 3,850 tonnes (7 tonnes/unit) and the TAC for Bremer Bay was reduced to 2,176 tonnes (8.5 tonnes/unit). These TACs were to be reviewed in late 1995.

In a Ministerial Briefing prepared on 20 June 1995, Dr Fletcher concluded: "None of the data collected so far this year indicate that there should be any alteration to the policy decided in February and March 1995. Whilst large numbers of pilchards are presently in the Albany area this was not unexpected, the model showed that good catches could be made this year. The ultimate problem is that there has been little recruitment coming through since 1992 to replace these individuals. The reduction in TAC was designed to soften the fall in catch and

catch rate in 1996. If there is substantial recruitment in September this situation may change."

Research advice in October 1995 was that the biomass of pilchard stock on Albany had decreased by half in the previous two years. The MAC recommended no increase in the TAC for Albany.

The Chairman's Summary of the Purse Seine MAC Meeting of 8 December 1995 noted that "the previous concern regarding stock levels held earlier in the year were not as strongly held at the present time." Further, in 1995, there was no recruitment of two year-olds in Albany; while there appeared to be recruitment of one year-olds across all areas.

On 31 January 1996, the Minister announced an increase in the TAC for Albany and Bremer Bay, bringing Albany TAC to 8 tonnes/unit (4,400 tonnes) and Bremer Bay to 10 tonnes/unit (2,560 tonnes). The Minister also established the Esperance Zone with a TAC of 1,800 tonnes (180 units and 10 tonnes/unit).

In his Research Report to the Purse Seine MAC Meeting of 28 August 1996, Dr Gaughan (replacing Dr Fletcher) indicated that "the poor recruitment of juveniles (two year-olds) seen in 1993, 1994, 1995, and thus far in 1996 is likely to produce relatively small numbers of four and five year-olds during 1997, with three year-olds already at minimal levels. Therefore the catch rate should decline, at least in the next two years. The relatively large number of residual six and seven year-old fish which will still be present during 1997 will, however, continue to buffer this impact.....Unfortunately these cohorts will soon be finished in the fishery. Even with the minimal recruitment in 1996 there will be very little stock in the Albany region left to fish in 1998 and the quota may have to be reduced substantially."

The Chairman's Summary of this meeting noted this advice, and that in relation to stock structure "that Esperance seems to consistently have juveniles, whilst Albany is sporadic. Dr Fletcher suspects that the spawning stock for these areas comes from the same breeding pool."

In his Report to the Purse Seine MAC of 13 December 1996, Dr Gaughan stated of the Albany region, and in the absence of an independent biomass estimate: "Based on observed levels of recruitment in previous years, the biomass in 1997 predicted by the model is 7,400 tonnes, the lowest since the start of research on the fishery.....As was evident at the time of the last meeting (August 1996), the recruitment was still lower than normal. Including the 'spring pulse' of recruits, the value for 1996 was 54 per cent of normal, which although still poor, is a vast improvement over the two previous years. However the reasonable recruitment for 1996 does not imply that the local Albany stock will have recovered by 1997. The four year-old fish which typically dominate the catch will again be at relatively low numbers due to poor recruitment in past years, as will be the five year-old fish. Thus the implications for the fishery of the low recruitments in 1993 to 1996 remain serious, and will continue to do so of recruitment does not return to its historically higher levels."

The Chairman's Summary noted the Research report, and indicated that the biomass figures calculated from the plankton data were close to the biomass figure predicted from the

computer modelling. Also noted was: "Age structure frequency of the catches from the Albany area since 1992 indicate the reliance of the fishery on progressively older fish and the absence of significant proportions of young fish in the samples. Dr Gaughan is concerned that if recruitment remains poor in this zone of the fishery, the biomass will be reduced significantly. He suggested the possibility of the biomass being reduced to less that what is currently being taken commercially, resulting in overfishing of the resource."

The research recommendation to this MAC meeting was that the Albany TAC should be set at 2,250 tonnes (4 tonnes/unit). The MAC recommendation to the Minister was 3,030.5 tonnes (5.5 tonnes/unit).

POOL QUOTA

History of the Bremer Bay Pool quota

The Bremer Bay pool quota was first established as an incentive to attract boats from Albany to Bremer Bay and as compensation to Albany zone C licensees who were displaced from the Albany zone when management arrangements changed. Bremer Bay licensees have been firmly of the belief that the pool quota was necessary to ensure both economic viability of the fishery in that zone and the development of the fishery.

Since 1993/4, the pool quota has been 50 units. This is available to Bremer Bay unit holders with entitlements in the fishery upon application once they have exhausted their own annual allocation.

History of the Esperance Pool quota

In 1995, the Minister approved the inclusion of the Esperance zone into the Managed Fishery and assigned 180 units to this zone. At 10 tonne per unit, this equated to a TAC of 1800 tonnes. Applications were called and assessed for access to this zone. The result was that, in 1996, 113 units were allocated to fishermen who met the entry criteria. Four of the five successful applicants were, and still are, Albany based fishermen.

This allocation left 67 units of pool quota which was allocated in individual units on application.

Allocation of the Pool quota

On the whole the following business rules applied to the allocation of pool quota.

- Notional equal share in first instance upon application by licensees
- Applications would be assessed after licensees had one unit of allocated quota remaining

It is anticipated that this year, all pool quota will be allocated for the first time since either pool was established. At the end of January 1997, distribution was made on the basis of remaining pool quota and the registered intention of those interested in accessing the pool.

Abolition of Pool Quota

Since November 1991, the MAC has argued that the pool should be disbanded and the quota allocated among licence holders for that zone. This was supported by the Department as administration of the pool quota is complicated and expensive.

As the Esperance pool did not exist at this stage, discussion was on the Bremer Bay pool quota. In 1994, the MAC provided the Minister with four options for distributing pool quota.

1. Put them up for tender.
2. Allocate on an equal or pro-rata basis to the Bremer Bay licensees.
3. Allocate quota to Bremer Bay licensees who have historical accessed the 'pool', the exact quantity per boat being dependent on the average of their past catch. Any unallocated quota would be removed from the system. This results in less units, and hence a lower TAC, being available in the zone. Any increase in TAC would then be distributed on an equal basis across all unit holders through an adjustment in unit value.
4. Remove all pool quota units permanently from the system with the associated adjustment in TAC.

The MAC supported and recommended option 3. The Minister sought additional advice from the MAC and the Department. In addition, he received a number of individual submissions. In January 1996, he approved the MAC recommendation to abolish the pool quotas, however, to date the allocation mechanism remains unresolved.

The management package discussed below involves the permanent removal of the pool quota in both Bremer Bay and Esperance zones and the distribution of those pools.

THE STRATEGIC APPROACH TO MANAGEMENT

Objectives

From the Department's perspective, the strategic objectives are to manage the fishery as a whole and hence to:

- maintain the breeding stock for the whole south coast and for each individual zone at a safe level
- set the TAC for each zone at a level that maintains adequate breeding stocks
- have one unit value for all licence holders in the Fishery, and
- increase the flexibility within, and economic return from, the fishery.

Rationale for adopting a more appropriate biological reference point, and calculating a Total Allowable Catch (TAC) for a pilchard fishery

Pilchards, like other small pelagic fish, are characterised by high rates of natural mortality and high levels of natural variability in recruitment of young fish to the stock. The high rate of natural mortality means that, even in the absence of fishing, the population can drop to very low levels if recruitment fails for a few consecutive years. Pilchard (sardine) populations elsewhere in the world have gone through huge fluctuations in abundance even before they were fished (fossil evidence). In recent decades, large stocks of small pelagic fish have crashed almost to local extinction when fishing continued at a high level during periods of low recruitment.

Like almost all marine fish and invertebrate species, the success of spawning and therefore subsequent recruitment of young fish is partly dependent on environmental factors and partly on the abundance of the adult stock. Environmental factors can be currents which carry larvae outside the area from which they can return to their parents' population; nutrient levels in the water limiting the production of planktonic food for the larvae and many other variables, most of which are generally not well understood at present by scientists. In the Albany area, relatively strong recruitment was shown to be correlated with a weak Leeuwin Current for a series of years before the correlation broke down as factors other than Leeuwin Current (possibly low spawning stock) dominated.

For most marine species, even in the absence of environmental variability, recruitment is not linearly related to the size of the spawning stock. At high stock levels, recruitment does not increase as the spawning stock increases, due to such factors as competition among larvae for food and concentration by predators on abundant larvae. At low stock levels there is a much more direct relationship between spawning stock size and the level of recruitment. Generally a stock can safely fall to about half of its average natural level without markedly affecting recruitment. If a finfish stock falls below 20 per cent, there is usually a serious affect on recruitment. If fishing continues in this situation, there is a good chance that the stock will collapse and take many years to rebuild.

Given the characteristics of high natural mortality and extreme variability in recruitment, the challenge in managing a pilchard fishery is to maintain the stock whenever possible at a level where it can generate the maximum level of recruitment and to avoid, as far as possible, the population declining to a level from which it cannot quickly rebuild.

Until now, the method of setting quotas has been based on allowing a certain proportion of the adult stock to be taken each year. This is good as long as the stock remains high. If the stock declines due to a series of years of low recruitment, this strategy of taking a fixed proportion of the standing stock can drive down a stock which is already at a low level to an unacceptably low level. It is safer to base management on ensuring that a certain level of breeding stock is maintained. An appropriate strategy would be one that, for example, aimed to keep the breeding stock above 50 per cent of the average annual pre-fished spawning biomass whenever possible, and on no account let it fall below 20 per cent of the average natural biomass.

In the south coast pilchard stock, although there is clearly enough mixing of the larval and juvenile stages to ensure genetic uniformity, it is not certain that the mixing of these early stages is complete. It is quite possible that a significant proportion of the recruitment to any zone in a particular year is spawned by the adults resident in that zone. **Thus responsible management would aim to ensure that the breeding stock remained above the safe minimum levels across the fishery as a whole, as well as in each zone.**

The exact levels which would be best as target minimum breeding stock sizes for management to aim for are yet to be precisely calculated. However, as indicated above, the target could be a minimum of 50 per cent of the average unfished breeding stock level to be left at the end of the quota year. The amount by which the standing stock was in excess of the minimum biomass figure could then be set as a quota for that year. Information on recruitment levels could be used to provide a preliminary quota estimate for the following year. The MAC may decide that if a high quota year looks like being followed by a low quota year, they would recommend to lower the quota in the first year to increase the amount of fish available in the second year, i.e. try to keep the year to year yield as constant as possible. If recruitment was constant from year to year at a level equal to the past average, the TAC under this example system would be approximately 20 per cent of the biomass per year, similar to what it has been in the past for the fishery as a whole.

With a species that has extremely variable recruitment, it is inevitable that the surplus over the minimum target biomass would vary from year to year. A constant quota strategy could be maintained when stock levels were average to high, but not when stocks were close to the minimum level. A variable quota strategy would give a bigger catch over the years than a constant quota but it would have to be accepted that quotas would go down as often as they go up. Variable quotas can also make marketing difficult. The actual strategy for setting the TAC could be governed by industry preferences, as long as the minimum biomass was left in the water.

Given the variability in recruitment, the mechanism for setting the TAC needs to deal with the possibility of a run of years of low recruitment. Fishing in a zone would cease if stocks fell below the minimum. With the minimum set at 50 per cent of the average unfished biomass, if there were three years in a row of zero recruitment, as long as there was no fishing in years two and three there would still be 20 per cent of the unfished stock surviving at the end of year three. If there was a longer run of years with low recruitment, no measure would be effective anyway.

It is envisaged that in the future, the Research Services Division will provide the MAC with its best estimates of standing stock in each zone, and estimates of the catch that could be taken in each zone which would leave the minimum stock in the water at the end of the quota year (both in the whole south coast stock and in each zone). Preliminary advice would also be given on the likely situation of the stock in the following year. The MAC would recommend a responsible TAC for each zone which would then be allocated across unit holders according to a prescribed formula.

Allocation of TAC

The sharing of a common spawning biomass with functionally separate stocks by all entitlement holders means that the catch from all fishermen has some affect on recruitment to the fishery in the different zones. The interactions between adult stocks and contribution recruitment in each zone is unknown and would be very difficult to estimate. Under this scenario it makes sense to manage the fishery as a whole rather than separately. Accordingly, all units should be attributed an equal share of the available biomass. A mechanism to permit the fishery to adjust to variable recruitment in each zone is presented below that has the following key principles:

- one unit value for all entitlement holders;
- entitlements may be utilised across a number of zones; and
- the same proportion of the original breeding stock remaining in each zone at the end of the quota period.

The principle of one unit value across each zone in the Fishery is fundamental to the future management arrangements. To be consistent with the biological objectives each zone should not fish at levels that are above those that are biologically sustainable.

The steps in the process that allocates an equal unit value to each licensee in each quota period are as follows:

1) scientists provide estimates of standing stock in each zone, and estimates of the TAC that can be taken leaving the minimum stock in the water at the end of the quota period;

2) the unit value to be applied across the whole fishery is calculated by dividing the sum of the TACs for each zone by the sum of the units for each zone;

3) for each zone, managers will calculate the tonnage that would be taken if all the units from each licensees' entitlement in the zone were fished;

4) if the tonnage calculated in (2) above exceeds the TAC for the zone, the excess TAC may be taken in a zone where the tonnage estimated from (2) above falls below the TAC for that zone;

5) additional TAC is allocated to those licensees who are unable to take their surplus TAC in their primary zone in zones where there is excess capacity. This will bring the catch to the average unit value;

6) the allocation above takes place until all licensees have been allocated TAC to give them an equal unit value.

Some licensees may take all their TAC in their primary zone whereas others may take it in a combination of zones.

The above model ensures that each licensee has the same unit value and the TAC for each zone is taken. However the allocation will depend on what stock is available in each zone.

FOR EXAMPLE under the following scenario where

- Zone 1 & 2 had a low stock;
- Zone 3 and Zone 4 had higher stock;
- an average unit value meant that all the Zone 1 & 2 TAC could not be taken by Zone 1 & 2 licensees in Zone 1 & 2;
- there was excess TAC in Zones 3 and 4 because the Zone 3 and 4 TACs were greater than the total TAC held by Zone 3 and 4 licensees.

Zone 1 & 2 licensees would be permitted to take the remaining balance of their TAC in Zones 3 and 4 as illustrated in the following example in Table 4.

Table 4: Example of TAC adjustment between zones

	Zone 1 & 2	**Zone 3**	**Zone 4**	**Totals**
TAC (tonnes)	3,000	3500	4000	10500
Units/zone	551	319	175	1045
Tonnes/unit	10	10	10	10
Total tonnage if taken in that zone	5510	3190	1750	10450*
Excess tonnage over TAC	-2510	+310	+2250	
Extra tonnage available per zone	0	0.5t/unit	4.0t/unit	

* this figure is slightly less due to rounding of units and tonnages

In this example, for an individual licensee holding 20 units in Zones 1 & 2, the distribution shown in Table 4 would result in the following allocation of TAC:

Zone 1 & 2: 5.5 t/unit available = 110 tonnes
Zone 3: 0.5 t/unit available = 10 tonnes
Zone 4: 4.0 t/unit available = 80 tonnes

If a licensee wishes to continue to base his/her operations in Zone 1 & 2, then he/she can seek to trade/lease his/her units from other zones and possibly acquire more units for Zone 1 & 2.

The model described above facilitates a more flexible quota administration that allows shifting in TACs according to the availability of stocks but ensures that everyone has the same unit value in the fishery regardless of the zone they hold entitlements in. However, for this to work, there needs to be mobility in TACs, i.e. leasing, as well as the capacity in processing.

Proposed Management Arrangements

There are a number of issues within the South Coast Purse Seine Fishery that have remained unresolved for a number of years. The biological instability is unlikely to change, given the nature of pilchards and the changing environmental conditions. However, it is possible to put into place a management regime that will facilitate economic stability while ensuring sustainability of the stocks.

The challenge to the MAC and to government has been to ameliorate the current problems by developing a management strategy that will move the fishery from the biological and economic uncertainty that exists at present to a future that provides sustainable fishing in Albany, greater economic stability and fuller utilisation of resources in other zones. The challenge to the industry is to take up the opportunities to develop the fisheries of the under-utilised zones, particularly Esperance.

This management strategy realigns what is known of the biology of pilchards and makes available an increase in catch to allow for the redistribution of effort. It continues a strategy commenced when effort from Albany was relocated to Bremer Bay, in that it endeavours to transfer fishing effort from Albany to Esperance. It removes the pool quotas and distributes part of them to existing licensees, once again providing some level of certainty for fishermen and processors alike.

The proposed management arrangements achieve the long term objectives, ie to move the fishery to all one unit value, with exploitation of each zone and the whole fishery above a minimum safe level of breeding stock. The package is based on the MAC recommendation of 5.5 tonne per unit in the Albany zone, combined with a redistribution of fishing effort from the overexploited to the underexploited areas of the fishery. This latter part of the package has not yet been considered by the MAC.

Presented below is the Department's position on the exploitation of the Albany zone and the MAC's position on the TAC for the Albany Zone, reached at its meeting in December 1996. Following it is the package developed by the Government which incorporates the MAC recommendation of 5.5 tonnes/unit for Zones 1 & 2, but which also addresses longer term management and the resolution of outstanding issues in the fishery today, such as pool quota.

The Department's Position

The Department has advised the MAC and the Minister that it considers a unit value of 5.5 tonnes for Albany to be a high risk strategy. The position put forward by the Executive Director of Fisheries is the one put forward by the Research Services Division, i.e. a 30 per cent exploitation rate in the Albany Zone (4 tonnes/unit). There has been little or no recruitment in this fishery from 1992 to 1996. Scientists will not know until mid-1997 whether recruitment has occurred this year. If it has not, a TAC of 5.5 tonnes/unit is too high, and could result in the collapse of the fishery off Albany during or after 1998.

The MAC Position on Zone 1 & 2 for 1997/98

On the basis of continued concern over the status of pilchard stocks, Dr Gaughan recommended to the MAC that the Albany zone unit value be set at four tonnes/unit. The MAC discussed the research recommendation in the context of what effect this would have on stocks and the viability of operators in the Albany fishery.

The majority of the MAC, although convinced of the need for a TAC reduction, was not willing to support the research recommendation because such a reduction would be financially too severe and they were not entirely convinced of the accuracy of the research prediction.

MAC members took the view that, because exploitation levels in Esperance and Bremer Bay were below the 15 per cent level, the TACs in those zones could be sustained at least in the short term and recommended that the unit value stay at 10 tonnes/unit for those zones.

Various exploitation levels in Albany were examined and the effect on the overall exploitation level on the South Coast noted. Members were concerned that the level of exploitation at Albany not go much higher that 30 per cent but considered that there was some possibility for an increase provided the overall exploitation level remained in reasonable bounds.

A 5.5 tonnes/unit value at a 41 per cent exploitation level in the Albany zone with an overall exploitation rate across the fishery of 17 per cent was considered to be reasonable compromise by the MAC. However, in consideration of the impact of this recommendation and uncertainty surrounding the biomass estimated, the MAC suggested that it was critical that a biomass survey be conducted in July 1997. The survey results would be used to re-assess the biomass levels and if it was proven that the estimates on which the recommendation was based were too low, there would be an opportunity to increase the TAC.

The MAC recommendation is that there be an exploitation rate of 41 per cent in the Albany zone (Zones 1 & 2). A summary of the MAC recommended TACs and exploitation rates is shown in Table 4.

This more optimistic view is based on concern by industry members on the MAC that the scientific data contains some uncertainty and that a severe TAC cut would cause economic hardship.

Table 5: Package as proposed by MAC - 41 per cent exploitation in Zones 1 & 2, no other changes.

	Zone 1/2	Zone 3	Zone 4	Totals
Allocated	551 units @ 5.5 t/unit (3030.5 tonnes)	206 units @ 10 t/unit (2060 tonnes)	113 units @ 10 t/unit (1130 tonnes)	870 units 6220.5 tonnes
Pool	0	50 (500 t)	67 (670 t)	1170 tonnes
Total TAC for the fishery	**3030.5 tonnes**	**2560 tonnes**	**1800 tonnes**	**7390.5 tonnes**
Exploitation rate	41%	15%	10%	17%

The Government's Package

The Minister has accepted the MAC recommended exploitation rate of 41 per cent for the Albany zone. However he has suggested a package be developed that results in a 'whole of fishery' management strategy commencing 1 April 1997. The resulting package includes the MAC recommended exploitation rate of 41 per cent as well as other measures which have not been considered by the MAC, such as an equal unit value of 8 tonnes/unit across all zones, and a redistribution of effort from Zones 1 & 2 into Zone 4.

More specifically, in this package -

- the TAC available for the Albany zone would fall from 4400 tonnes to 3030.5 tonnes. Licensees would be allocated a unit value of eight tonnes/unit; 5.5 tonnes/unit of which could be taken in Zones 1 & 2;

- the TAC for Bremer Bay would set at 2,560 tonnes, which includes the pool quota, and the TAC allocated at a unit value of eight tonnes a unit. This unit value allows for 319 units to be allocated across the existing seven licensees, ie, each licensee receives an extra nine units. The pool quota will be allocated firstly on the basis of historical access to the pool and any excess will be allocated evenly across all Zone 3 licensees;

    - the current unit holding is 206 units (2,060 tonnes)
    - the pool quota is 50 units or 500 tonnes
    - giving a total tonnage of 2,560 tonnes
    - 2,560 tonnes at eight tonnes a unit is 320 units, which equates to an extra 64 units in the zone
    - across seven licensees, 64 units provides nine each, with one left unallocated and removed from the system;

similarly, the TAC and unit holdings for Esperance will adjust according to the following allocations;

- existing licensees will be allocated a proportion of the pool quota that is equivalent to the proportion of extra TAC allocated to licensees of Zone 3, ie, 27 units, giving a total of 140 units and a TAC of 1400 tonnes. This allocation will be made on the same basis as the Bremer Bay Pool;
- the remaining existing pool quota (40 units) is abolished;
- 1,400 tonnes at 8 tonnes/unit is 175 units for Zone 4;
- this equates to an additional 35 units or seven units per licensee;
- licence holders of Zone 1 & 2 licences would be permitted to take the remaining 2.5 tonnes/unit from their current allocation in the Albany zone (Zones 1 & 2) from stock within Zone 4 (a total of 1377.5 tonnes)
- the total TAC for Zone 4 will be 1,400 + 1,377.5, that is, 2,777.5 tonnes
- 2,777.5 tonnes equates to an exploitation rate of 15.4 per cent for the Esperance zone, which is in the lower end of the range of maximum sustainable exploitation.

This package is summarised in Table 5.

All units and TACs would be fully transferable, however, each Zone 1 & 2 unit has two components: 5.5 tonnes/unit that can be taken in Zone 1 & 2 (as per existing entitlement), and 2.5 tonnes/unit that can be taken in Zone 4. The Zone 4 component can be transferred to another licensee for the quota period, however, each unit still only allows a holder to take 5.5 tonnes from Zones 1 & 2.

> *For example, if a holder has 20 units in zones 1 & 2, he would have 5.5 tonnes x 20 units = 110 tonnes to be taken in Zones 1 & 2, and 2.5 x 20 = 50 tonnes to be taken in Zone 4.*

Table 6: Package including MAC recommendation of 41 per cent exploitation rate in Zones 1 & 2

	Zone 1/2	Zone 3	Zone 4	Totals
Allocated	551 @ 5.5 t/unit (3030.5 tonnes)	206 @ 10 t/unit (2060 tonnes)	113 @ 10 t/unit (1130 tonnes)	6220.5 tonnes
Allocated Pool	0	50 units (500 tonnes)	27 units (270 tonnes)	770 tonnes
Abolished pool	0	0	44.4 units (444 tonnes)	444 tonnes
Total number of allocated units	551 (3030.5 tonnes)	256 (2560 tonnes)	140 (1400 tonnes)	**6990.5 tonnes**
Common unit value	8 tonnes/unit	8 tonnes/unit	8 tonnes/unit	8 tonnes/unit
Adjusted number of units	551 units	319 units (=2560/8)	175 units (=1400/8)	**1045**
Extra units per licensee	0	9 (total 63)	7 (total 35)	
TAC before redistribution	4408 tonnes	2552 tonnes	1400 tonnes	**8360 tonnes**
Reallocated fishing effort	-2.5 t/unit -(1377.5)	0	2.5 t/Z1&2 unit (1377.5)	1377.5 tonnes
TAC for the fishery	**3030.5 tonnes**	**2552 tonnes**	**2777.5 tonnes**	**8360 tonnes**
Exploitation rate	41.0%	15.0%	15.4%	19.4%

Research requirements

The research needs for the south coast purse seine fishery can be divided into

(1) those that are currently ongoing as part of the monitoring of the fishery, and
(2) those which could be carried out to gain further information about the pilchard and the fishery.

Current ongoing research consists of the following:

- obtaining monthly samples of fish from the commercial catches at Albany, Bremer Bay and Esperance to ascertain the size, reproductive stage and age of pilchards;
- analysing catch and fuel data obtained from the fishery; and
- modelling the Albany fishery.

Further possible areas of research which are currently not being undertaken are listed here.

- Spawning biomass surveys using plankton surveys (Daily Egg Production Method) once every two years for each region.
- Acoustic surveys of pilchard biomass.
- Modelling of the entire south coast pilchard fishery.
- Ecology of juvenile pilchards between the larval stage and recruitment stage (2 years old).
- Assessment of the influence of environmental factors (eg Leeuwin Current) on recruitment and the south coast pilchard fishery in general.
- Mortality rates of discarded ('rolled') fish.

The first three points are complimentary in that each would be aimed at providing an estimate of biomass, while research into the ecology of juveniles would be aimed at trying to enhance our knowledge of what factors are responsible for the large variations observed in recruitment levels. Understanding environmental influences is important to both the modelling the south coast stocks and to the ecology of juveniles. The final point relates to the ongoing problem of 'rolling' fish which are in excess of a boats ability to handle or sell.

Any additional research required in this fishery outside that currently funded by the Department would have to funded by industry and in that context, should be considered by the MAC and budget sub-committee.

SUMMARY

Since 1989, when dedicated research commenced on the pilchard stocks of the south coast, the advice has been consistent in the call for precautionary management. Caution was necessary because of the uncertainty over stock discrimination, the schooling behaviour of the pilchard which makes them vulnerable to overfishing by net, and the natural fluctuations in the stocks due to environmental conditions.

Although research advise that the stock of pilchards is one genetic breeding stock with separate adult populations in each of the zones, there will always be variability in the stock available in the fishery and in each zone. Management needs to account for this variability and provide flexibility so that both the stock and the commercial industry are sustainable.

This paper has presented a strategy for moving the management of the small pelagics fishery off the south coast to management of the whole fishery, which facilitates a more biologically sound and economically stable fishery.

It involves the abolition of the pool quotas, moving all units to an equal value, and a biological objective that sets the minimum breeding stock level for each zone and for the total fishery.

Instead of individual allocations being restricted to catch within a particular zone, the TAC may be taken across a number of zones according to the level of the available breeding stock. For 1997/98, this results in the reallocation of fishing effort from Albany to Esperance. Despite this reallocation, the exploitation rates for both Esperance and the total fishery are

within safe limits, although the exploitation rate for Albany is still 21 per cent higher than that advised by the research scientists.

Taking the whole south coast stock, the exploitation rate is sustainable, however, the adult stock in the Albany zone will continue to be severely reduced under the proposed zonal TAC for 1997/98.

This flexible system provides a method of spreading effort across the total fishery and is responsive to recruitment variations in each zone. The chance of local depletion is reduced and economic stability increased.

For 1997/98, the TACs will be 3030.5 tonnes for Zones 1 & 2, 2,552 tonnes for Zone 3 and 2,777.5 tonnes for Zone 4.

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