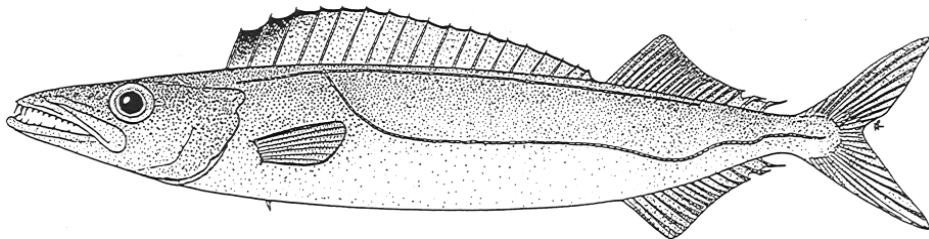


**Monitoring of the fishery for  
Gemfish *Rexea solandri*, 1996 to 2000.**

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## 1. INTRODUCTION

Gemfish, *Rexea solandri*, are relatively large, predatory members of the family Gempylidae, and are caught at depths of 100 to 700 m off southern Australia and New Zealand. The species grows relatively quickly, reaching 50 cm in length and 1 kg in weight after three years, and growing to a maximum length of about 120 cm, corresponding to a weight of about 14 kg and age of about 17 years. The majority of fish in the mature population are between 4 and 8 years of age (60 to 90 cm in length, and 2 to 6 kg in weight). Gemfish occurring off NSW, eastern Victoria and eastern Tasmania belong to a single 'eastern' stock of *R. solandri* (Paxton and Colgan, 1993). Separate stocks of gemfish occur in waters west of Tasmania and off New Zealand.

In the late 1970s, and throughout the 1980s, gemfish comprised a very significant proportion of demersal trawl catches off New South Wales (NSW). The bulk of the annual catch (3000 to 5000 tonnes) was taken during the winter months, as mature fish formed pre-spawning aggregations at depths of 350 to 450 m, before migrating north towards spawning grounds at 32°-34°S latitude (Rowling, 1994a). Additionally, juvenile and some adult gemfish were trawled year-round on upper continental slope grounds off southern NSW and in eastern Bass Strait. In the late 1980s a dropline fishery also developed on a small number of suitable grounds along the NSW continental slope, and more recently gemfish have been targeted by recreational and charter boat fishers (Steffe *et al.*, 1996).

Monitoring of the size and age composition of gemfish landings in NSW commenced in the late 1970s, soon after the development of the fishery (Rowling, 1979). This work was undertaken as part of a wider research project studying the Danish seine and trawl fishery, and was jointly funded by the Commonwealth and NSW governments. During the mid 1980s, analysis of data from monitoring of gemfish catches showed a decline in the average size of fish in the winter catches, and a reduction in the standardised catch rate for the trawl fishery. Following the release of a discussion paper (Rowling, 1987), a Total Allowable Catch (TAC) of 3000 t was introduced for gemfish for the 1988 winter fishery. Fishers disputed the need for regulation of gemfish catches, and were very critical of both the implementation of these catch controls and the scientific basis on which the decision was taken (Anon., 1988).

The implementation of TAC management in the gemfish fishery coincided with a period where recruitment to the mature population was well below normal. As the magnitude of this failure in recruitment became apparent during the early 1990s, the TAC for eastern gemfish was sequentially reduced. During this period there was considerable debate about the status of the resource, and the desirability and effectiveness of TAC management of the fishery (Anon., 1992; Rowling, 1991 and 1992). Following indications of four consecutive years of poor recruitment, the TAC for eastern gemfish was set to zero in 1993. However, debate about the status of the stock continued until the decline in recruitment was confirmed by the results of an industry-based research project (Prince and Wright, 1994). The TAC for eastern gemfish remained at zero from 1993 to 1996. Throughout this period however, incidental catches of gemfish by both trawl and non-trawl fishers were marketed under 'trip limit' provisions, and monitoring of these catches allowed continued assessment of the size and age structure of the gemfish population (Rowling, 1994b and 1995). The results of these assessments indicated that two slightly stronger year classes (spawned in 1990 and 1991) would enter the mature population as 5 and 6 year old fish in the 1996 winter season.

To determine the likely improvement in the abundance of mature gemfish due to the recruitment of the 1990 and 1991 year classes, a research survey was conducted during the

1996 winter season (Prince, 1996) and monitoring of the commercial by-catch was continued. The design of the survey, and the incorporation of the results in a dynamic population model of the eastern gemfish stock, was undertaken by the newly formed Eastern Gemfish Assessment Group (EGAG), which comprised industry, scientific, conservation and management representatives. The stock assessment produced by EGAG following the 1996 season (Anon., 1997a) indicated a significant improvement in the abundance of mature gemfish, and led to the re-opening of the fishery in 1997, when a TAC of 1000 t was set for the trawl fishery. Landings by non-trawl operators remained subject to trip limit regulations.

Unfortunately, the 1997 fishery failed, with only 350 t of gemfish being landed by the trawl sector. Inclusion of the results from monitoring of the 1997 commercial landings in EGAG's stock assessment resulted in a more pessimistic appraisal of the status of the eastern gemfish stock (Anon., 1997b). In 1998, management of the trawl fishery reverted to a zero 'targeted' TAC for eastern gemfish, although a transferable 'by-catch' TAC of 300 t was allocated amongst individual trawl fishers in proportion to their eastern gemfish quota holdings, the aim being to minimise discarding of incidental catches. Similar arrangements were in place during subsequent years, except that the 'by-catch' TAC was reduced to 250 t in 1999 and 200 t in 2000. Catches by non-trawl fishers have continued to be managed by way of trip limits (e.g. 50 kg per day for all methods/jurisdictions during the 2000 winter season).

This volume provides a compilation of the annual reports which summarised the results from each year of monitoring of commercial landings of eastern gemfish during the period from 1996 to 2000. This work was jointly funded by NSW Fisheries and the Australian Fisheries Management Authority, and the reports have been included in the form in which they were originally submitted to these funding bodies (editorial changes have been kept to a minimum). The results of this research, together with results from research surveys completed in 1996 and 1998, have been used in the development of annual stock assessments by EGAG. The reader is referred to both the background papers to EGAG meetings, and the resulting stock assessment documents (e.g. Anon., 1998), for additional detail in this regard.

There is now little doubt that the eastern gemfish stock has been very significantly reduced by a prolonged failure in recruitment and continued fishing pressure. Although there was some improvement in the stock abundance due to stronger age classes spawned in 1990 and 1991, recent data indicate that the year classes spawned from 1992 to 1995 are all well below normal levels of abundance. The mature population of eastern gemfish has declined further as these poor age classes recruited to the adult stock in recent years. It is not possible to accurately forecast the implications for future levels of recruitment of this further decline in the abundance of mature gemfish, but the stock is now well below the level considered necessary for a viable population. Management measures aimed at the conservation or protection of the remaining mature gemfish have recently been canvassed, and the conservation status of eastern gemfish is also currently under review.



## **2. MONITORING OF THE BY-CATCH OF EASTERN GEMFISH DURING THE 1996 SPAWNING SEASON**

### **2.1 Introduction**

One of the key sources of data used in the stock assessment of eastern gemfish is the size and age composition of fish present on the fishing grounds during the winter spawning season each year. Since 1993, a zero TAC has been in place for eastern gemfish, and limits have been placed on the quantities of gemfish which may be landed from individual fishing trips. In all seasons since the zero TAC was implemented, this landed "by-catch" of eastern gemfish has been monitored, principally at the Sydney Fish Market, to provide data on changes in the size and age structure of the eastern gemfish population. This report details the results of monitoring carried out during the 1996 winter season, and discusses the results in the context of the current stock assessment for eastern gemfish.

### **2.2 Project objectives**

1. To monitor the size composition of the landed by-catch of eastern gemfish during the 1996 winter spawning period (June - September).
2. To collect a representative sample of otoliths from the catch of eastern gemfish during the 1996 winter season.

### **2.3 Progress of the 1996 Season**

Significant catches (>300 kg per day) of large gemfish were reported by dropliners off north-east Tasmania during late May and early June. Size composition data collected in early June onboard dropline vessels by Mr. A. Wiltshire from the Tasmanian Parks and Wildlife Service showed the majority of gemfish sampled were between 70 and 80 cm length to caudal fork (LCF) with a few larger fish also included in the catches. Dropline vessels off NSW were taking trip limit (100 kg) catches of gemfish measuring 50 - 80 cm LCF during late May and early June. Small by-catches of mostly immature gemfish were recorded from trawlers at most NSW ports during this period.

The first trawl catches of spawning run gemfish were reported from grounds south of Eden about 11-12th June. By-catches of 1-5 t were reported, and significant discarding of catches in excess of the trip limit (200 kg) occurred. During field work carried out in the Eden area during 17-20th June fishers reported that the first "run" had apparently passed through the southern grounds the previous week, and that after this first run the quantities of fish on the grounds appeared to be lower. It was also commented by fishers that conditions were consistent with a 'good' gemfish season, following a good early run of ling.

During 14-16th June gemfish by-catches of 1-2 t per shot were reported from grounds off Bermagui. By-catches of gemfish continued off both Eden and Bermagui in the following weeks, however catch rates were lower than when the fish first appeared, and in most cases catches were apparently less than the 200 kg daily trip limit.

Gemfish catch rates on the Ulladulla grounds were low until about the 20th June. The Spawning Run Survey commenced on the 18th June when gemfish abundance was judged to be increasing on local grounds. The first significant commercial by-catch of spawning run fish (about 4 t) was reported on the Ulladulla grounds on 22nd June, and the survey boats made good catches on 25-27th June. After a spell of bad weather, catch rates on the Ulladulla grounds declined in early July, and stayed relatively low in the following weeks. The Ulladulla survey boats relinquished their research permits after consistently low catches during the week ended 12th July. Small by-catches of spawning run gemfish continued to be made by Ulladulla based trawlers through to late July.

Gemfish catches from the Sydney and Wollongong grounds were low until the first week in July, when trip limit catches were taken in both areas. The Wollongong survey boats made good catches during 10th-12th July, then another spell of bad weather was followed by declining catch rates in the week ended 19th July. Commercial by-catches and survey catches increased again in the last week of July and the first week of August in both the Wollongong and Sydney areas. By 10-11th August gemfish were being taken by trawlers working in the Port Stephens - Forster area.

By-catches of spawning run gemfish declined in mid August and the proportion of spent fish in catches increased. Towards the end of August and into September, by-catches of gemfish again increased in the Sydney and Wollongong areas, consistent with a 'back-run' of fish after spawning. Some running ripe female gemfish were still being recorded in catches as late as 26th September, however the majority of fish in trawl catches during September had already spawned.

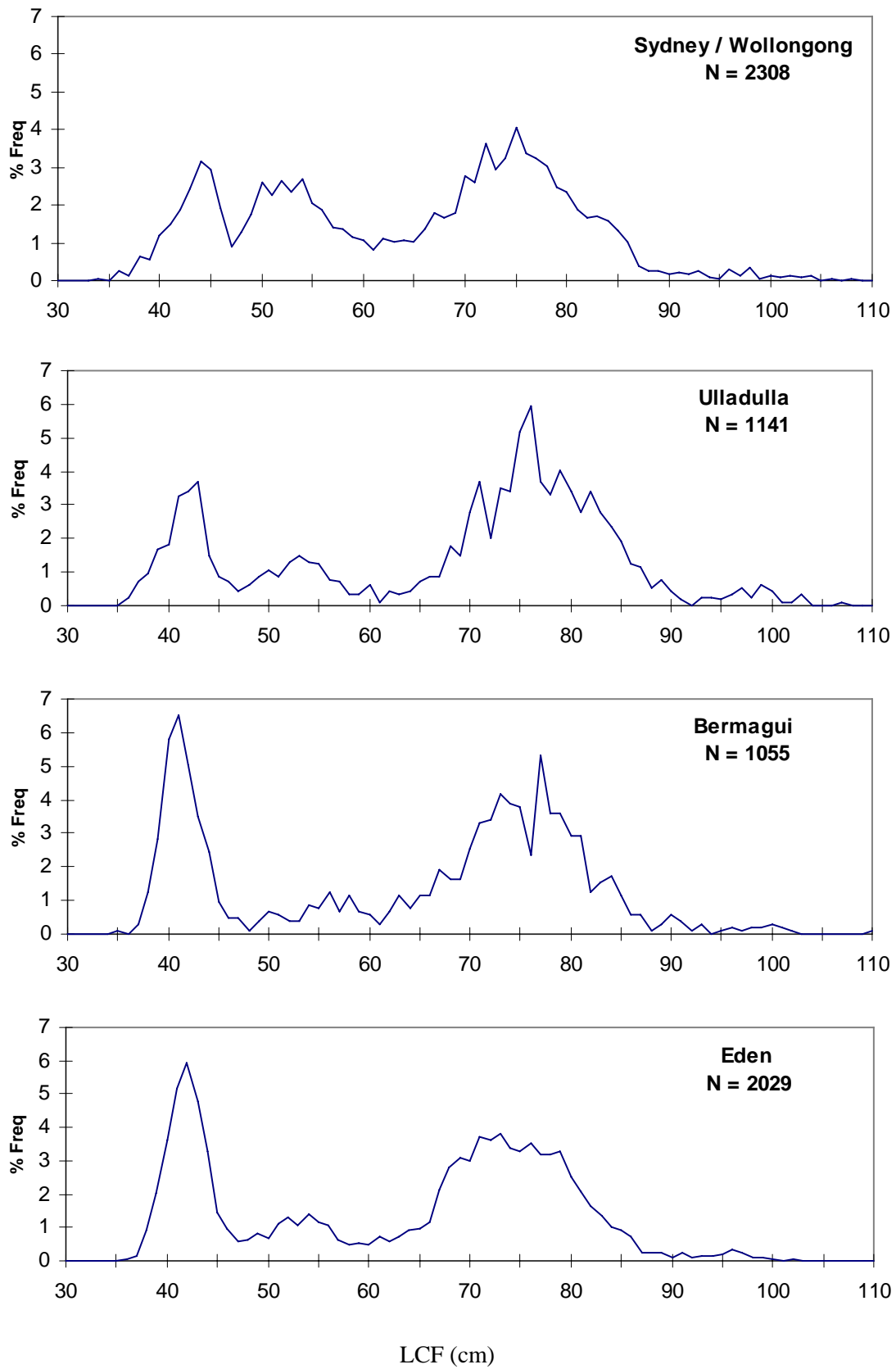
Dropliners also landed significant catches of eastern gemfish during the 1996 season, most notably at the ports of Kiama, Bermagui and Eden. Off NSW, dropliners were subject to a daily trip limit of 100 kg during the main season from May to September, and there were many occasions when this trip limit was reached at these ports. Dropline catches in a given area appeared to be heaviest when trawl by-catches in that area were also heavy, although it was often the case that significant catches continued to be made on droplines for a considerable period after the fish had apparently left nearby trawl grounds.

#### **2.4 Size Composition of Gemfish By-Catch during the 1996 Season**

Prior to the 10th June, small by-catches of eastern gemfish were being landed at most of the main south coast ports. These catches were comprised mostly of immature 2 and 3 year old fish (35 - 55 cm LCF).

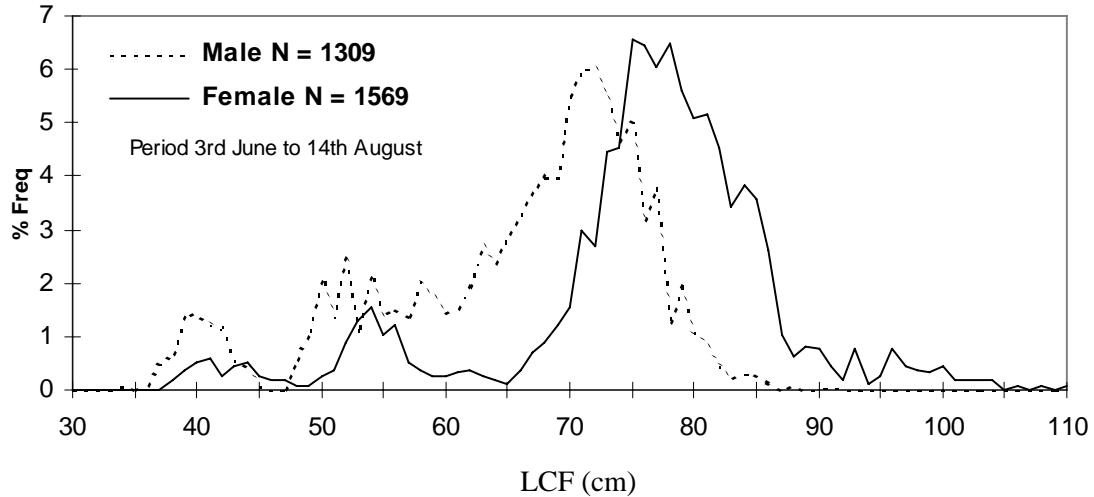
After the 11th June, larger mature gemfish (> 60 cm LCF) became significant in landed by-catches, first in the Eden area then gradually spreading to each of the northern ports. By early July, large gemfish were present in the by-catch at all of the main trawl ports on the NSW south coast. The size composition data (for the period 11th June to 30th September) are presented separately in Figure 2.1 for each of the main areas. The size distribution of fish landed in each area was generally similar, the only significant variation being in the Sydney/Wollongong area where a higher proportion of 3 year old fish (mode at 50 - 55 cm LCF) was present in the catch.

**Figure 2.1** Size composition of eastern gemfish trawl by-catch for the 1996 winter season by port of landing.



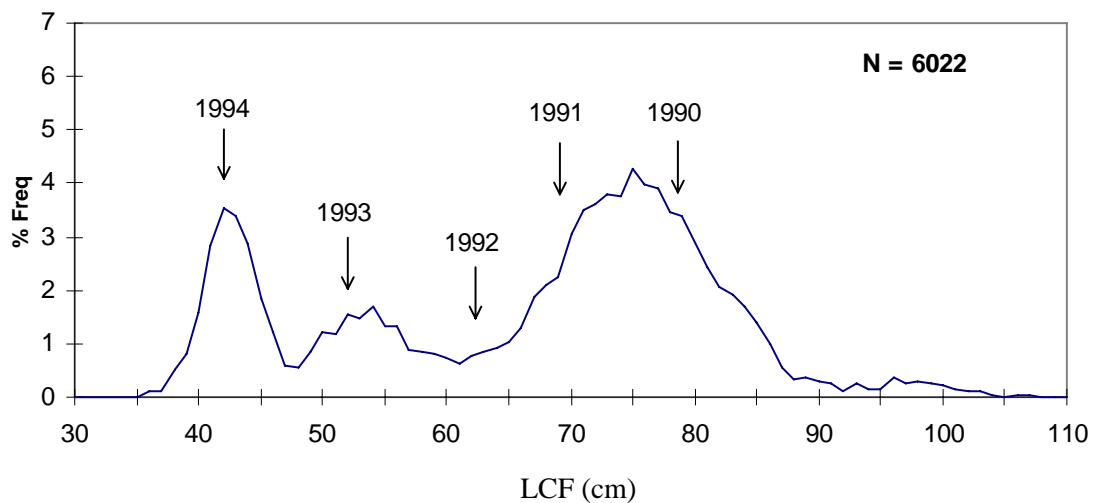
The size composition of all samples able to be sexed during the pre-spawning period is shown in Figure 2.2. Small gemfish (< 45 cm LCF) were often marketed in separate boxes, which were not selected for sexing, and these size classes are therefore under-represented in the sexed sample. Females comprised 55% of the fish in the sexed catches.

**Figure 2.2** Size composition of sexed samples of eastern gemfish from trawl by-catches during the 1996 winter season.



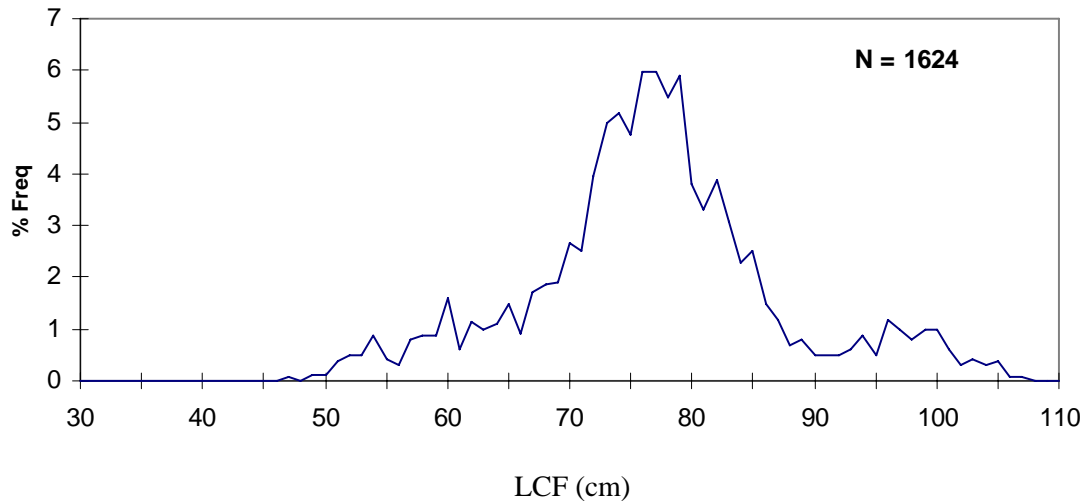
The size composition of all samples measured from commercial landings during the period of the “main season” (11th June to 30th September) is shown in Figure 2.3. This distribution clearly showed modes at 40 - 45 cm LCF (2 year olds, 1994 cohort), 50 - 55 cm LCF (3 year olds, 1993 cohort), and 70 - 80 cm LCF (anticipated to be mostly comprised of 5 and 6 year old fish, the 1990 and 1991 cohorts). The relative abundance of fish greater than 85 cm LCF (8 year olds and older) was very low. The results also indicated a relatively low abundance of 55 - 65 cm LCF gemfish (4 year olds, 1992 cohort), which strongly suggests that this cohort is weaker than the 1990 and 1991 cohorts and may be below normal strength.

**Figure 2.3** Size composition of the eastern gemfish trawl by-catch for all ports for the 1996 season (11th June - 30th September).



The size composition of eastern gemfish measured from dropline catches is shown in Figure 2.4. As with the trawl by-catch, the dropline catch showed a strong mode at 70 - 80 cm LCF. Dropline catches also had a slightly stronger representation of fish > 90 cm LCF, and a much poorer representation of fish < 55 cm LCF, which are only partially vulnerable to the dropline gear.

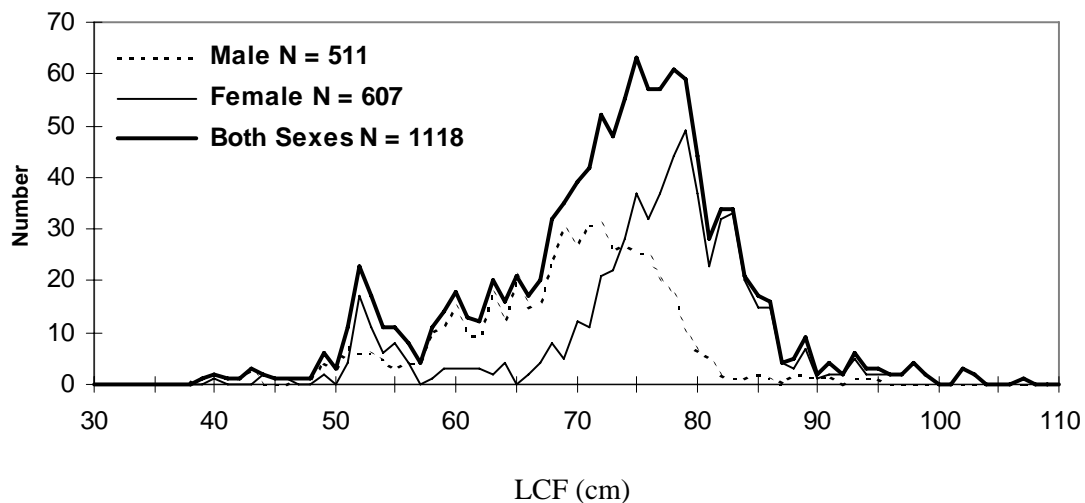
**Figure 2.4** Size composition of eastern gemfish measured from dropline catches during the 1996 winter season.



## 2.5 Otolith Sample

A total of 1118 fish (511 males and 607 females) were sampled for otoliths during the 1996 season. The samples were mainly drawn from fish caught as part of the industry survey of the spawning run, although some additional samples were also obtained from commercial by-catches. The size composition of gemfish sampled for otoliths is shown in Figure 2.5. Small fish (35 - 45 cm LCF, known to be 2 year olds) were not selected for otolith sampling due to their poor representation in survey catches and the more pressing need to sample as many fish as possible from the mature population (> 60 cm LCF). All otoliths obtained during the 1996 season were forwarded to the Central Ageing Facility for age determination.

**Figure 2.5** Size composition of eastern gemfish sampled for otoliths during the 1996 winter season.

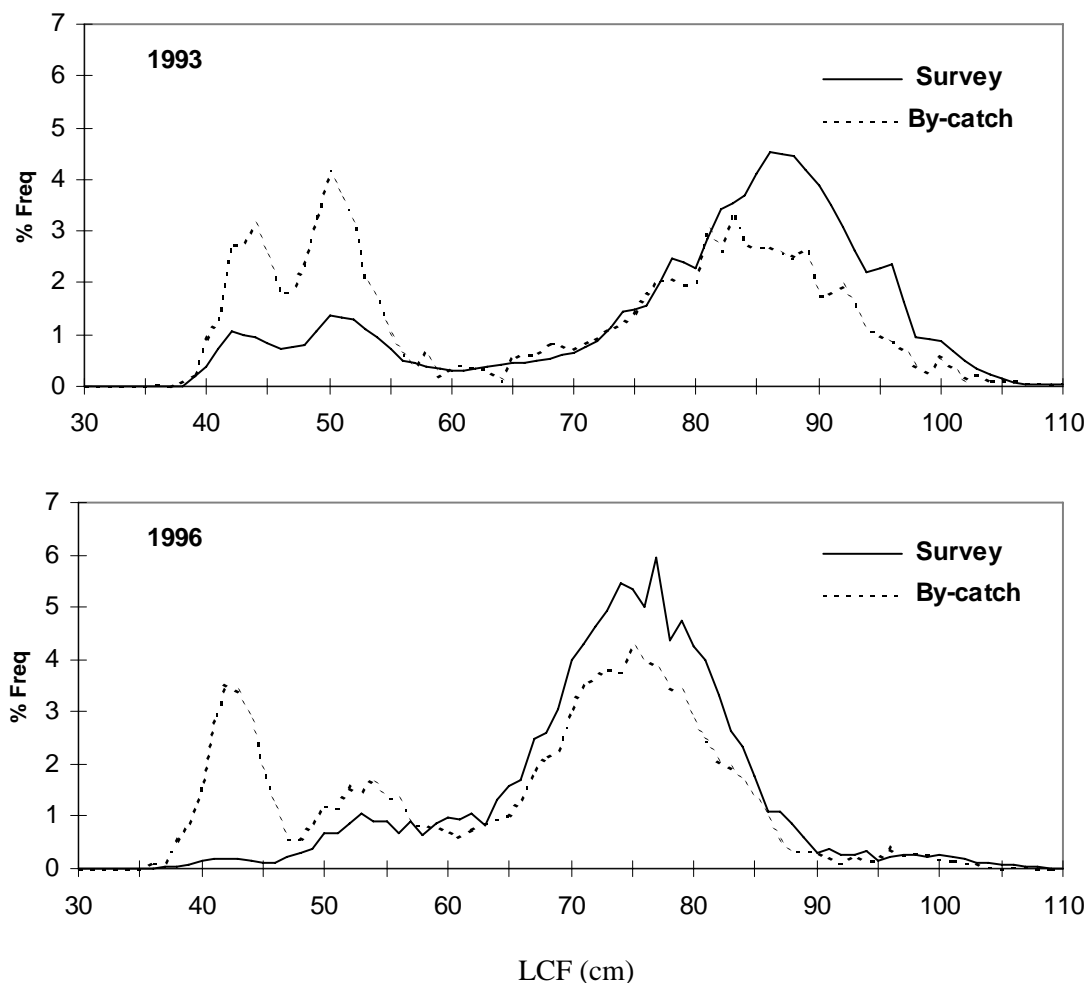


## 2.6 Use of By-Catch Monitoring in Stock Assessment

Concern has been expressed by some members of industry that size composition data obtained by monitoring by-catches of gemfish during the winter season may not be representative of the size composition of the spawning run of mature gemfish.

To assess the validity of the by-catch derived data, in Figure 2.6 the size compositions determined from the two industry surveys of the spawning run in the 1993 and 1996 seasons were compared with the size compositions determined from monitoring of the by-catch in each of those years. The 1993 survey results are those presented as "all aggregation samples" in Figure 2b of Prince and Wright (1994), and the 1996 survey results are as provided electronically by Dr. J. Prince towards the end of the 1996 survey. The results show that in each of the two seasons the by-catch size composition closely reflected the size composition determined from the industry survey for fish greater than about 55 cm LCF. Additionally, the by-catch measurements correctly indicated the significant difference between the seasons in the position of the mode in the larger fish - a broad mode at 80 - 95 cm in 1993, and a narrower mode at 70 - 80 cm in 1996.

**Figure 2.6** Comparison of size composition of eastern gemfish determined from industry surveys and from monitoring of commercial by-catches during the winter seasons of 1993 and 1996.



The by-catch measurements contained a higher proportion of small (< 55 cm LCF) gemfish, which was expected as they mostly came from catches which were not targeted at the spawning run. This is not a significant factor when assessing the usefulness of the by-catch derived data for inclusion in relevant population models, as recent models used in the gemfish assessment generally exclude data for these small fish or assess biases resulting from inclusion of the small fish in the model (see for example Punt, 1996, p 9-10 and Bax, 1996, p 79-80).

It was therefore concluded that the data obtained for gemfish > 55 cm LCF from monitoring of the trawl by-catch in the years when a zero TAC applied can validly be considered to represent the relative size composition of gemfish in the spawning population in those years.

## 2.7 Discussion

Both the number and size of the “by-catches” of eastern gemfish reported during the 1996 season appear to have been greater than 1995 levels, which may indicate an increase in abundance of gemfish during the 1996 spawning season. This is consistent with the observation from the size composition data of a significant recruitment of newly matured fish (65 - 85 cm LCF) to the 1996 spawning stock

During the 1996 winter season there were reports of many trawl catches of gemfish in excess of the 200 kg trip limit being discarded at sea. No measurements of discarded fish were made during the current study, however it is probable that these discards would have been comprised mostly of large fish (> 60 cm LCF) and there is no reason to suspect that the size composition of these catches was significantly different to catches which were marketed during the 1996 season. The size composition data obtained from landed catches were also very consistent between the different areas of the fishery. It was therefore considered that the results presented in Figure 2.3 were representative of the size composition of gemfish present on fishing grounds during the 1996 season.

Comparison of the results of monitoring the landed by-catch of gemfish with data obtained during industry surveys of the spawning run in the 1993 and 1996 seasons confirmed that the by-catch data could be considered representative of the size composition of eastern gemfish on the fishing grounds during the winter season, at least for fish greater than 55 cm LCF.

Preliminary analysis of the results from monitoring of the 1996 season suggested there had been some recovery of the eastern gemfish stock, based on two cohorts spawned in 1990 and 1991 (5 and 6 year old fish in 1996). Further analyses of the results from the industry survey of the 1996 spawning run would be required to estimate the relative strength of this recruitment pulse. However, the low representation in the 1996 spawning run of 55 - 65 cm fish confirmed that the 1992 cohort (4 year olds in 1996) was another poor cohort, which would recruit to the spawning population as five year olds in the 1997 season.

### **3. MONITORING OF THE 1997 SPAWNING SEASON FISHERY FOR EASTERN GEMFISH.**

#### **3.1 Introduction**

A TAC of 1000t was set for eastern gemfish during 1997, following a 4 boat research survey during the 1996 season and the development of a dynamic population model by the Eastern Gemfish Assessment Group (EGAG). The 1997 TAC was allocated to SEF endorsed trawlers according to their entitlement under the ITQ system. Trawlers and dropliners fishing under NSW jurisdiction, and Commonwealth non-trawl operators, were restricted to 'trip limits' of 200 and 100 kg respectively.

In order to assess the current status of the eastern gemfish stock, and to update the model and provide advice to managers about future harvest strategies, EGAG recommended that gemfish landings by the commercial fishery be monitored during the 1997 winter season, in a manner consistent with that used in previous seasons. It was also recommended that a representative otolith sample be obtained to provide information on the current age composition of the mature population.

This report presents the results of a research program which monitored the 1997 spawning season catch of eastern gemfish. The objectives of this study were:

1. To obtain representative size composition data for the landed catches of eastern gemfish during the 1997 winter season;
2. To collect a representative sample of otoliths from spawning-run catches of eastern gemfish, and to forward same to the Central Ageing Facility; and
3. To analyse commercial catch and effort data available from the SEF2 returns, and to calculate a standardised CPUE figure for the 1997 season.

#### **3.2 Progress of the 1997 Season**

The trawl TAC of 1000t came into effect on 21st May. During late May and early June small catches of "summer" run gemfish were taken by Eden and Lakes Entrance based boats. Dropline catches in NSW were also sporadic through this period and consisted mainly of small to medium fish.

Around the 10th June the first significant spawning run catches of gemfish were landed by Lakes Entrance based trawlers (there were strong suggestions from industry that some of these fish may in fact have been taken in mesh nets). Catches by Eden based trawlers increased to around 400 to 600 kg per trip. From 15th to 20th June there was a period of very bad weather, with strong S and SE winds along the NSW coast. Later reports from Tasmanian dropliners suggested significant catches of gemfish between St Helens and Flinders Island after 10th June.

In the last week of June catches by the larger Eden and Lakes Entrance based vessels increased (up to 2 t per trip), however the poor weather continued and few significant catches



were taken by trawlers in the more northern ports. The size composition of fish in dropline catches also changed significantly in late June, with the larger spawning run fish present in catches after about 23rd June.

In early July the main trawl catches continued to be taken in the Eden area, extending to Bermagui about the 7th July. Sporadic catches were reported from the Bermagui and Ulladulla grounds over the following week, but they were by no means consistent nor predictable.

By mid July the fish appeared to have left the Eden area, and were being taken more consistently in the Bermagui and Ulladulla areas, with small sporadic catches off Wollongong. However, it was still apparent that good catch rates could not be maintained from day to day, despite considerable searching by a large number of trawlers.

In late July catches were made by Sydney based trawlers and some small catches (less than the 200 kg trip limit) were observed from the northern areas of the fishery (the first running ripe female fish of the 1997 season were observed in a catch from the Nelson Bay area taken on the 27th July). There were reports from industry of some discarding of catches in excess of the 200kg trip limit on fishing grounds off Port Stephens.

Significant catches continued to be made by dropliners on most south coast grounds through mid to late July, however trawl catches on the main Ulladulla and Wollongong grounds were unusually low through what is normally the main period of the winter fishery. In early August, catches declined on both the trawl grounds and the dropline grounds. Landings by all methods were low during August, prior to early/mid September when significant catches of spawning fish were again made in the Wollongong / Kiama area. Many of the fish in these catches were spent, but a significant proportion of males and some females were still running ripe.

Small catches of 'return run' fish were made off most south coast ports during mid to late September, but bad weather, combined with declining catch rates, led to low catches towards the end of September.

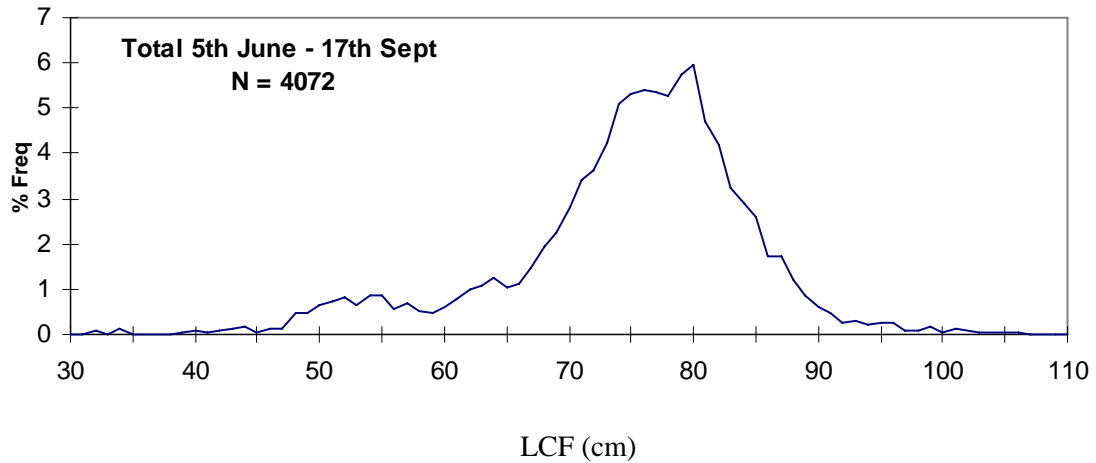
### **3.3 Size Composition of Spawning Run Gemfish**

Despite the sporadic nature of trawl catches of eastern gemfish during the 1997 season, a good coverage of all the main catching periods and areas was obtained by samples taken at both the Sydney Fish Market and Poulos Bros. processing plant near Wollongong. The size compositions of catches measured from the different ports throughout the season were very consistent, being mainly comprised of fish between 70 and 90 cm LCF, with very poor representation of both smaller (< 70 cm) and larger (> 90 cm) fish in catches. The size composition of all gemfish measured from trawl catches during the 1997 winter season is shown in Figure 3.1.

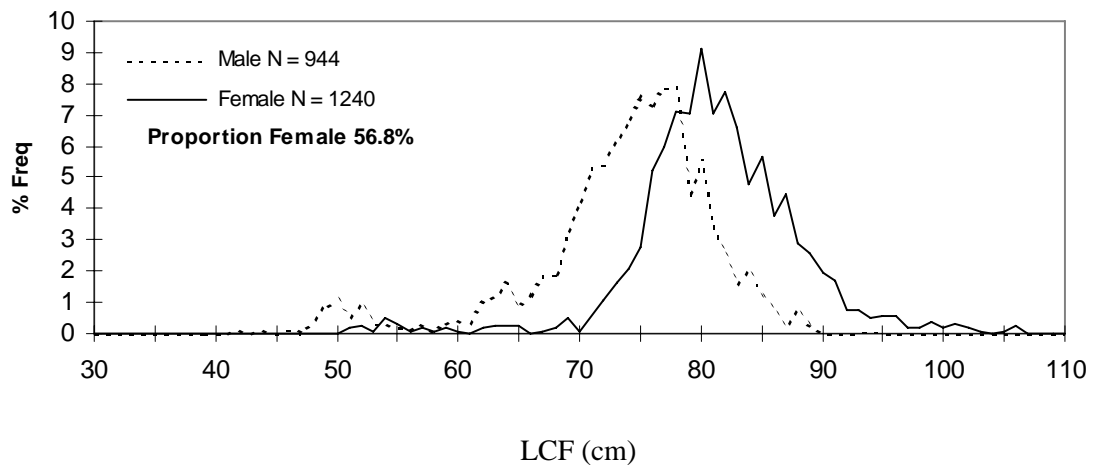
The size compositions of the male and female components of the trawl catch during the 1997 spawning season are shown in Figure 3.2. Females comprised about 57% (by numbers) of all catches sexed during the season, however for catches sampled during the main part of the season (July) the proportion of females exceeded 60%.

The size composition of gemfish caught on droplines during the spawning season was very similar to that of the trawl catch, except for a slightly greater proportional representation of large (> 90 cm) fish (Figure 3.3).

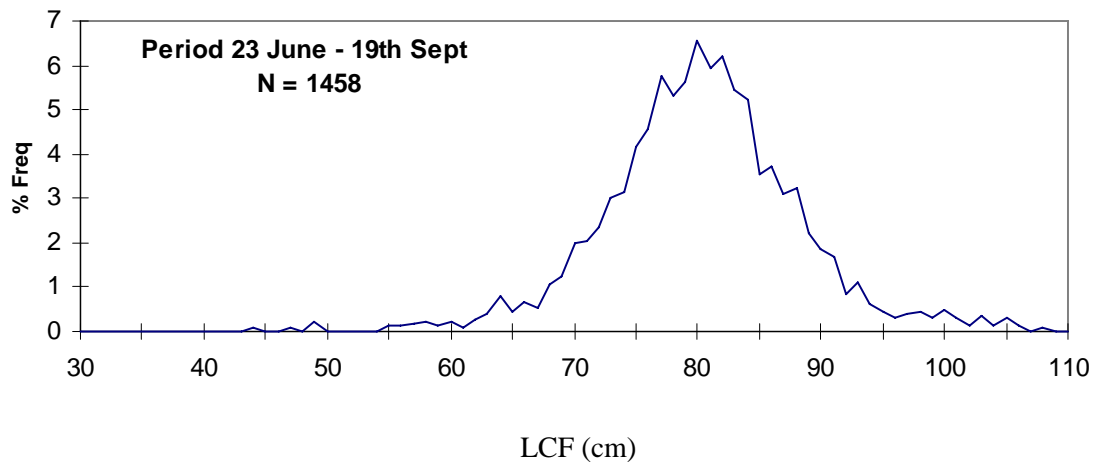
**Figure 3.1** Size composition of trawl catches of eastern gemfish during the 1997 winter season.



**Figure 3.2** Sexed size composition of eastern gemfish sampled during the 1997 winter season.



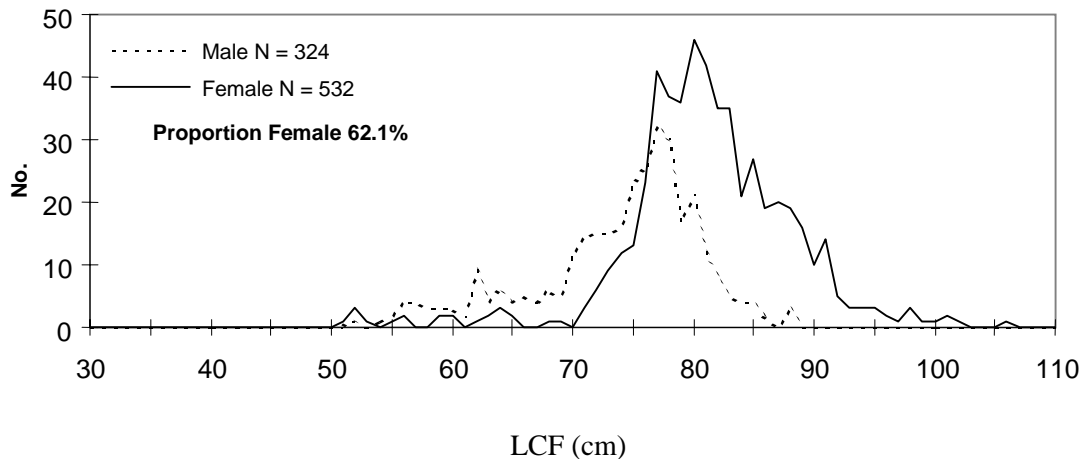
**Figure 3.3** Size composition of dropline catches of eastern gemfish sampled during the 1997 winter season.



### 3.4 Otolith Sample

A total of 856 pairs of otoliths were sampled from spawning-run gemfish between 5th June and 17th July, and these were forwarded to the Central Ageing Facility for age determination. The sexed size composition of the fish sampled for otoliths is shown in Figure 3.4.

**Figure 3.4** Size composition of male and female gemfish sampled for otoliths during the 1997 winter season.



### 3.5 Analysis of Catch and Effort Statistics

According to the SEF2 database, 49 trawlers landed a total of 309 tonnes of eastern gemfish during the main period of the 1997 winter season (to 8th August). Despite the availability of a significant amount of quota, 10 of these trawlers landed less than 1 tonne of gemfish during this period.

Of the trawlers which landed gemfish in the 1997 season, 36 had been included in catch and effort analyses in previous gemfish seasons, and for 27 of these a 'Relative Fishing Power' value was available. These 27 vessels caught almost 180 tonnes of gemfish during the period analysed, at a standardised catch rate of 416 kg per standard day (Table 3.1).

**Table 3.1** Summary results from analyses of eastern gemfish catch and fishing effort statistics for the 1997 winter season to 8th August.

	Number of Boats	Total Catch kg	Fishing Days	Effort std days	Mean Catch Per Day kg	Standardised CPUE kg/std day
All boats	49	309,030	379	n/a	815	n/a
All boats with RFP	27	179,905	288	432	625	416
Boats satisfying the 5t/5d rules	11	144,737	136	224	1064	646
"Survey" boats	4	77,598	56	96	1386	808

Previous analyses to estimate standardised CPUE of gemfish for each season have involved a selection rule to include in the analyses only boats which caught greater than 5 tonnes of gemfish and targeted gemfish on at least 5 days during the season. A total of 11 boats satisfied these rules in the 1997 season. Standardised CPUE for these 11 vessels (also shown in Table 3.1) was calculated to be 646 kg per standard day.

In 1996, four of the most consistent gemfish trawlers were selected to undertake a 'survey' of the forward run of the gemfish season to provide an estimate of CPUE in the absence of a targeted commercial fishery. The combined results for these 'survey' boats for the 1997 season (and earlier seasons 1986 - 1992 where data were available) are shown in Table 3.2, and a comparison of the standardised catch rates for all boats satisfying the selection rules and the 1996 survey boats is presented in Figure 3.5.

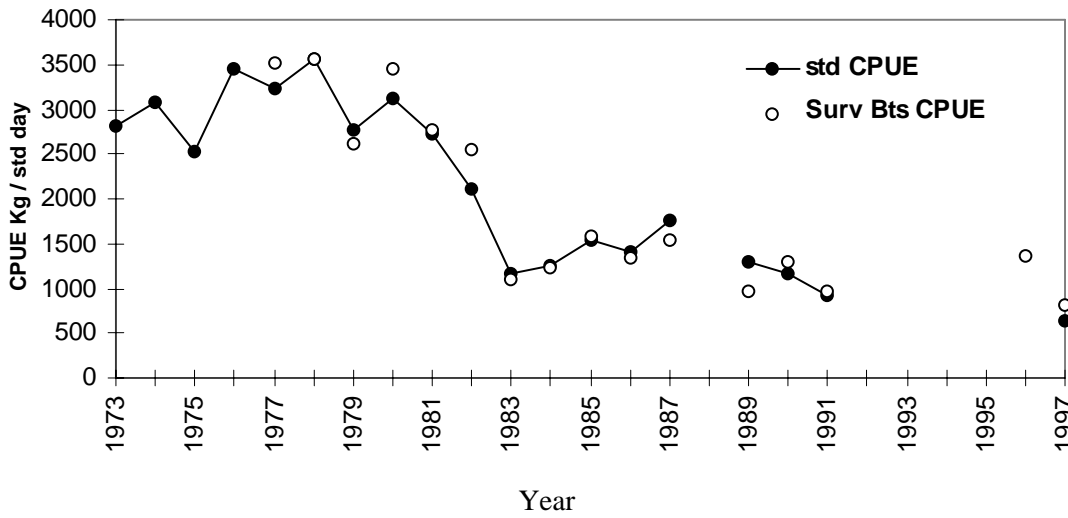
**Table 3.2** Summary of catch and fishing effort statistics for the four 'survey' boats from SEF Logbook data for 1986 to 1992, survey data for 1996 and SEF2 data for 1997.

# Note: Data not available for all four boats in some years.

\* A Global TAC applied in 1988 and the fishery was closed on the 10th July

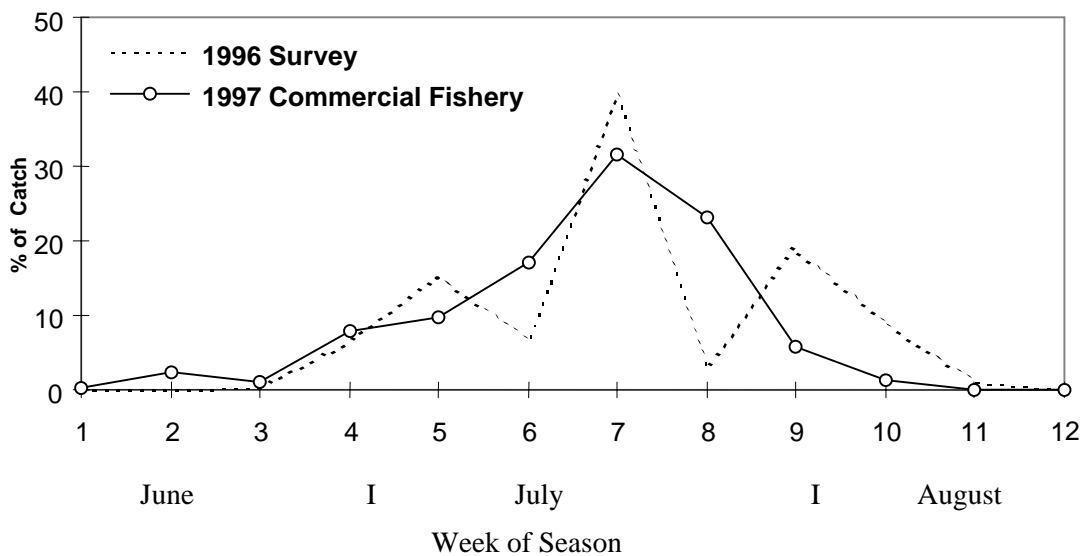
Season	Period of Main Run	Fishing Days	Total Catch t	Mean Catch per Boat (t)	Mean Catch per Day (t)
1986	June 12 - July 27	72	249	62.3	3.46
1987	June 12 - Aug 9th	98	377	94.3	3.85
1988 # 3 boats	June 22 - July 10th*	38	141	47.0	3.71
1989 # 3 boats	June 17th - Aug 2nd	40	132	44.0	3.30
1990 # 3 boats	June 20th - July 24th	46	214	71.3	4.65
1991 # 2 boats	June 26th - Aug 1st	13	19	9.5	1.46
1992 # 2 boats	June 30th - July 27th	31	54	27.0	1.74
1996 Survey	June 21st - July 10th	44	140	35.0	3.18
1997 Fishery	June 21st - July 27th	56	78	19.5	1.39

**Figure 3.5** Standardised CPUE of eastern gemfish for all boats satisfying the 5 tonnes / 5 day rule (●), and for the 1996 Survey Boats (○).



The temporal distribution of landings of gemfish through the main part of the 1997 season was as would be generally expected. The distribution was similar to that recorded during the 1996 survey (noting that the survey catches were taken north of 36°S), however the commercial fishery in 1997 finished about a week earlier than the 1996 survey (Figure 3.6). In both years, peak catches occurred in week 7 of the season (10th - 16th July).

**Figure 3.6** Distribution of eastern gemfish catch by week for the 1996 survey and the 1997 winter season.



### 3.6 Discussion

The 1997 size composition of the spawning-run catch of eastern gemfish from both trawlers and dropliners was consistent with the expected dominance of the 6 and 7 year old age classes (1990 and 1991 cohorts, 70 to 90 cm LCF). The size composition data suggest that age classes younger than 6 and older than 7 were very poorly represented in the 1997 catch, which implies that the newly recruiting 1993 and 1992 cohorts (4 and 5 year old fish) were only present in low levels of abundance. This raises concern about future spawning stock levels, as the 1990 and 1991 cohorts decline in abundance through natural and fishing mortality. A large and representative otolith sample was obtained during the 1997 season, and was forwarded to the Central Ageing Facility so that an accurate estimate of the current age composition of the spawning population may be made for eastern gemfish.

One notable feature of the 1997 winter gemfish season was the lower than expected catch rates by trawlers throughout the whole area of the fishery, when compared with the results of the 1996 survey. In 1997, significant gemfish shots (> 2 t) occurred infrequently, and there was only one 'large' shot (9 t) reported during the whole season. The geographical and temporal distribution of gemfish catches through the 1997 season was generally as would be expected, with about 35% of the total catch being taken on grounds from Eden south, 50% of landings being made on grounds from Bermagui to Ulladulla, and 15% of the reported catch being landed from Greenwell Pt north.

The 'average' catch rate achieved by trawlers judged to be targeting gemfish in the 1997 season was around 650 kg per standard day, which was well below the average catch rate achieved by the four boats during the 1996 survey of around 1400 kg per standard day, and also well below the catch rates observed during the mid 1980's of around 1500 kg per standard day.

The results from monitoring of the 1997 season indicate that there has been little sustained 'recovery' in the eastern gemfish stock, and a further decline in the abundance of mature gemfish is to be expected during the next couple of years as more poor cohorts recruit to the spawning population.

## 4. MONITORING OF THE BY-CATCH OF EASTERN GEMFISH DURING 1998

### 4.1 Introduction

The fishery for eastern gemfish *Rexea solandri* has been the subject of detailed monitoring and assessment since a collapse in recruitment to the stock became apparent during the early 1990's. From 1993 to 1996 the fishery was subject to a zero TAC, and regulations were in place to limit the quantity of gemfish landed while targeting other species. Improved recruitment from cohorts spawned in 1990 and 1991 saw a TAC of 1000 t set for 1997, however poor catch rates and indications of a further period of poor recruitment resulted in a less optimistic assessment of the status of the stock following the 1997 season (Anon., 1997b).

During 1998, management arrangements for eastern gemfish reverted to a zero targeted TAC, and the arrangements for by-catch consisted of a 300 t quota which was allocated as individual transferable quotas according to the individual trawl fisher's entitlements. Non-SEF endorsed fishers off NSW were restricted to a 200 kg trip limit during the 'summer' months. During the 1998 winter season, trawlers north of Barrenjoey Pt. were restricted to a 200 kg trip limit, while the trip limit for dropline vessels off NSW was set at 150 kg.

Commercial landings of gemfish during the 1998 winter season were monitored by staff from NSW Fisheries, according to protocols used for monitoring previous years' catches. The objectives of the research program were:

1. To determine the size composition of the landed catch of eastern gemfish from both the trawl and dropline sectors during the summer (October to May) of 1997/98 and the 1998 winter spawning period (June to September).
2. To collect a representative sample of otoliths from the catch of eastern gemfish during the 1998 winter season.

As a targeted commercial fishery for gemfish did not occur during 1998, the catch rate data from the commercial fishing fleet was not analysed in order to provide an index of abundance (this was derived from a research survey conducted during the 1998 winter season - see Prince *et al.*, 1998). However the commercial catch data were used to indicate periods of high by-catches to help in defining the pattern of the gemfish migration during the 1998 winter season, and a brief descriptive analysis was carried out to provide some insight into the efficacy of the 'by-catch' quota in minimising catches of gemfish during the winter period.

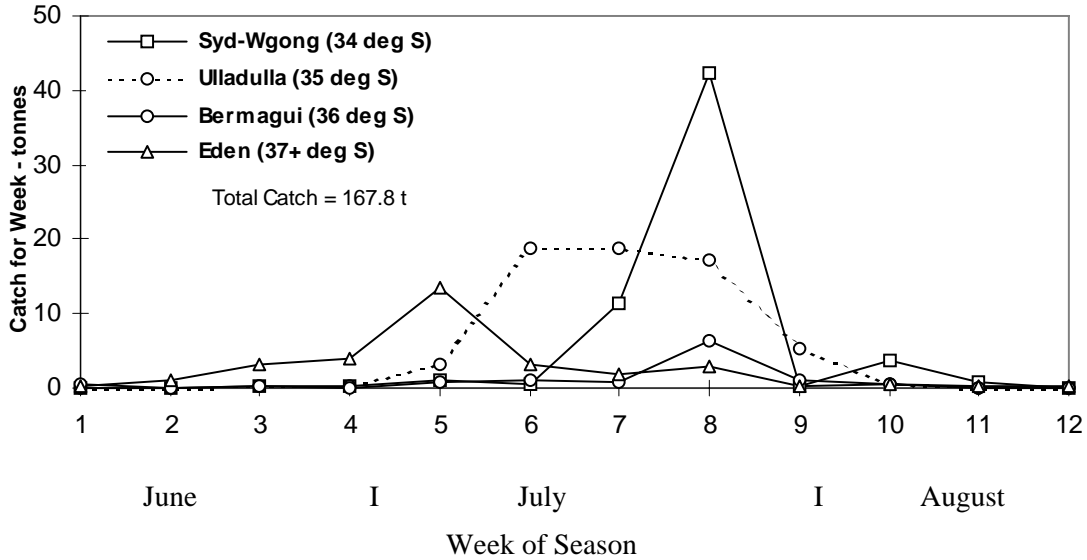
This report presents the results of the monitoring and briefly discusses the implications of the results for determining the current status of the eastern stock of gemfish.

### 4.2 Progress of the 1998 Winter Season

The progress of the 1998 pre-spawning run of gemfish, as inferred from the occurrence of significant by-catches, was outlined in a progress report to the Eastern Gemfish Assessment Group prepared in July 1998. Landings of gemfish generally followed a similar pattern to that observed during the last couple of winter seasons, the bulk of the fish appearing on Eden grounds during late June, the Ulladulla grounds in early-mid July, and the Wollongong to

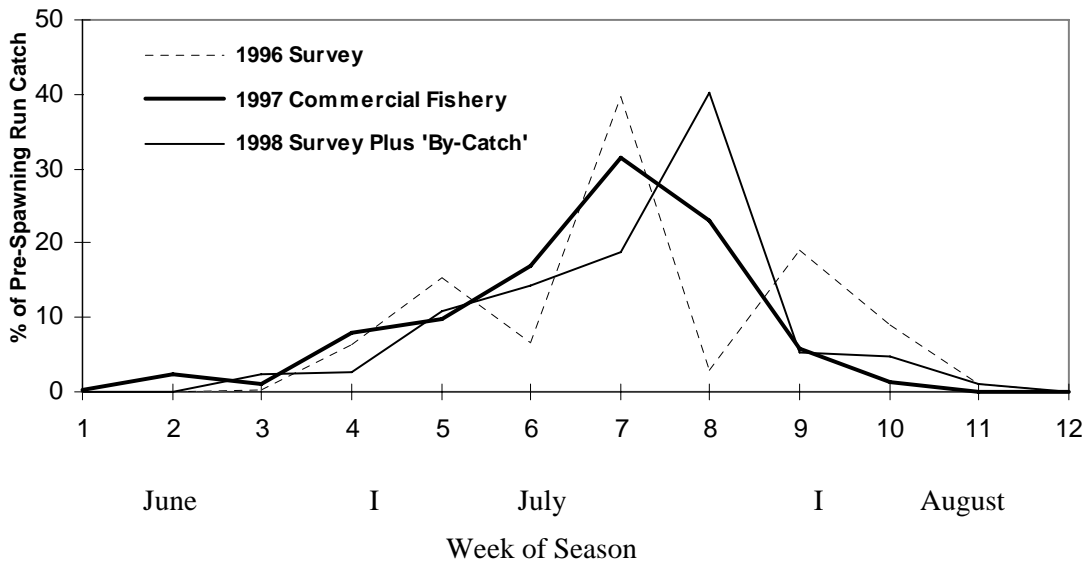
Sydney grounds during late July (Figure 4.1). In early August a prolonged period of bad weather signalled the end of the main 'pre-spawning' fishery. Catches on dropline grounds increased again in late August and September, however trawl catches during the post-spawning period were generally low and sporadic.

**Figure 4.1** Distribution of pre-spawning catches of eastern gemfish by week of the season for each of the main NSW areas for the 1998 winter season.



The similarity of the temporal pattern of landings during the last three winter seasons is evident in Figure 4.2. The bulk of landings in each season were made during the last half of July, and in the area from Ulladulla north. This is consistent with the possibility that the abundance of gemfish has declined to such an extent that it takes longer for the fish to form into aggregations, and significant aggregations have occurred more consistently on the more northern grounds in the fishing area. In 1998 the period of peak catches was slightly shorter and later than the period of peak catches in the two preceding years.

**Figure 4.2** Distribution of pre-spawning catches of eastern gemfish by week of the season for the winter seasons 1996, 1997 and 1998.

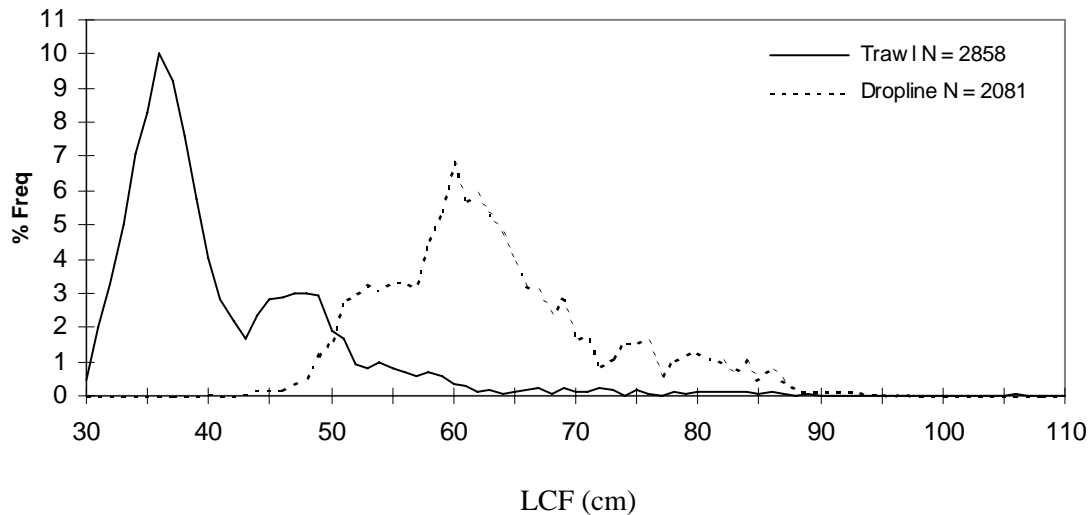




### 4.3 Results of Size Composition Monitoring

The size compositions of gemfish landed by the trawl and dropline sectors during the summer (October to May) of 1997/98 are shown in Figure 4.3. The major components of trawl catches over the summer period were fish in the 1+ and 2+ age classes (the 1996 and 1995 cohorts, 30-40 cm and 40-50 cm in length, respectively). The dropline catch during the summer period was dominated by 4+ fish (60-65 cm LCF), with a significant representation of 3+ fish (50 - 60 cm).

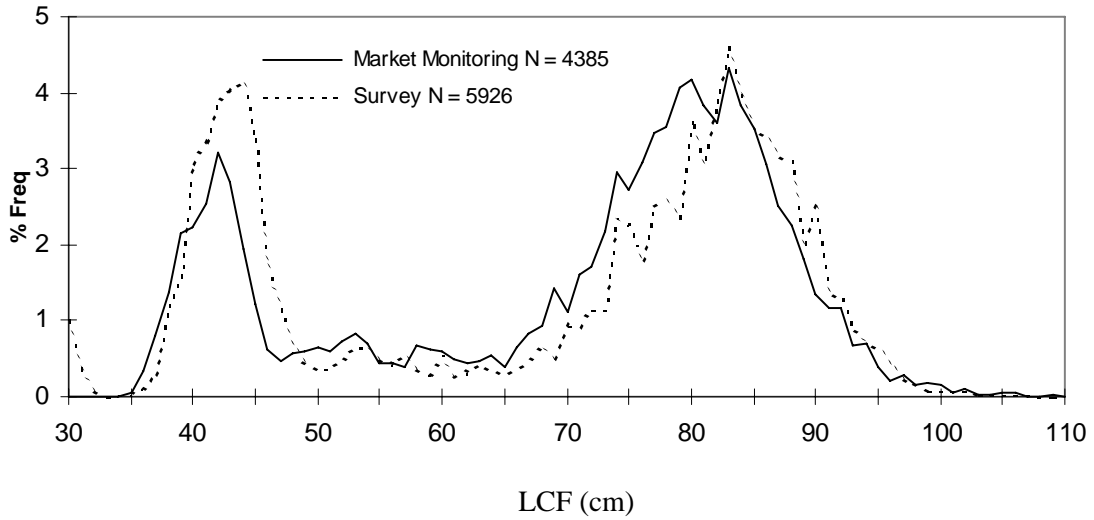
**Figure 4.3** Size composition of gemfish measured from trawl and dropline landings during the summer of 1997/98.



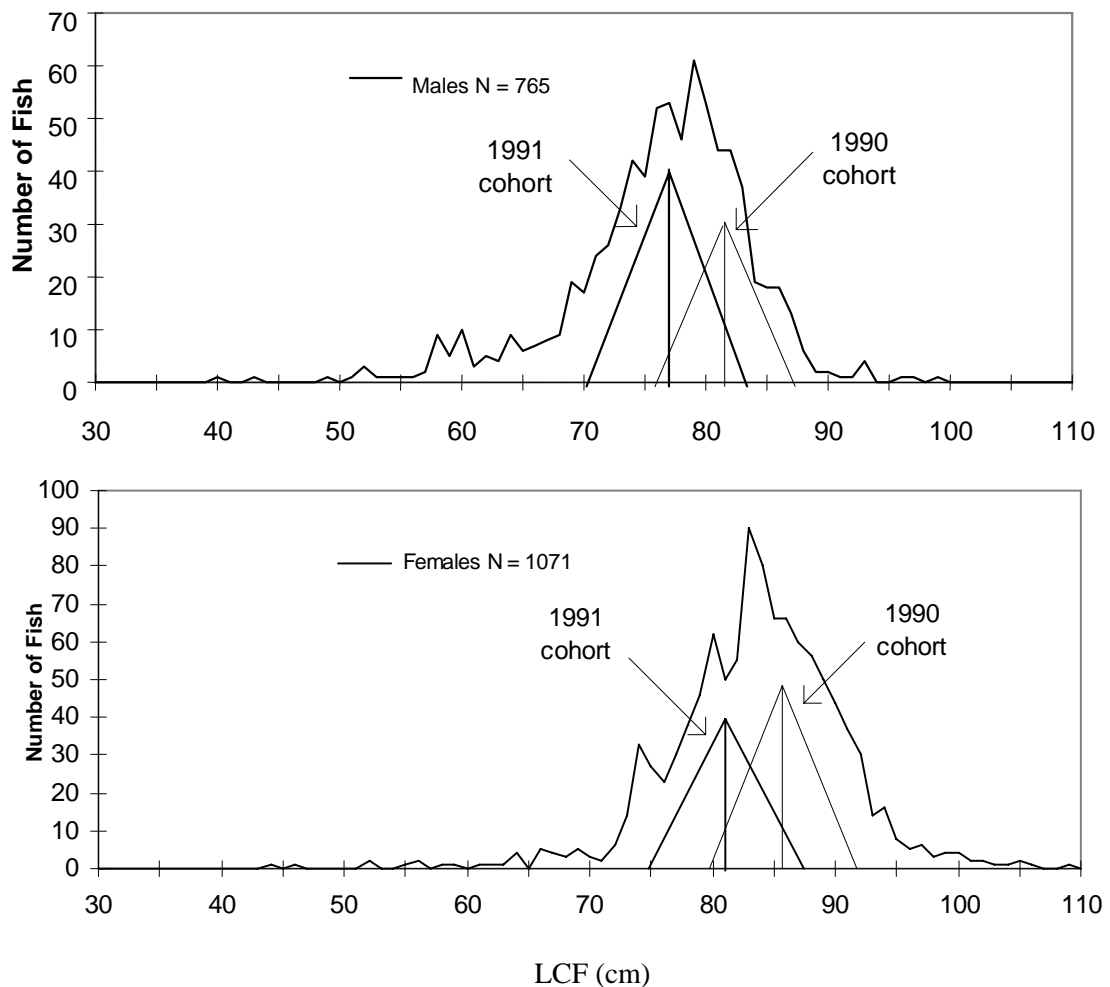
The size composition of trawl landings of gemfish measured during the 1998 winter season is shown in Figure 4.4, along with the size composition determined for the Research Survey catches measured by onboard observers (Prince *et al.*, 1998). The results are consistent with the expected dominance of the 1990 and 1991 cohorts in the spawning population. The very strong mode of quite large fish at 78 - 85 cm LCF is unusual for the spawning run fishery, and corresponds to the size range expected for 7 to 8 year old fish. Gemfish between 60 and 75 cm in length (4 and 5 year old fish, the 1993 and 1994 cohorts) are comparatively poorly represented in the catch, although these age classes are generally only partially recruited to the spawning population. The 1992 cohort (6 year old fish in 1998, about 75-78 cm in length) is also poorly represented relative to the larger fish, which confirms previous indications that this cohort is poor, as 6 year old fish are expected to be almost fully recruited to the spawning run. Significant numbers of 40 to 50 cm gemfish (mainly 2 year olds, the 1996 cohort) were measured during the early part of the winter season and again during the months of August and September, however these fish were not present to any great extent in the large landings from the Ulladulla - Sydney area during the main part of the winter season.

The dominance of the 1990 and 1991 cohorts is more clearly apparent in the sexed size composition data (Figure 4.5). The expected mean length and distribution of 7 and 8 year old fish (from Rowling, 1990, Table 4) are plotted against the observed size composition for each sex. It can be clearly seen that fish from cohorts spawned after 1991 (fish younger than 7 years of age in 1998) made a relatively minor contribution to the spawning population in 1998, which suggests very poor levels of recruitment for these younger cohorts. Male fish were more numerous than female fish in size classes less than 80 cm, and female fish were dominant in all size classes larger than 80 cm. Female fish comprised about 58 % of the

**Figure 4.4** Size composition of trawl catches of eastern gemfish measured during monitoring of the 1998 winter season landings compared with measurements made by observers during the 1998 research survey.



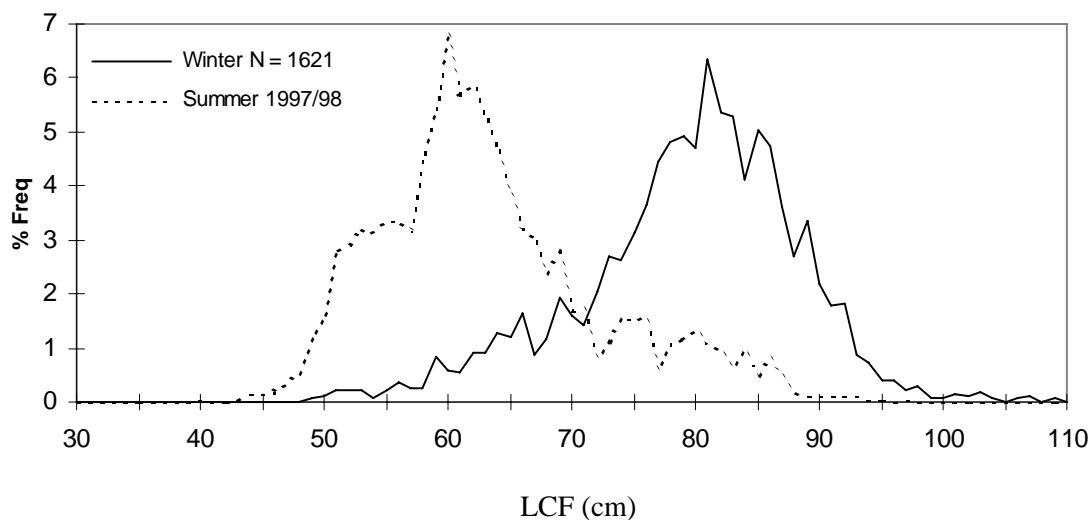
**Figure 4.5** Size compositions of male and female gemfish during the 1998 winter season. The expected mean length and distribution of the 1990 and 1991 cohorts (the 8 and 7 year old age classes) are shown.



spawning-run catch (in terms of numbers - the contribution in terms of weight would be much larger than this because of the greater average size of female fish). Gonad development during the 1998 season appeared normal, and the first 'running ripe' female fish were observed in catches marketed on the 20th July. Reports from industry indicated a high proportion of 'running ripe' females in catches off Sydney during early August, which suggests spawning occurred in the southern part of the spawning area in 1998.

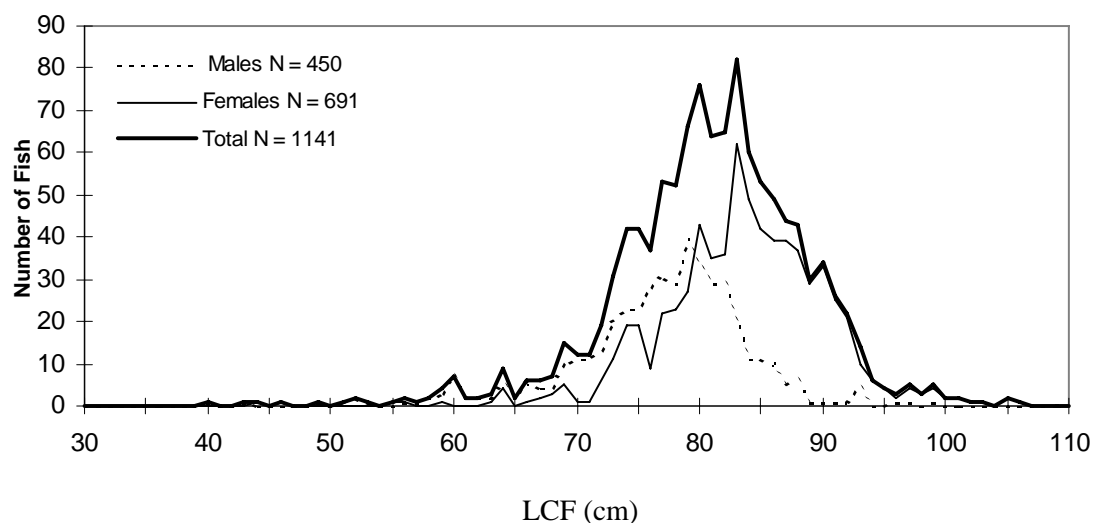
The size composition of dropline catches measured during the 1998 winter season (Figure 4.6) is similar to that of the trawl catch, with a very strong mode at about 80 - 85 cm LCF. There was a slightly better representation of 60 to 70 cm fish in the dropline samples, although catches during the main part of the season (mid to late July) were somewhat under sampled due to time constraints, and these catches appeared to be dominated by the larger 80 - 90 cm fish. There was a significant difference in the size composition of gemfish caught on droplines during the winter spawning period when compared to fish caught during the previous summer period (see the dashed line in Figure 4.6).

**Figure 4.6** Size composition of dropline catches of gemfish measured during 1998.



#### 4.4 Age Composition Sampling

A large otolith collection was obtained during the 1998 winter season, with a total of 1141 fish being sampled. The sexed size composition of these fish is shown in Figure 4.7. The otolith sample was representative of the size composition of male and female gemfish for fish greater than 60 cm LCF. Small fish (less than about 60 cm LCF) were not representatively sampled for otoliths, as they were infrequently encountered amongst the catches consigned to the processors, and fish of this size can be adequately aged from length frequency analysis. The otolith samples obtained during the 1998 winter season were forwarded to the Central Ageing Facility in Victoria for age determination.

**Figure 4.7** Size composition of gemfish sampled for otoliths during the 1998 winter season.**Table 4.1** Summary of results of analysis of gemfish catch and effort data (from SEF2) for the 1998 winter season to the end of July.

'Fishing Day' refers to the days on which gemfish was landed, ordered from the day of highest landings to the day of lowest landings, for each vessel. Note: data for 'Charissa' not included (see text).

**For all boats which landed > 1 tonne:**

No. Boats:	22
Total Gemfish Catch:	93,768 kg
No. Days Gemfish Caught:	231 (mean/boat: 10.5 days)
No. Days (Gemfish > 100 kg):	114 (mean/boat: 5.2 days)

Fishing day:	Day 1	Day 2	Day 3	Day 4
Mean % of total gemfish catch:	48.6%	68.8%	79.4%	85.9%

**For all boats which landed > 5 tonnes:**

No. of Boats:	8
Total Gemfish Catch:	56,868 kg
No. Days Gemfish Caught:	83 (mean/boat: 11.6 days)
No. Days (Gemfish > 100 kg):	39 (mean/boat: 4.9 days)

Fishing day:	Day 1	Day 2	Day 3	Day 4
Mean % of total gemfish catch:	54.4%	77.0%	87.5%	93.3%

#### 4.5 Analysis of Catch and Effort Data

Data on daily landings from the SEF2 database were analysed for 23 trawl vessels which caught > 1 tonne of gemfish during the period of the pre-spawning run to the end of July. One of these vessels, the 'Charissa' was considered to be a 'de-facto' survey vessel, having landed around 22 t of gemfish to the end of July (see Prince *et al.*, 1998) - landings by this vessel were not considered further in this analysis.

The 22 trawlers for which catch and effort data were analysed landed a total of 93.8 t of gemfish on 231 fishing days during June and July. Total landings for the season ranged up to 9.4 t for individual vessels (see Table 4.1). The average number of days on which gemfish were landed by an individual vessel was 10.5 (range 3 to 27 days), however daily landings exceeded 100 kg on only 5.2 days per vessel (range 1 to 9 days). Eight trawlers landed > 5 t of gemfish during the period analysed, and these eight vessels recorded a total catch of 56.9 t for 83 fishing days. On average, about 50% of a given vessel's total catch of gemfish for the period analysed was taken on one day, about 70% was taken in two days and about 90% of the total quantity of gemfish landed by most vessels was taken in just 4 days fishing. The results indicate that only a small number of vessels exhibited a pattern of a large number of low catches; rather, the predominant pattern was for a few days (< 5) of very heavy landings and very low landings (< 100 kg) for the remainder of the season.

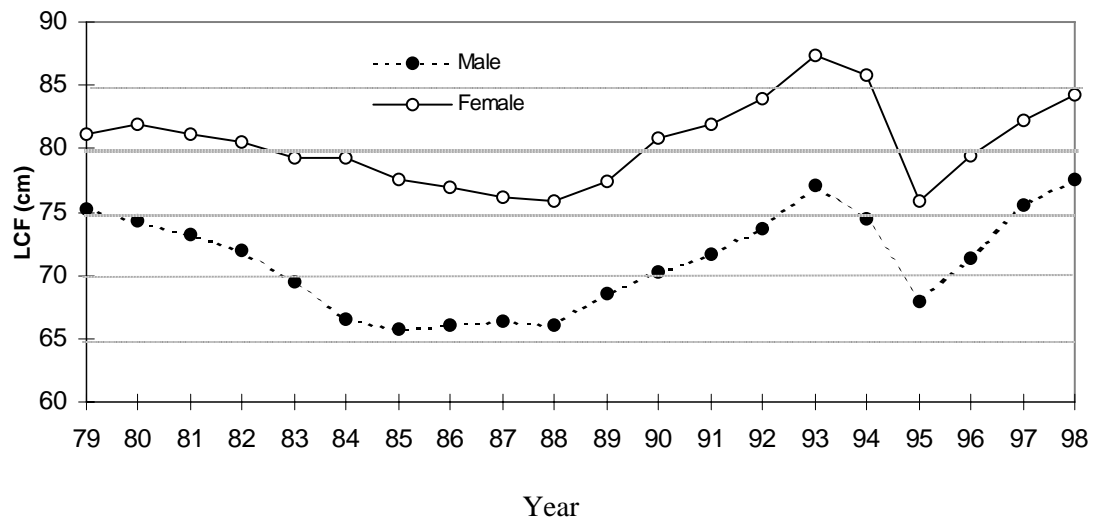
#### 4.6 Conclusions

The size composition of gemfish caught during the summer of 1997-98 was comparable with that for previous summer seasons. The trawl by-catch during the summer months was comprised almost entirely of juvenile fish less than 3 years old, and was suggestive of the possibility of a significant 1996 cohort now entering the stock. Catches by dropliners during the summer were mostly comprised of fish between 50 and 70 cm LCF, which were pre-adult fish (3 to 5 years of age) probably involved in feeding behaviour. This was similar to the pattern observed for dropline catches in previous summer seasons.

The size composition data for gemfish landings during the 1998 winter fishery were consistent with data collected during previous winter seasons, and show the progression through the population of the mode due to the two relatively strong cohorts which were identified in earlier years. In 1998 this led to a significant mode of quite large fish (78 to 85 cm LCF). Comparison with the size composition of fish measured from research survey catches targeted at gemfish aggregations confirmed that the landed by-catch was representative of the size composition of gemfish present on the main grounds during the winter season.

The sexed size composition data were consistent with the pattern observed in previous years, with females dominating in the larger size classes. The mean size of fish of both sexes is currently increasing (see Figure 4.8), mirroring the increase which occurred in 1989-93 when the earlier series of poor cohorts recruited to the mature population. However, data for the 1998 season indicate that the next cohort of any consequence appears to be that spawned in 1996, and these fish will not recruit to the mature population in significant numbers until they are 5 years of age in 2001. During 1999 and 2000 it is likely that the mean sizes of male and female fish in the mature population will increase even further, and that the proportion of males in the spawning stock will decline due to the effects of increasing natural mortality.

**Figure 4.8** Mean lengths of male and female gemfish measured from winter season catches, 1979 to 1998.



The analysis of the SEF2 landings data indicated that during the 1998 pre-spawning run the period of peak abundance of gemfish in any particular area was extremely restricted, generally lasting only 2-3 days. This is consistent with a significantly reduced stock, with the majority of fish forming just one aggregation, or a very small number of aggregations. Industry advice was that discarding of gemfish at sea during the 1998 season was minimal, so the pattern of landings can be considered to be a reasonable representation of the pattern of gemfish catches during the 1998 winter season.

Overall, the data from the 1998 season were consistent with the recruitment of a further series of poor cohorts to the spawning population of eastern gemfish. Cohorts spawned from 1992 to 1994 (which were aged from 4 to 6 years in 1998 and should have comprised a significant proportion of the mature population) were very poorly represented in the winter season catch. The mature population in 1998 was dominated by the 1990 and 1991 cohorts, which were 7 and 8 years of age. The abundance of fish in these cohorts will decline rapidly over the next couple of years due to a high natural mortality rate (especially for male fish, as very few males reach 10 years of age). With no sign of any significant recruitment until the 1996 cohort matures as 5 year olds in 2001, it appears that a further decline in the abundance of mature gemfish will occur over the next two years.

## 5. MONITORING OF THE BY-CATCH OF EASTERN GEMFISH DURING 1999

### 5.1 Introduction

Following a prolonged recruitment failure during most of the past decade, recent management of fisheries catching eastern gemfish has discouraged targeted fishing and implemented measures to control the by-catch of gemfish during fishing targeted at other species. In 1999 Commonwealth trawl fishers were subject to a zero targeted Total Allowable Catch (TAC), with 250 t being allocated to eastern gemfish quota holders to minimise discarding of incidental catches. Trawl fishers under NSW jurisdiction, and dropline fishers operating off NSW, were subject to a trip limit of 150 kg of eastern gemfish. Despite these restrictive management measures, significant quantities of eastern gemfish were landed by both trawl and dropline fishers during 1999.

The research described in this report continues a long time series (>20 years) of monitoring of the commercial landings of eastern gemfish. Comparison with research survey results in past years has shown that, even in the situation of a zero TAC, the 'by-catch' of gemfish marketed during the winter season accurately reflects the size composition of fish present in the pre-spawning aggregations. Together with the collection of a large sample of otoliths, the size composition data from the landed catches can be used to describe changes in the age composition of the eastern gemfish stock. These data are used by the Eastern Gemfish Assessment Group (EGAG) to update the stock assessment for eastern gemfish following each winter season.

### 5.2 Objectives

The research reported here had the following objectives:

1. To monitor the size composition of the landed catch of eastern gemfish during the summer of 1998/99, and the winter of 1999, for both the trawl and dropline sectors of the fishery.
2. To obtain a representative sample of otoliths from eastern gemfish in the mature population.

Methods used to achieve these objectives were consistent with those used to monitor gemfish landings in previous years. The majority of the size composition data were obtained at the Sydney Fish Market. Otolith samples, and additional size composition data, were obtained from catches consigned to the Poulos Bros. processing plant at Unanderra, south of Wollongong. After removal from the fish, otoliths were stored dry in paper envelopes with the relevant details noted. At the conclusion of the winter season the otoliths were forwarded to the Central Ageing Facility at Queenscliff, where they will be aged.

Fish lengths were measured from snout to caudal fork, to the whole cm below the true length. A proportion of the catch was marketed as 'headed and gutted' frames and for these fish

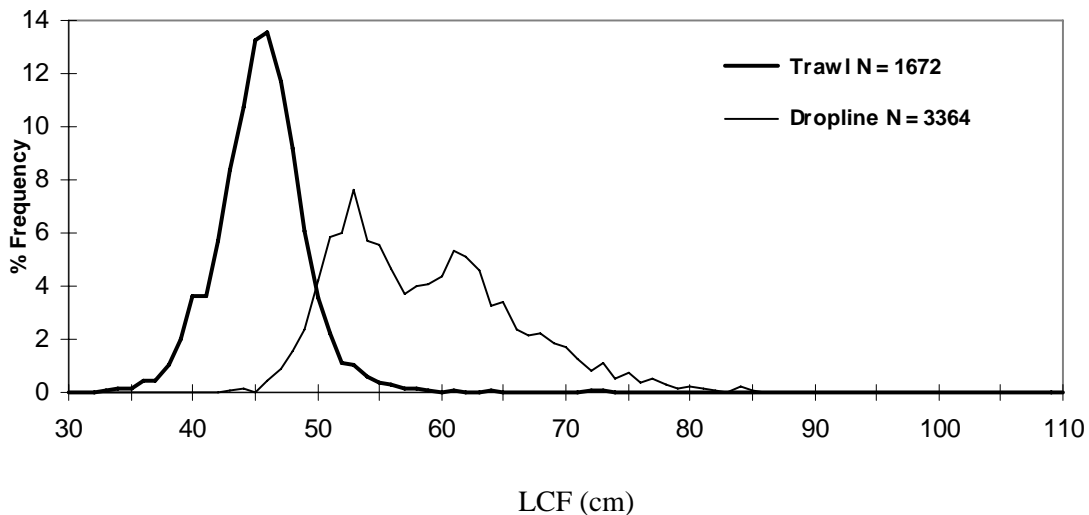
'partial lengths' (PL) were measured from the anterior junction of the two lateral lines to the caudal fork, and the measurements were converted to LCF using the following relationship:

$$\text{LCF} = 1.46 \times \text{PL} + 2.18$$

### 5.3 Results - 1998/99 Summer.

Measurements were obtained from catches of eastern gemfish marketed through the Sydney Fish Market. Most measurements were made during the periods October-November 1998 and February - May 1999, as very few gemfish were marketed during December and January. Results for both trawl and dropline catches are shown in Figure 5.1. Trawl catches during summer were almost entirely comprised of fish from the 1996 cohort (45 - 50 cm LCF), which would be expected to be aged 2+ years. Dropline catches comprised mostly fish between 50 and 70 cm LCF, which would be expected to be aged 3+ to 5+ years (the 1993, 1994 and 1995 cohorts). These are the size / age classes of gemfish generally exploited by the dropline fishery during the summer period.

**Figure 5.1** Size composition of eastern gemfish catches in the summer of 1998/99.



### 5.4 Progress of the 1999 Winter Season

In 1999 the *targeted* TAC for eastern gemfish was again set at zero, and 250 t was allocated to the SEF trawl sector to allow for incidental catches. Catches by SEF non-trawl fishers, and those under state jurisdiction, were subject to trip limits of 50 and 150 kg respectively.

The 1999 winter season was very slow to get underway. The first 'large' catch of spawning run fish was observed from a Lakes Entrance trawler on 15th June. From mid June through to the 25th June, generally small (<100 kg) landings were sampled from NSW trawlers from Eden, Bermagui and Ulladulla. These catches contained a significant proportion of fish from the 1996 cohort (3 years of age, 45 to 55 cm LCF).

During the last week of June larger catches (150 to 250 kg of headed and gutted fish) were sampled from Eden and some Ulladulla vessels also had catches exceeding 100kg. These catches contained a smaller proportion of 3 year old (1996 cohort) fish. Landings by dropline



vessels, which had been sporadic earlier in the season, increased to approach the trip limit, and trawl catches were made by Greenwell Pt boats.

By 5th July catches had increased in the Bermagui area (Jeremy Prince reported a 1 t catch off Tathra) and the Eden boats and the dropliners continued to take significant catches. Some 3 year old female fish were noted with developing gonads, and most larger females were at an advanced stage of development. From about 7th July small quantities of fish were consigned to the processors. The proportion of small fish (<60cm LCF) in the catches from the main NSW grounds was noticeably lower after about 9th July, although catches of small to medium fish continued to be taken by Eden based vessels on the southern-most grounds. A significant deterioration in the weather prevented fishing from 12th - 18th July.

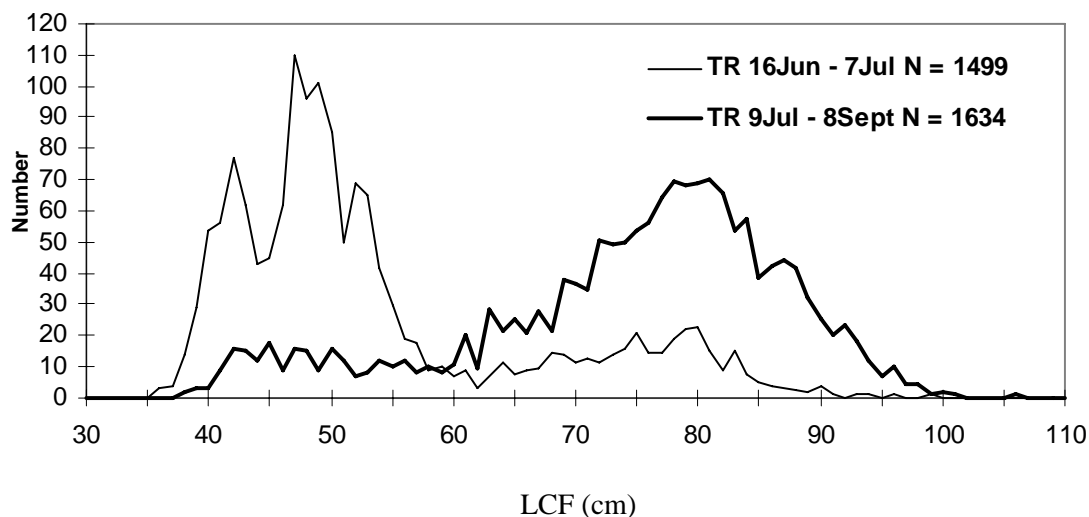
Trawl catches from the Greenwell Pt - Wollongong - Sydney area remained sporadic during late July, with the main catches continuing to come from grounds south of Ulladulla. Dropline catches on the main grounds (Sydney, Kiama and Bermagui) improved in late July and early August, although catches were still somewhat inconsistent from day to day. Trawl catches from grounds north of Ulladulla continued to be sporadic throughout August, with the notable exception of the period 23rd - 25th August, when a spawning aggregation of gemfish was contacted by trawlers from Wollongong and Sydney on a ground ENE of Wollongong. Approximately 20 t of gemfish were landed during this three day period. Sampling indicated a high proportion of the female fish in these catches were 'running ripe' and close to spawning.

During late August and September, trawl catches continued to be low and sporadic. Catches by dropliners on the Kiama ground appeared to be reasonably consistent throughout the latter part of the winter season, although fishers advised that the fish remained 'patchy' and generally difficult to catch. Fish with developing gonads were noted amongst samples from dropline catches throughout September.

### 5.5 1999 Winter Size Composition

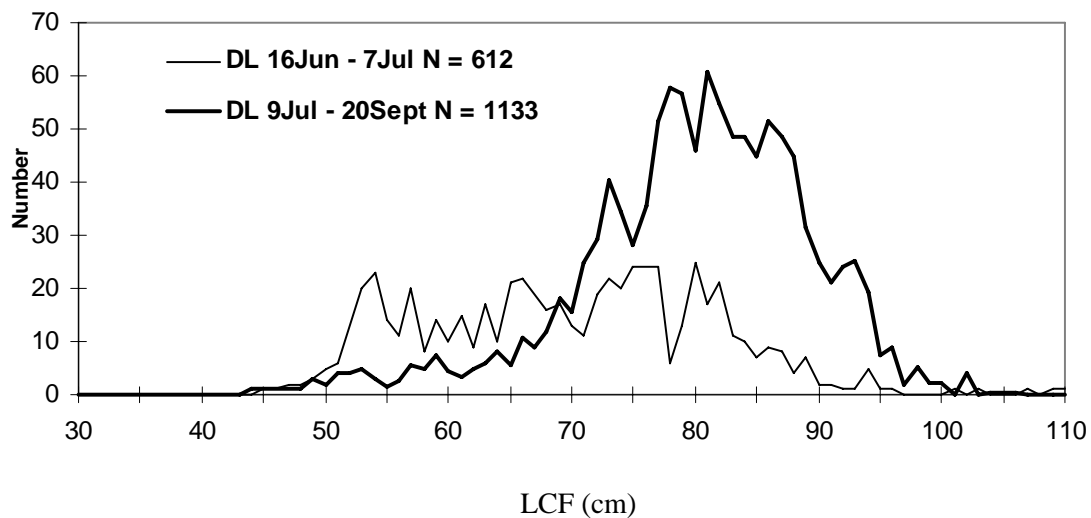
The size composition of gemfish from winter trawl catches is shown in Figure 5.2. Catches during the early part of the 1999 winter season contained a relatively high proportion of small (<60 cm) fish. Trawl landings after 9th July comprised mostly large, mature fish between 70 and 90 cm in length, with a modal length of around 80 cm. A total of 3133 fish were measured from trawl catches during the 1999 winter season.

**Figure 5.2** Size composition of eastern gemfish 1999 winter trawl catches.



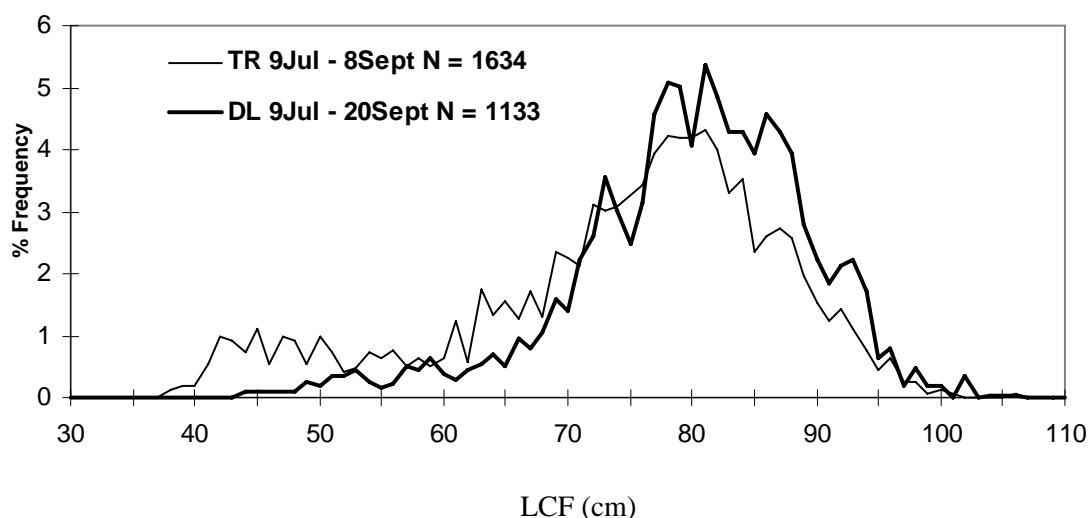
The size composition of dropline catches measured during the winter season is shown in Figure 5.3. During the early part of the season, dropline catches contained a large size range of gemfish, from 50 to 90 cm LCF. After 9th July, dropline catches were comprised mainly of large fish, 70 to 95 cm LCF, with a modal length of 80 - 85 cm. A total of 1745 fish were measured from dropline catches during the 1999 winter season.

**Figure 5.3** Size composition of eastern gemfish 1999 winter dropline catches.



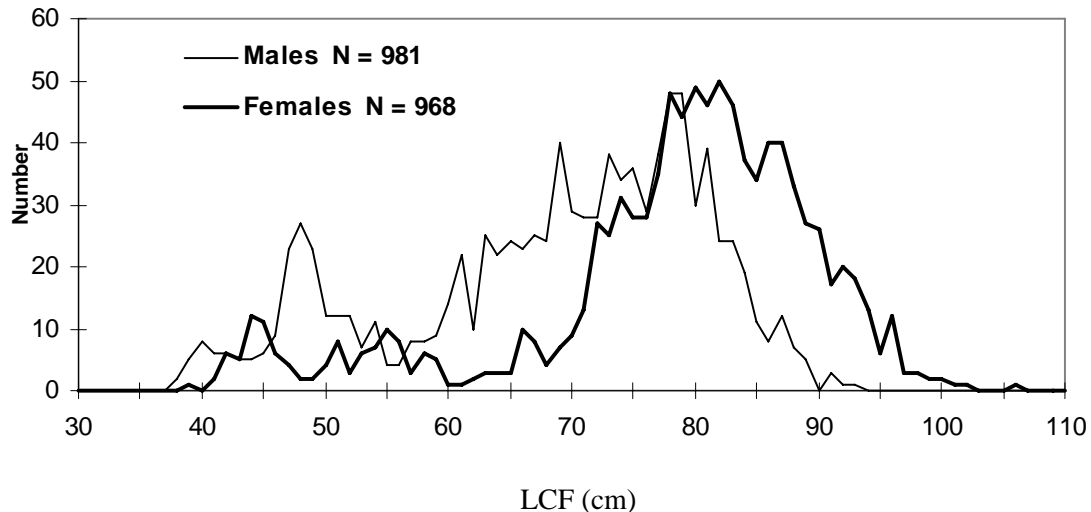
The size composition of gemfish caught by trawls and droplines was very similar during the main winter spawning season from early July to mid September (Figure 5.4). Dropline catches tended to have a slightly lesser representation of smaller (< 70 cm) fish when compared with trawl catches from the same period. Catches by both methods were dominated by fish from 75 to 90 cm in length, and appeared to be deficient in fish from the 60 to 75 cm size classes (these fish would be expected to be 4 to 6 years of age, the cohorts spawned in the years 1993 to 1995).

**Figure 5.4** Comparison of size composition of dropline and trawl catches during the main period of the 1999 winter season.



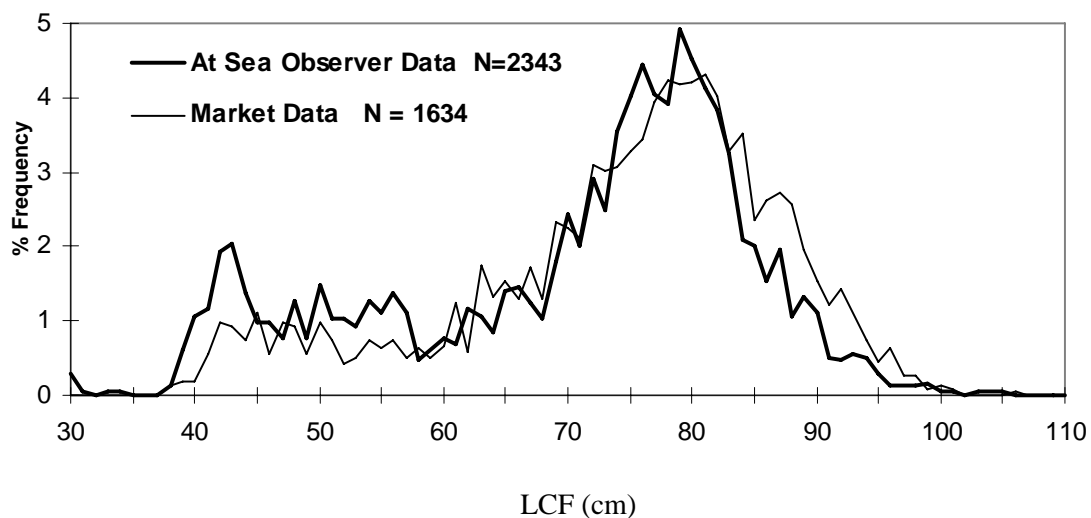
The sexed size composition determined from samples taken during the 1999 winter season is shown in Figure 5.5. Sampling for sex composition of the catch was conducted during the main part of the winter season, from early July to mid September. Females comprised the majority of the catch for fish greater than 80 cm LCF, whereas males predominated in size classes less than 70 cm. Males comprised 50.3% of the fish sexed.

**Figure 5.5** Sexed size composition of eastern gemfish winter catches.



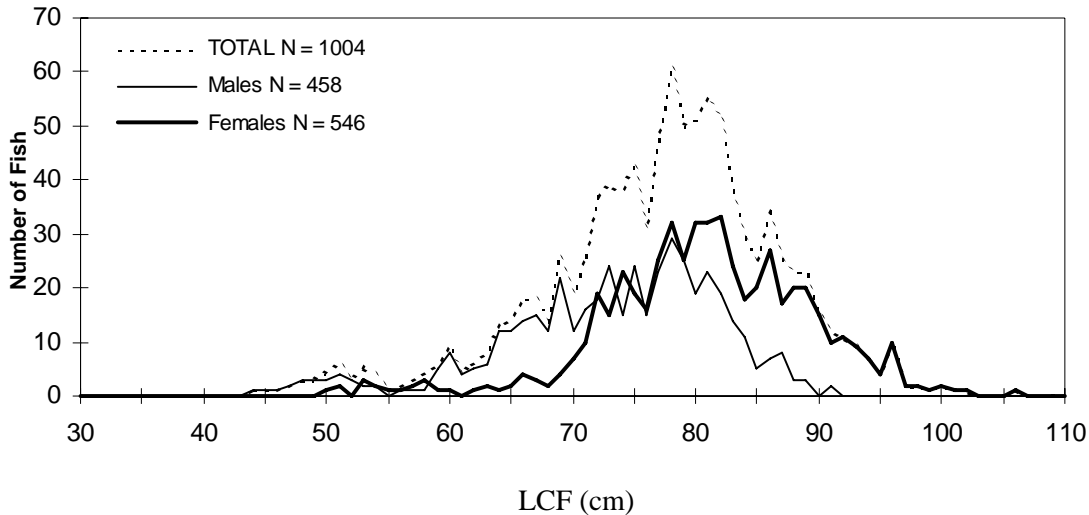
The size composition data from onboard monitoring by the Biospherics observers (from Punt *et al* 1999) was very similar to the size composition determined for landed fish sampled at the markets between 9th July and 8th September (Figure 5.6). The poor representation of fish between 60 and 75 cm LCF in these samples reinforces the conclusion that the cohorts spawned from 1993 to 1995 are relatively poor. Fish from the 1996 cohort (3 year olds, around 50 cm LCF in 1999), although present in early winter catches, were not abundant in catches during the main part of the winter season from July to September.

**Figure 5.6** Comparison of size composition data for 1999 winter trawl catches.



A total of 1004 fish were sampled for otoliths during the winter season. This sample was mainly comprised of fish greater than 60 cm LCF (Figure 5.7), and is considered to be representative of the mature population of gemfish older than 4 years of age in the 1999 spawning season. The otoliths were forwarded to the Central Ageing Facility at the conclusion of the winter season.

**Figure 5.7** Size composition of eastern gemfish sampled for otoliths from 1999 winter catches.



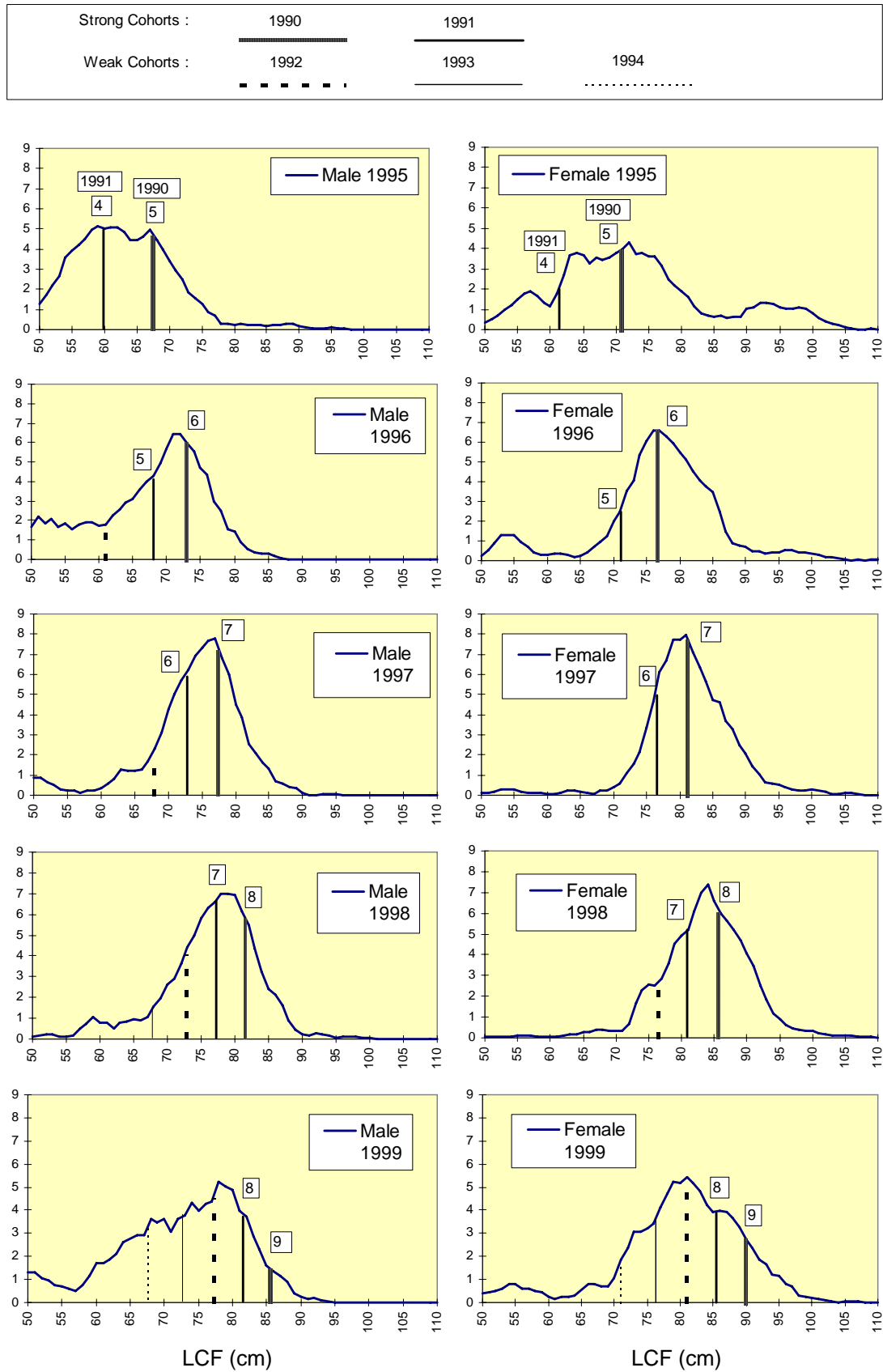
## 5.6 Conclusions

The research project successfully achieved all objectives set for the 1998/99 year, with representative size composition data obtained for eastern gemfish catches during both the 'summer' and 'winter' seasons, and a representative otolith sample obtained from catches during the main winter pre-spawning period. These objectives were met despite sporadic and relatively low catches, especially during the main winter period.

Data from the 'summer' catches were reasonably consistent with the pattern expected for each of the fisheries during the non-spawning period. Dropline catches during the summer period are generally comprised of fish between 50 and 70 cm LCF (mostly 3 - 5 year old fish), and this pattern was maintained during the summer of 1998/99. Trawl catches landed in NSW during the summer period were dominated by 2+ year old fish from the 1996 cohort. The data indicate that the 1996 cohort is more abundant than the cohorts which preceded it (the 1992 - 1995 cohorts, which appear to be in low abundance), however, it is not possible with the data available at the present time to accurately determine the strength of the 1996 cohort, relative to the 'normal' level of recruitment for eastern gemfish.

Data from the winter catches were also consistent with information collected during past winter seasons, and showed that the pre-spawning aggregations of eastern gemfish in 1999 were comprised mostly of fish between 70 and 90 cm LCF. Analysis of the size composition data indicates that fish from the 'relatively strong' 1990 and 1991 cohorts were less abundant in the 1999 catch than was expected (Figure 5.8), and that the majority of fish in winter catches in 1999 were from the relatively poor cohorts spawned from 1992 to 1995.

**Figure 5.8** Size composition of male and female eastern gemfish measured during the winter seasons from 1995 to 1999, with the mean lengths indicated by lines for the relevant cohorts.



In summary, there is cause for grave concern about the current status of the mature population of eastern gemfish, and it is considered very likely that the spawning biomass declined significantly between the 1998 and 1999 seasons. Management decisions should focus on conserving the remaining eastern gemfish and promoting the maximum spawning output from the spawning aggregations which do occur in future winter seasons. Trends in the size of the spawning stock after 2000 will depend entirely on the strength of incoming year classes, and whilst the optimistic view of some in the industry suggests an improvement will occur due to a strong 1996 cohort, there is little quantitative support for this view from the data collected in 1999. A review of the current management of the fishery is recommended, with a view to implementing measures to protect pre-spawning aggregations of eastern gemfish from the effects of fishing.

## 6. OBSERVATIONS ON THE FURTHER DECLINE IN THE EASTERN GEMFISH STOCK.

### 6.1 Introduction

The status of the eastern gemfish stock has been a contentious issue since the first 'stock assessment' was produced in the late 1980s, when annual landings exceeded 3000 t. Catch restrictions for fisheries taking eastern gemfish have been in place since 1988, however it is arguable if recent management measures have led to an effective control of fishing mortality, especially in the years since about 1996 when the last 'strong' age class recruited to the mature population as six year old fish. Earlier calls (Rowling 1998) for more conservative management measures for eastern gemfish went unheeded. However, following a public discussion paper circulated in October 1999, from May 2000 the 'trip limit' for gemfish caught by fishers operating under NSW jurisdiction was reduced to 50 kg. Under Commonwealth jurisdiction non-trawl fishers were also subject to a 50 kg trip limit during 2000, but trawl catches were covered under a 'by-catch TAC' of 200 t, which was allocated to endorsement holders according to their individual gemfish quota holdings.

The best estimates of unexploited biomass of eastern gemfish are in the region of 10-20,000 t (Allen and Rowling, 1998; Punt, 1999). The fishery increased rapidly in the 1970s and annual landings peaked at around 6000 t in 1978-80. Landings remained above 2000t per annum throughout the 1980s, however quantitative assessments (Allen, 1992) indicated a significant recruitment failure occurred during the late 1980s. The reasons for this failure in recruitment remain poorly understood, but a reduction in the biomass of spawning gemfish to around 30% of the unexploited level (probably as a result of fishing) is considered to be a significant factor. From 1993 to 1996 a zero TAC was in place for trawl catches of eastern gemfish, and total winter fishery landings (by all methods) were estimated to range between 400 and 1000 t during these years. In 1997 a targeted fishery for eastern gemfish was reinstated with a TAC of 1000 t, but landings amounted to less than 400t. Incidental catches of eastern gemfish by all sectors were estimated to be about 300 t in 1998 and 200 t in 1999; in 2000 it appears that landings will be significantly less than 100 t (Punt *et al.*, 2000).

Recent quantitative assessments (Anon., 1999) of the status of the eastern stock of gemfish cover a range of plausible scenarios, and estimate the biomass of mature fish in 1999 to be between 700 and 2600 t. Projections of biomass levels for four specified catch scenarios (Figure 2 of Anon., 1999) showed a decline in biomass to a minimum during 2000, followed by "*some recovery thereafter, driven by the 1996 year class entering the winter run*". However, these assessments have not been able to fit recent size and age composition data for the mature population at all well, prompting examination of the possibility of an increase in natural mortality to explain the sudden disappearance from the catch of the relatively strong 1990 cohort in the 1999 season (Punt, 2000). After dismissing this explanation, the draft assessment prepared following the 2000 winter season has invoked a "mortality event" of unknown cause to better fit the recent data.

In this brief paper an interpretation of the indicators available from monitoring of gemfish catches during the past few years is used as a basis to develop an alternative assessment of the likely current status of the mature population of eastern gemfish, which is consistent with the

observed size composition and catch information generated during the 1999 and 2000 seasons.

## 6.2 Catches by the Trawl and Dropline Fisheries

The catch of eastern gemfish taken by the winter trawl fishery can be used to broadly indicate trends in the mature population size, even under a zero targeted TAC. This is because a reasonable amount of trawling has occurred each season in the gemfish depth range (350 to 450 m), irrespective of whether the fishing was targeted at gemfish or not. During the first period when the TAC was set to zero (1993 to 1996) a 'trip limit' policy was applied to allow landing of gemfish by-catch, and fishers advised it was difficult to avoid large incidental catches of gemfish. Trawl *landings* of gemfish during this period declined from about 200t to about 50t, before increasing again to 200t in 1996 as the 1990 cohort recruited to the mature population. Estimates by the Eastern Gemfish Assessment Group (EGAG) of discards (reported by Punt *et al.*, 2000) indicated that actual catches during this period may have declined from 400-1000 t to 170-400 t before increasing to 450-490 t in 1996 (the ranges reflect the differing views within EGAG about discards and unreported catches). It is clear that, even though the TAC was zero, incidental trawl catches were a minimum of 200 t per winter season before the full recruitment of the 1990 cohort, and at least 450 t in 1996 when fish in the 1990 cohort were six years of age.

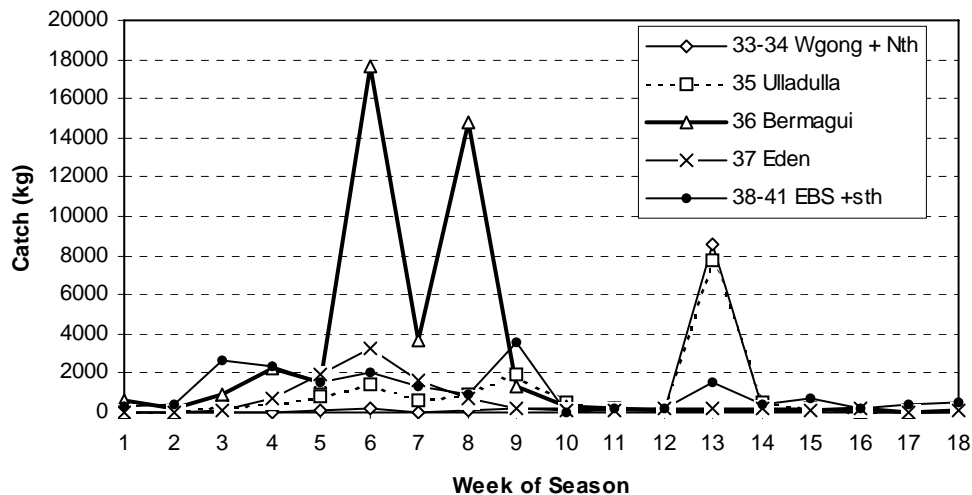
It is significant that in the 1997 season when the fishery was opened with a 1000 t TAC, a **highly targeted** trawl fishery only caught about 350 t of eastern gemfish. Acceptance of suggestions that "bad weather or oceanographic factors" led to this poor catch (and the poor standardised catch rates achieved during the 1997 fishery) ignored the possibility that the biomass of newly recruited fish was in fact much lower than had been estimated by the population models. If this was the case, then the 'by-catch' (c. 450t) in 1996 and the targeted catch (c. 350t) taken in 1997 may have removed a large proportion of the incoming cohort before the fish reached full recruitment at 7 years of age. (Note that the dropline fishery also took about 300t of gemfish from the stock between 1995 and 1997, and a proportion of this catch would also have been from the 1990 cohort).

In 1998 the (all methods) winter catch of about 300 t again contained a significant number of fish from the 1990 cohort, and the weaker 1991 cohort also formed a large part of the catch (see Table 5 in Punt *et al.*, 2000 and also Figure 4.5 in this report). Fish from these two cohorts were estimated to comprise 61% of mature males and 67% of mature females in the 1998 winter catch of gemfish.

The pattern of trawl catches in the 1999 winter season showed two interesting factors (see Figure 6.1). Relatively high daily catches, ranging from 200 kg to 2 t per boat, were consistently reported by Bermagui based trawlers during weeks 6 and 8 (between 4th July and 23rd July). Trawl landings of 53 t were reported during this period, about 70% of which was taken by Bermagui based vessels. In late August a single peak in catches was also reported during week 13 (23rd to 25th August) which resulted from contact with a spawning aggregation on grounds ENE of Wollongong. Catches by a number of Sydney and Wollongong based trawlers contributed to a total catch of 16 t during this period. In all other areas reported catches were generally less than 2 t per week, with trawlers apparently able to avoid large incidental catches. One way of interpreting these data is that few pre-spawning fish made it to grounds north of Bermagui during the 1999 season, with the exception of the single spawning aggregation contacted on 23-25th August.



**Figure 6.1** Distribution of gemfish catches by week and latitude block for the 1999 winter season (from SEF 1 logbook data).



Trawl catches during the 2000 winter season were reported to be uniformly very low. This was generally unexpected by industry, given some encouraging signs (water temperatures, currents etc) observed early in the season, and gave rise to numerous comments about the likely causes.

The total catch by NSW dropliners declined from >100t in 1998 to about 75t in 1999. It is not known if reduced availability / abundance contributed to this decline. Dropline catches after May 2000 were affected by the imposition of the 50 kg trip limit, which apparently led to a very large reduction in the amount of dropline fishing effort targeted at eastern gemfish. It is likely that the NSW dropline catch of eastern gemfish in the 2000 winter season was very much smaller than in previous years.

### 6.3 Use of Catch Rate as an Abundance Index

In the absence of a fishery independent method for estimating biomass, the catch rate of the winter fishery has been used to index the abundance of mature eastern gemfish. Standardised catch rates of around 3 t per vessel per day were common in the 1970s and early 1980s, but by the early 1990s this index had declined to around 1 t per day, and there was evidence of a marked shortening of the period of peak catches during the winter season (Rowling, 1998). Interpretation of daily catch rate data was confounded by the significant reduction in the TAC in the early 1990s, and by the aggregating and migratory behaviour of eastern gemfish. A trawl survey designed to yield comparative catch rate data in 1996 produced a standardised estimate of 1.37 t per standard day, whereas the estimate obtained from selected vessels operating in the open fishery in 1997 was 0.64 t per standard day. Application of generalised linear modelling techniques to shot-by-shot catch rate data for eastern gemfish suggested a 70% decline in catch rates during the winter seasons between 1987 and 1998 (Larcombe, 1999).

Catch rate data for mainly juvenile gemfish taken during the summer months are not considered to usefully index relative abundance, and no adequate recruitment index exists for the eastern gemfish fishery. It is therefore not possible with the data currently available to accurately judge the strength of incoming cohorts until they are close to fully recruited to the mature population (and an adequate measure of relative abundance has been obtained for that population).

The failure to carry out targeted trawl surveys in the winters of 1999 or 2000 means that a defensible index of current mature biomass has not been obtained since 1998. Even if results from a targeted survey were available, it is uncertain if the type of survey undertaken to date adequately indexes the population abundance of eastern gemfish at very low stock sizes (the highly aggregated nature of pre-spawning eastern gemfish means that the daily catch rate is likely to remain relatively high until an aggregation can no longer be found).

#### 6.4 Observer Data

A large volume of data are now available from onboard observers for the years since 1993, although it is difficult to quickly compare the results because of differences in sampling design and data stratification. Observers funded by the Fisheries Research and Development Corporation and The Australian Fisheries Management Authority covered boats working from the ports of Ulladulla and Eden for the years 1993 to 1997 (results were summarised by Liggins, 1997). Table 6.1 summarises the results for eastern gemfish.

**Table 6.1** Estimated total and discarded catches of gemfish from on-board observations made between 1993 and 1997 (from Liggins, 1997).

Year	Total Gemfish Catch Estimated for Eden + Ulladulla t	Estimated Discarded Catch of Gemfish t	Approximate Catch Rate kg/day		
			Retained	Discarded	Total
1993	487	397	30	120	150
1994	88	37	20	15	35
1995	35	3	15	2	17
1996	39	6	17	3	20
1997	181	17	70	10	80

The size composition data collected by observers from 1993 to 1997 provides some insight into the discarded catch throughout each of these years, but sample sizes were small for the latter years in the period. In general, catches during 1993 and 1994 contained a high proportion of fish in the 40-70 cm size classes (indicative of the strong 1990 and 1991 cohorts, which were 2 to 4 years of age in these years). Few fish less than 2 years of age were observed in catches during the period 1993 to 1997.

In 1998 and 1999, observers employed on the Integrated Scientific Monitoring Program collected information which was summarised according to SEF statistical zones (Knuckey and Sporicic, 1999; Knuckey 2000). A summary of the results for eastern gemfish is given in Table 6.2. A significant decline in catch rate of eastern gemfish was observed between 1998

and 1999 in all areas, and especially off eastern Tasmania, where large fish comprised the bulk of catches in 1998. In 1998, discarded fish comprised 9% and 11% of the gemfish catch (by weight) in eastern zones A and B respectively, and size composition data indicated these fish comprised both 1 and 3 year old fish. In 1999, discards increased to 24% in zone A, which was largely comprised of 1 year old fish. The observer data are consistent with a decline in the relative abundance of large gemfish, and an increase in the discard rate (due to discarding of small unmarketable fish) in trawl catches since 1998.

**Table 6.2** Approximate catch rates (kg/shot) of eastern gemfish in SEF statistical zones in 1998 and 1999, from onboard observations carried out for the Integrated Scientific Monitoring Program (Knuckey and Sporcic, 1999; Knuckey 2000).

Year	Eastern Zone A			Eastern Zone B			Eastern Tasmania		
	Ret.	Disc.	Total	Ret.	Disc.	Total	Ret.	Disc.	Total
1998	45	5	50	70	15	85	180	-	180
1999	20	8	28	20	4	24	16	-	16

### 6.5 Size Composition Data

Figures 6.2 and 6.3 summarise the size composition data for landed catches of eastern gemfish for both trawl catches for June-July, and dropline catches for May-June-July, for each year from 1996 to 2000. Both sets of data strongly suggest that the relative abundance of mature gemfish has significantly declined in 1999 and 2000. The trawl data suggest that this was not due to the recruitment of a strong 1996 cohort – in fact the 1996 cohort appears to be only marginally more abundant than the poor cohorts which now dominate the mature population. The most abundant size classes of eastern gemfish present in trawl catches during the main part of the winter season in 2000 were fish smaller than 45 cm LCF (2 year old fish), the majority of which are immature and not capable of spawning effectively.

### 6.6 Conclusions

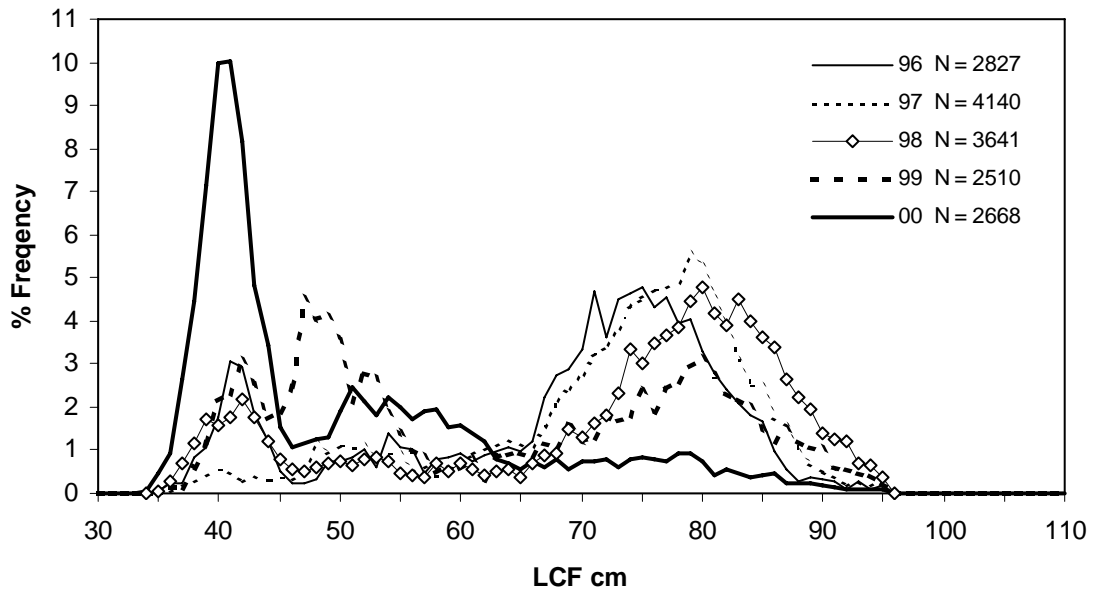
The above data are consistent with the progressive fishing out of the newly recruited 1990 and 1991 cohorts as they recruited to the mature population between 1996 and 1998. Fish from these cohorts are now no more abundant than the poor cohorts which followed them, and this is why the size composition of large gemfish (>60 cm LCF) consists of a 'flat scattering of all size classes' in the 2000 samples.

The absolute strength of the 1996 cohort (on which any 'rebuilding' of the mature population will depend) remains uncertain as they are not yet fully recruited to the mature population. However, there are strong indications that fish from this cohort are much less abundant than was the case for fish from the 1990 cohort.

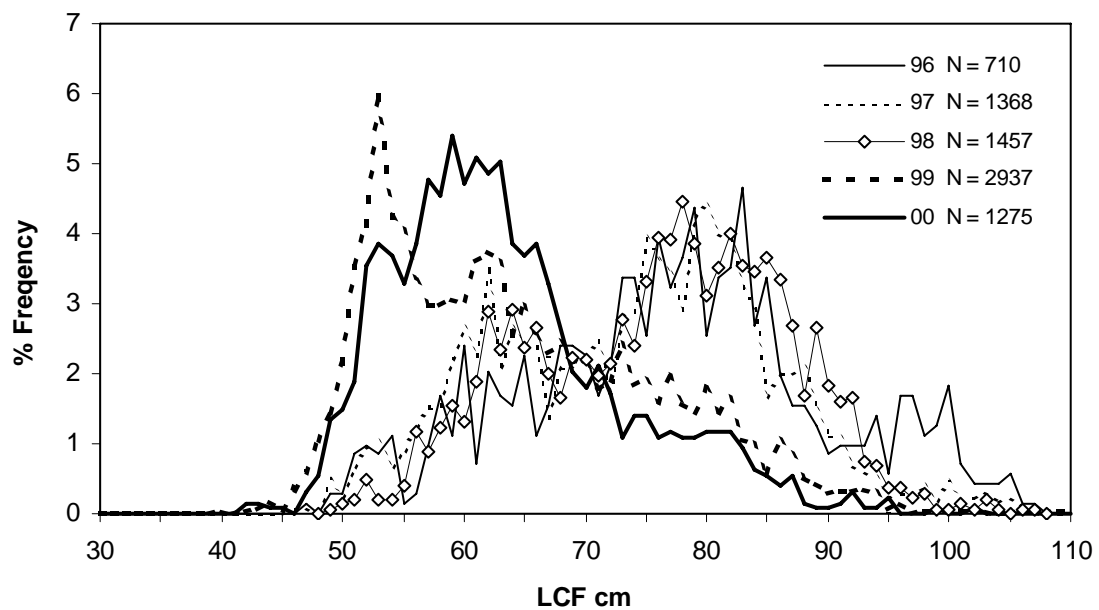
It is concluded that the current spawning population of eastern gemfish has collapsed to a dangerously low level, and trawling continues to catch large numbers of juvenile fish before they have a chance to mature and contribute to the spawning population. There are strong indications that recent management practices have seen a further reduction in the population of mature eastern gemfish, and more conservative management measures should be considered - these measures should be aimed at protection of the pre-spawning aggregations

of eastern gemfish, and more appropriate gear regulations to minimise the capture of juvenile gemfish.

**Figure 6.2** The size compositions of trawl catches of eastern gemfish marketed in Sydney during June and July, for the years 1996 to 2000.



**Figure 6.3** The size compositions of dropline catches of eastern gemfish marketed in Sydney during May, June and July, for the years 1996 to 2000.



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