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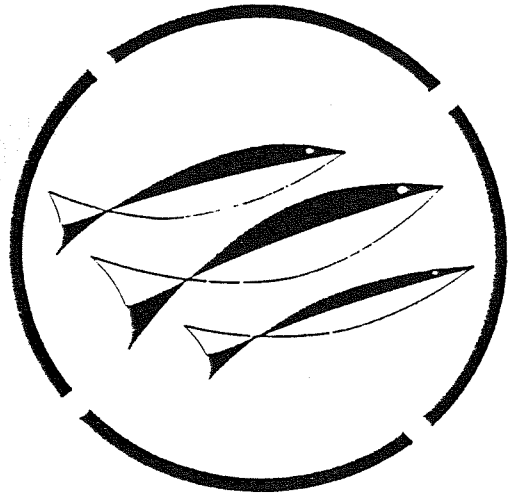

ONBOARD OBSERVATION OF THE 1989 GEMFISH FISHERY.

Final Report, FIRDTF Project 88/126

K. R. ROWLING, D. C. SMITH, F. A. LAURENSON, L. BROWN and M. BROADHURST

August, 1990.

NSW Agriculture & Fisheries

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Final Report - FIRDTF Project No. 88/126

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INTRODUCTION

The fishery for spawning run gemfish (*Rexea solandri*) occurs from May to September each year along the edge of the continental shelf between eastern Bass Strait and central New South Wales. In 1988, a Total Allowable Catch of 3000 tonnes was imposed on the fishery (Anon. 1988), following the results of research which showed there had been a significant change in the composition of the spawning stock catches since the fishery was first developed in the mid 1970's (Rowling 1987). This research was part of a larger project investigating the N.S.W. trawl fishery as a whole, and sampling was conducted mainly at the Sydney Fish Markets, because of its central location and through-put of fish from most areas of the fishery.

In August 1988, during discussions with industry representatives regarding the results of research on gemfish, concern was expressed at the small amount of sampling undertaken aboard commercial fishing vessels. It was claimed that catches of gemfish were frequently sorted aboard the vessel, the larger fish being sent directly to processors, which may have caused a bias in samples taken solely at the Sydney Fish Markets. It was also suggested that a significant quantity of small gemfish were discarded at sea, and this could have altered the estimation of the size composition of the actual gemfish catch. Additionally, questions were raised about the reliability of catch per trawler-ton-day as an indicator of gemfish abundance, as it did not take into account increased time spent 'queueing' while waiting to shoot the nets on the narrow gemfish grounds.

A special meeting of the Demersal and Pelagic Fish Research Group was held in October 1988, to review the results of research on gemfish up to and including the 1988 season. At that meeting the group recognised the need for collection of length frequency and catch composition data aboard gemfish fishing vessels, and accorded the work a high priority. Application was made to the Fishing Industry Research and Development Council for funding to allow three observers to carry out at-sea measurement of gemfish catches during the 1989 season. The project was jointly undertaken

by staff from N.S.W. Agriculture & Fisheries and the Victorian Department of Conservation, Forests and Lands (now the Department of Conservation and Environment).

The objectives of the study were -

* To describe the fishing practices used in the winter gemfish spawning run fishery, especially the methods and degree of 'searching', the incidence of 'queueing' and the factors influencing sorting of the catch and discarding of unwanted catch.

* To determine the size, length frequency and composition of gemfish catches in relation to depth, time of day, area fished and stage of the season.

This report summarises the observations made during the 1989 gemfish season, and discusses the significance of the results in relation to assessment of the state of the gemfish stock. The difficulties encountered during the course of the study are outlined, together with suggestions to overcome these difficulties if observer coverage of future gemfish seasons is planned.

METHODS

Three observers visited the main ports between Lakes Entrance and Sydney during the period June-September 1989. The movements of the observers reflected as far as possible the northerly movement of the main concentrations of gemfish, commencing in mid June in the Eden/Lakes Entrance area and gradually moving northward to the area off Sydney by early August. Observations were also made of "post-spawning" catches of gemfish during late August and September.

At each port, the observers approached trawl fishermen, informed them about the study, and asked if they would be willing to participate by taking an observer on board for one day while targeting on gemfish. Participation in the study was entirely on a voluntary basis. An attempt was made to make contact with the skipper of every trawler holding gemfish quota in each port.

At sea, observers recorded details of fishing activity and the

catch on a standard report form, a copy of which is attached as Appendix 1. Basic information was collected on the vessel, its crew and fishing gear. From observation and discussion with the skipper, methods of locating fishing areas, time spent searching and the incidence of queueing and competition between vessels were noted. The depth, time of day and location of each shot were recorded and the species composition of the catch was noted. Gemfish in the catch were sexed, and for each fish the length to caudal fork (LCF) was measured to the nearest whole cm below the true length. Large catches were sub-sampled while the catch was being sorted and boxed, with fish being measured from all sections of the catch, where possible. Attempts were also made to ascertain the quantity and species composition of discarded catch.

Catch rate, mean size and sex ratio of gemfish were analysed against the depth, latitude and time of day at which the fish were caught. Where depth changed during the shot, the mid point of the depth range was used in analysis of the results. The length frequency distributions of gemfish catches measured at sea by the observers were also compared with measurements made at the Sydney Fish Markets and at Poulos Brothers processing factory at Unanderra.

RESULTS

Observations were made on a total of 50 shots (mean duration 4.0 hr) aboard 21 different vessels, between 14th June and 19th September, 1989. Gemfish comprised 69% of the total catch of all species from all shots, with gemfish catches ranging from a few fish to over 4 tonnes in a single shot. The species composition of the catch from all shots observed is shown in Table 1, and the distribution of gemfish catch rates for individual shots is shown in Figure 1.

Fishing Practices

All target fishing for gemfish was carried out on well defined trawl grounds at depths in which good catches had previously been taken. Common practice was to steam to a known ground and have the net in the water by 6.30 am, as the dawn shot was considered by most fishermen to be the most productive for gemfish. Although echo

sounders were used universally for showing water depth and indicating the presence of fish on the grounds selected, they were rarely used to actually search for concentrations of fish prior to shooting the net. Active searching was carried out on only one occassion while an observer was on board, and the resulting shot yielded only 2 boxes of gemfish.

The species composition of the catch was sometimes used as a guide to determine the depth of the next shot, e.g. if the catch contained a high proportion of blue grenadier, the next shot was generally at a shallower depth, as blue grenadier are known to prefer a slightly greater depth than gemfish.

The fact that target fishing for gemfish was carried out on reasonably well defined trawl grounds, which are limited in size, led almost inevitably to competition between vessels intending to fish the same ground. In many cases the trawlable area was large enough to allow competing vessels to spread out and maintain an adequate separation between boats. The level of co-operation between vessels in this situation varied. However, in a number of instances vessels were observed to have to wait to shoot their nets. This occurred in 9 (18%) of the shots observed - in 6 cases the vessel had to wait less than 1 hour, however in 3 cases waiting times of 2 to 2.5 hours were recorded. Such queueing was observed on fishing grounds off all major ports from Eden north.

Catch Composition

Gemfish comprised nearly 70% of the catch from the observed shots. The main species taken as a by-catch with the gemfish were mirror dory, blue grenadier, ling and southern frostfish (which were mostly discarded).

Catch variation with depth.

The observed shots were carried out at depths ranging from 290 to 550 m. Over 70% of the gemfish catch was taken in 38% of the shots at depths between 350 and 385 m (Table 2). Only 4 shots were observed at depths greater than 450 m - these trawls caught only 750 Kg of gemfish (less than 2% of the total catch of gemfish from all shots observed).

Relatively high catch rates (>500 Kg/hr) were recorded for shots at depths ranging from 310 to 385 m, although there is considerable variation in catch rate between shots within this depth range (Figure 2).

Although there was a significant relationship between the percentage of female fish in the catch and the depth of the shot (Figure 2), there was considerable variation about the regression ($t=4.06$, d.f.=46, $p<0.001$, $r^2=0.268$). If this analysis is restricted to the depth range over which most of the catch is taken (340 - 420 m) no significant relationship is found between sex-ratio of the catch and depth of shot ($t=0.717$, d.f.=33, $0.20<p<0.50$, $r^2=0.015$). A similar result is obtained for the relationship between mean length of the catch and depth of shot - a statistically significant relationship is obtained using data for all depths observed, however no significant trend is found over the depth range 340 - 420 m (Appendix 2).

Catch variation with latitude.

Observations were distributed across a range of latitudes from 38°S to 34°S. The highest catch rates were recorded in the more southern latitudes (Figure 3) although the range of catch rates in these latitudes was also very large. High catch rates were not observed in the more northern latitudes, possibly due to the fact that fewer shots were observed in this area due to bad weather and the apparently rapid movement of the fish. The trend in catch rates shown in Figure 3, although significant at the 5% level, should therefore be interpreted with caution.

The proportion of female fish in catches increased from south to north, but again there was considerable variation about the regression ($t=-3.09$, d.f.=46, $p<0.005$, $r^2=0.172$). The mean size of gemfish caught was relatively constant over the range of latitudes observed (Figure 3).

Catch variation with time of day.

As mentioned previously, the preference of fishermen was to commence trawling by about 6.30 am, so as to have the gear on the bottom and fishing when the gemfish descended in the water column to near the sea floor just after sunrise. On many of the trips

observed, only a single dawn shot was made, thus limiting the information available regarding variations in catch rate and composition with time of day. For the data avaiable, observed mean catch rates (and peak catch rates) were actually highest in shots commenced after 10 am (Table 3). However, large standard deviations (due to big variations in catch rates between shots) mean that this result is not statistically significant, and catch rates for all the time periods analysed are more or less equal. This conclusion is still at variance with common industry perception that the dawn shot is superior.

The same general conclusion is reached if the analysis is restricted to the best 5 shots in each time period (to exclude the relatively large number of shots with poor catch rates). It should be noted, however, that all the shots with high catch rates occurred on the southern grounds, and the relationship between catch rate and time of day may not be the same on the more northern grounds, for which only limited data were available.

Little difference was found in mean size of fish caught at different times of the day (Table 4), however there was a slight decrease in the proportion of female fish in catches taken later in the day.

Catch length frequency.

Lengths (LCF) of 6483 gemfish were measured onboard by observers during the 1989 season, of which 2828 were males, 3618 were females and 38 were small fish not sexed. The overall sex ratio in the catches observed was therefore 1 male : 1.28 females (females comprised 56% of the catch, by number). There is considerable variation in the sex ratio of individual catches, with the proportion of females ranging between 40% and 80% from single shots.

Length frequency distributions for gemfish measured from pre-spawning catches are shown in Figure 4. On average, female fish are larger than male fish, with very few females in the observed catches less than 70 cm LCF. Fish greater than 90 cm LCF are almost all females. Size distributions of fish from post-spawning catches are similar to those from pre-spawning catches (Figure 5). Females

were more predominant in post-spawning catches (67% females, by number), however sample sizes for each sex are only small.

The length frequency distribution of fish retained from pre-spawning catches, measured onboard by the observers, is very similar to the distributions for fish measured at the Sydney Fish Market and at the processing factory during the same period (Figure 6). Mean lengths determined for each of these sets of measurements differed by less than 0.5 cm.

Sorting of the Catch

The number of small (less than 50 cm LCF) gemfish caught in observed trawls was very low - approximately 100 fish out of a total catch of about 13,000. These smaller fish were sometimes discarded, and sometimes kept for bait or added into the main catch of gemfish "to make up box weights". No grading of fish (for different markets) was observed.

Discarding of unwanted catch

Most of the by-catch was kept for sale. Apart from the small gemfish mentioned above, species frequently discarded included southern frostfish, small whiptails, spiny flathead, skates (family Rajidae) and small crustaceans (mostly crabs, family Portunidae). It was often difficult to make an accurate estimate of the discarded catch because the observer's main efforts were directed at measuring and recording the gemfish catch, and the other retained species, and because discards were thrown straight over the side as the catch was sorted! During the study, it was estimated that discards from observed shots totalled approximately 4.5 tonnes, or 7% by weight of the total catch taken.

DISCUSSION

This study represents the first application of onboard observers in the South East Trawl Fishery. Although the study was initiated in response to industry requests for information to be collected aboard the catching vessels, the level of co-operation from individual fishermen varied considerably. Most skippers approached were happy to participate, and considerably assisted the observers,

once the aims and background to the study had been explained to them. However, there were many who could see no direct benefit from the work and were reluctant to participate, and some who flatly refused to have the observers on their vessels. Lack of co-operation seemed to be associated with the following main factors:

i) a lack of advance publicity about the observer study, which clearly set out the reasons behind the study, its aims and the fact that it had no connection with monitoring the recently introduced individual vessel quotas;

ii) disenchantment of fishermen with the management of the gemfish fishery, the imposition of quotas, and the general "intrusion" of government into their day to day operations.

Even when good co-operation was obtained from fishermen, a number of other factors intervened to reduce the level of coverage of the fishery by the observers. Bad weather was perhaps the most common (and frustrating) of these factors, but difficulties in contacting owners/skippers between trips, the locally unpredictable occurrence of high catches, and the short period over which high catches were made at any one port all contributed to the problem of achieving a good coverage of the fishery. Although the observers collected data from only 50 shots targetted at gemfish during the season, these shots were reasonably well distributed spatially and temporally and are considered to be representative of the fishery during the 1989 season.

The major findings of the study were as follows:

1. Target fishing for gemfish took place on known grounds at times and depths which had been previously successful. Very little 'searching' for fish concentrations was observed.

2. 'Queueing' of vessels to fish the same ground occurred frequently, although only in about 20% of cases did the vessel have to wait to shoot the fishing gear, and waiting times were generally short. The success of the shot did not appear to be related to the position of the vessel in the queue.

3. No size-selective sorting of the gemfish catch was observed, with the exception that a few very small fish (<40 cm LCF) were discarded.

4. Catch rates of gemfish showed considerable variation between shots. Catch rates in excess of 500 Kg/hr were observed for shots at depths between 320 and 380 m, and for latitude blocks from 36°S to 38°S. Although industry perception was that dawn shots produced superior catch rates for gemfish, this was not supported by the results for those shots observed.

5. The mean length of gemfish caught showed no significant variation with changing latitude, but showed a slight increase with increasing depth (though this trend was not significant over the depth range 340 - 420 m).

6. The proportion of female fish in the catch increased with increasing depth and with decreasing latitude, and showed a slight decline for shots commenced after about 7am. However, large variations in sex-ratio were found between shots in all locations, making interpretation of these trends difficult.

7. Apparent poor recruitment of four year old gemfish (mean length about 60 cm LCF) to the 1989 spawning run may have influenced the conclusions drawn above.

The results indicate that, in the 1989 season, there was no sorting or discarding of gemfish aboard commercial trawlers that would have produced a bias in measurements made at the Sydney Fish Market. This result may have been complicated by the apparent absence of four old fish from the 1989 catch, which caused an increase of nearly 4 cm in the mean size of fish in 1989 compared with the previous season. However, it is important to note that this increase in mean length was also observed for gemfish measured at the Sydney Fish Market during the 1989 season.

The size composition of gemfish in observed catches showed only minor variations between different shots, areas or times of the season. This result is at variance with previously available information, which suggested that smaller fish (<70cm LCF) were more prevalent in catches from the southern grounds. The apparent

absence of the 4 year old cohort may also have reduced the impact of such a distribution on the composition of the 1989 catch.

There was considerable variation between shots in both the catch rate and the sex-ratio of the gemfish catch. The degree of variation between shots, combined with the relatively low frequency and uneven distribution of observations, made it difficult to ascribe a high level of significance to trends which were found in both catch rate and sex-ratio of catches. In general it could be said that, for the depth range over which the highest catches and catch rates of gemfish occurred, there were no significant trends in catch rates or sex-ratio of the catch. Male fish tended to comprise a higher proportion of catches at shallower depths, and females were more significant in catches from greater depths, however catch rates (and therefore catches) of gemfish outside the main depth range were low.

Assessment of the effect of "queueing" on the historical CPUE analysis was also complicated by the relatively large variations observed in catch rates between shots. Catch rate did not appear to be related to the position of a vessel in a queue, nor to the time of day that the shot was commenced. Trawlers were actually delayed in their fishing operations on less than 20% of the days observed, and the average delay was less than one hour. Such results do not support the contention that estimates of fishing effort used in previous analyses have been significantly biased because of interaction between vessels.

In summary, the results of the observer study support the representative nature of the data on which the current assessment of the gemfish stock is based. Detailed information was obtained on the fine-scale variations in structure of the gemfish spawning run during the 1989 season, however at this stage the usefulness of this information in a comparative sense is limited because such data are only available for the 1989 season.

ACKNOWLEDGEMENTS

The authors would like to thank those owners/skippers who participated in the study, and all those on shore who assisted with organising contacts, provision of information, etc.

The study was funded by Fishing Industry Research and Development Trust Fund grant number 88/126.

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Table 1. Species composition of the catch recorded by observers from all gemfish target shots. * signifies species mostly discarded

Species	Weight (tonnes)	% of catch
Gemfish *Rexea solandri*	44.4	68.8
Mirror Dory *Zenopsis nebulosus*	5.7	8.8
Blue Grenadier *Macruronus novaezelandiae*	3.5	5.4
Southern Frostfish *Lepidopus caudatus**	3.5	5.4
Ling *Genypterus blacodes*	2.9	4.5
Whiptails Family *Macrouridae**	1.0	1.5
Sharks Family *Squalidae*	0.8	1.2
Ocean Perch *Helicolenus sp.*	0.4	0.6
Warehou *Seriolella spp.*	0.4	0.6
Royal Red Prawns *Haliporoides sibogae*	0.2	0.3
Spiny Flathead *Hoplichthys haswelli**	0.18	0.28
Squid *Nototodarus spp.*	0.1	0.15
Jackass Morwong *Nemadactylus macropterus*	0.06	0.09
Other species of fish & invertebrates*	1.4	2.17

Table 2. Depth distribution of observed gemfish target shots and total gemfish catch within each depth zone.

Depth Range meters	Number of Shots	Gemfish Catch tonnes	%
<350	14	5.41	12.2%
350 - 385	19	32.50	73.2%
386 - 450	13	5.75	12.9%
>450	4	0.75	1.7%

Table 3. Catch rate (CR) of gemfish observed for shots commenced at different times of the day.
For mean catch rates, standard deviation is shown in parentheses.
* - latest recorded shot time was 2.30 pm

Time shot commenced	No. of shots	Mean CR Kg/hr	Mean CR of best 5 shots Kg/hr	Peak CR Kg/hr
Before 7 am	22	210 (227)	563 (161)	724
7 am - 10 am	12	163 (237)	345 (288)	759
After 10 am*	16	267 (281)	600 (274)	880

Table 4. Mean length and sex-ratio of gemfish catches from shots commenced at different times of the day.
n - number of fish measured.
* - latest recorded shot time was 2.30 pm.

Time Shot Commenced	No. of Shots	Mean LCF cm	Sex-Ratio M : F ; %F
Before 7 am	22	73.3 (n=2576)	1 : 1.36 ; 57.6%
7 am - 10 am	12	72.9 (n=1267)	1 : 1.22 ; 54.9%
After 10 am*	16	73.5 (n=2135)	1 : 1.15 ; 53.5%

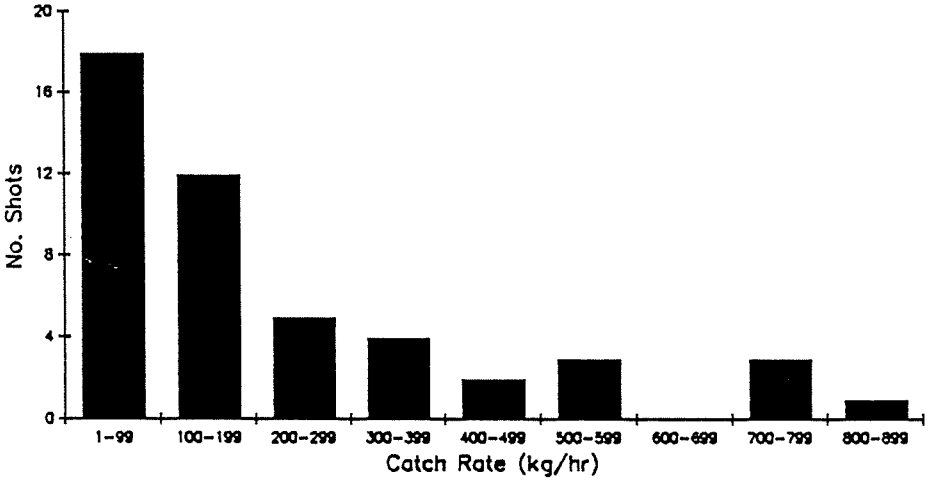

Figure 1. Distribution of gemfish catch rates for individual shots observed.

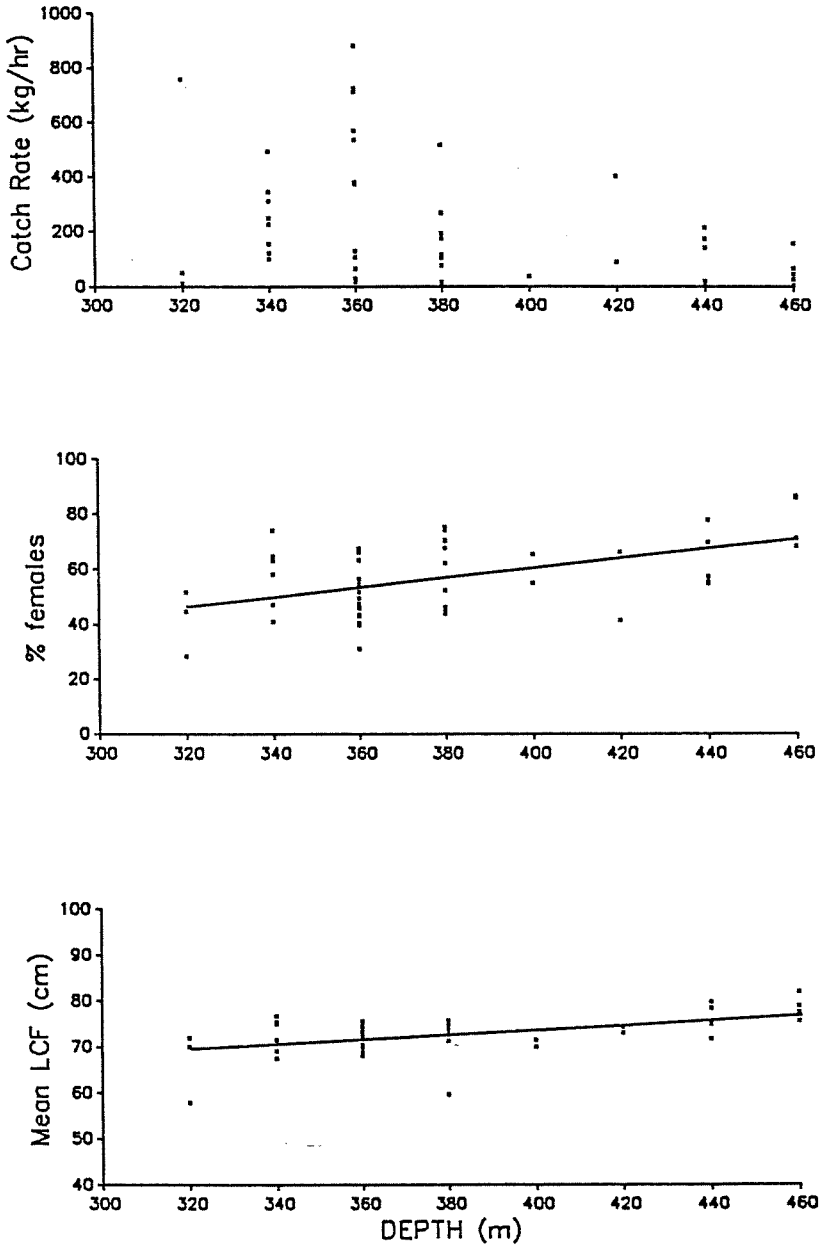

Figure 2. Trends in gemfish catch rate, proportion of female fish in the catch and mean length of the catch with depth.

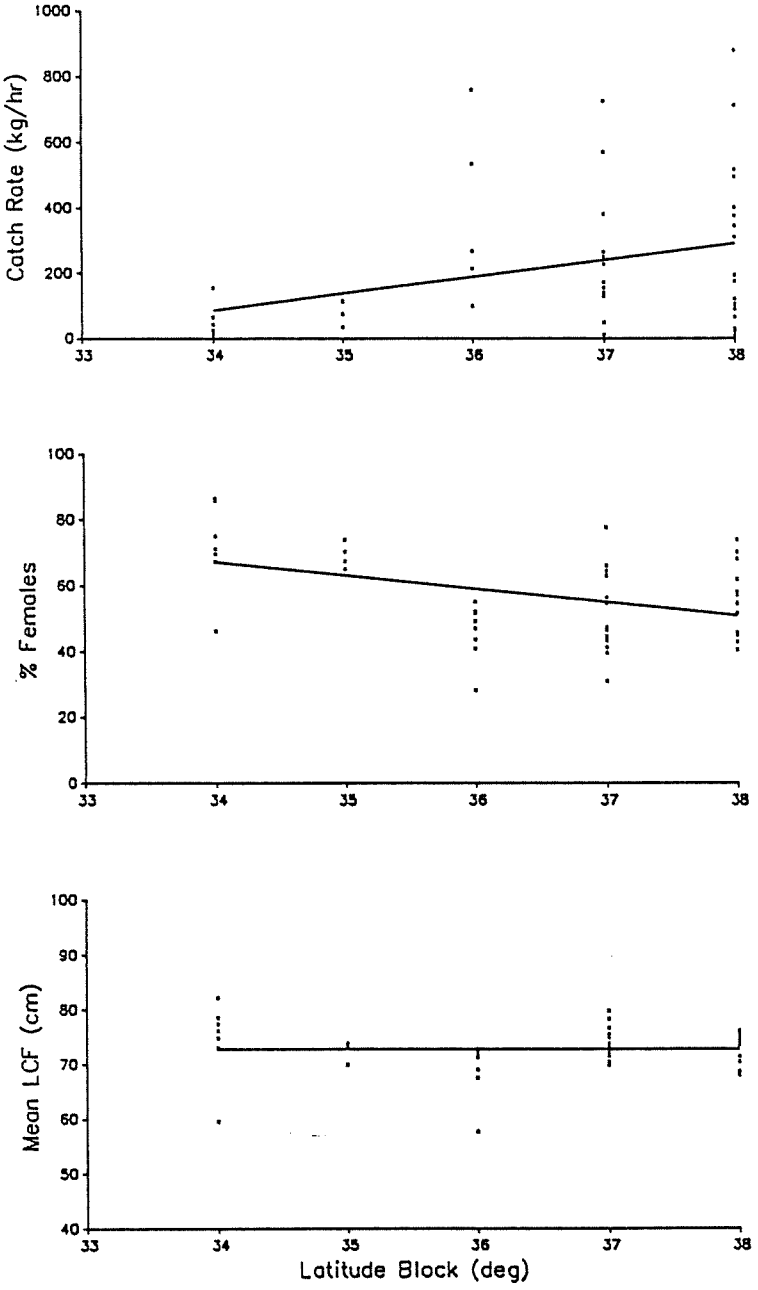

Figure 3. Trends in gemfish catch rate, proportion of female fish in the catch and mean length of the catch with latitude.

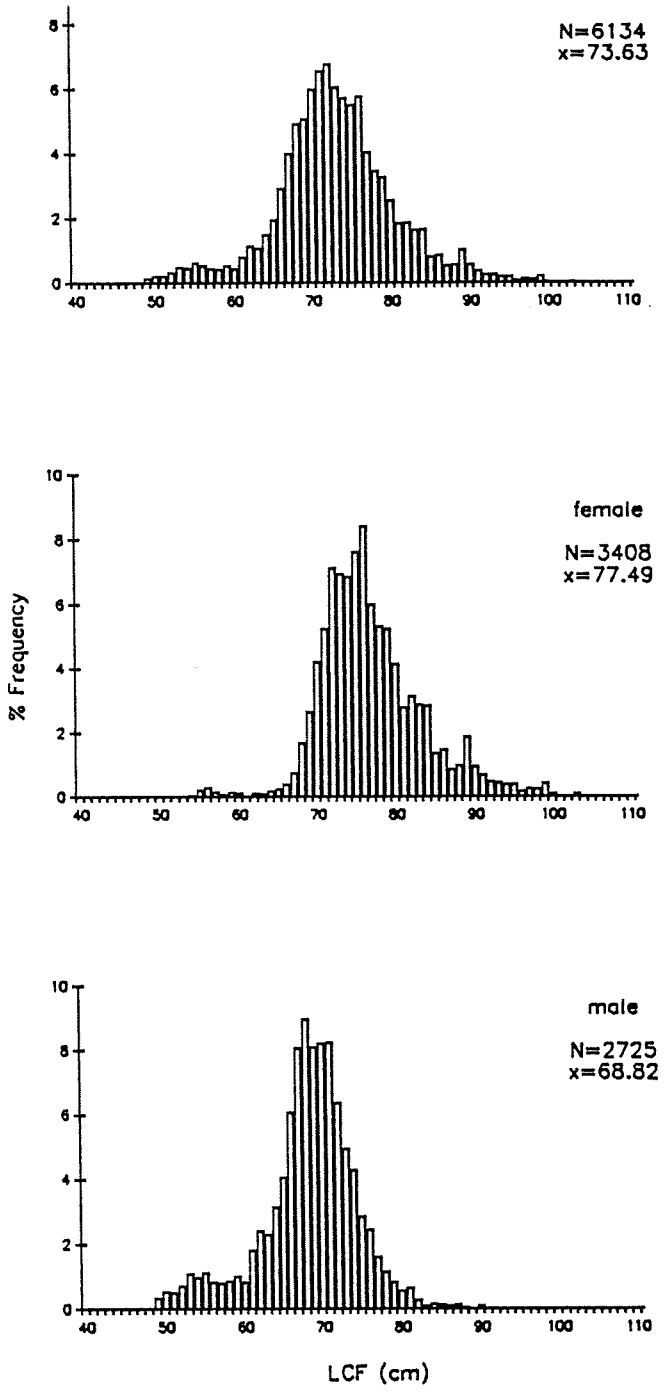

Figure 4. Length frequency distributions for gemfish retained from pre-spawning catches.
N = number measured
x = mean length (cm).

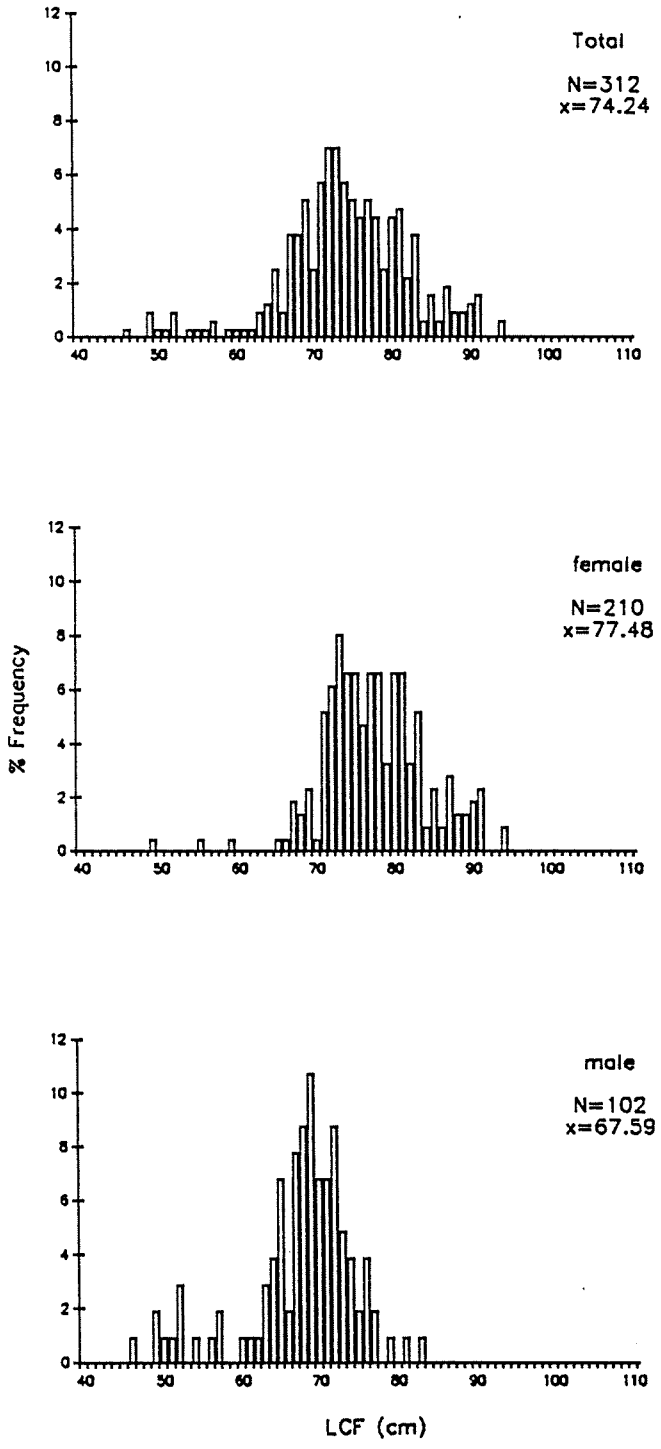

Figure 5. Length frequency distributions of gemfish retained from post-spawning catches.
N = number measured
x = mean length (cm).

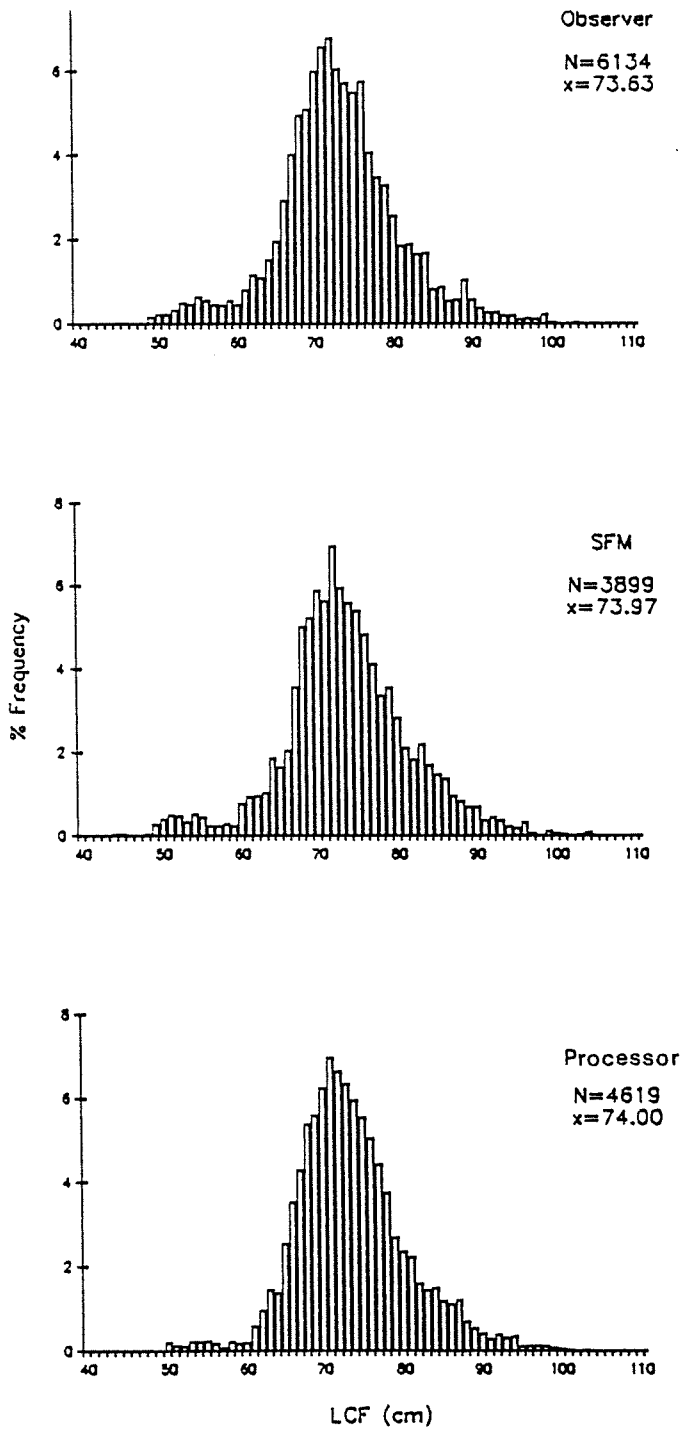

Figure 6. Comparison of gemfish length frequency distributions for fish measured at sea by the observers, at the Sydney Fish Market (SFM) and at the Processing Factory (Poulos Bros.). N = number measured x = mean length.

GEMOBS4.1

1989 GEMFISH OBSERVER REPORT

Date: ..... Observer: .....

Port: ..... Weather: .....

Vessel: ..... Skipper: .....

Time Left Wharf: ..... Crew: .....

Net Description: .....

.....

Searching: ☐ NO ☐ YES Approx. Time spent searching: .....

Echosounder: type ....KHz

How 1st shot located: .....

.....

Total no. shots for day: .....

Comments: .....

.....

.....

.....

Appendix 1

GEMOBS4.2 Obs: .....

Date: ..... Vessel: .....

Shot No.: ..... out of .....

Queueing: ☐ NO ☐ YES Time waiting to shoot: .....

Names/Location of nearby vessels: .....

Q/Posn. O.V.:..... .....

SHOT DETAILS:

Time: ..... Tow: ..... Current to ....
(brakes on) Direction

knots .....

Depth (fm): ..... Location: .....
(grid ref/ Lat.Long)

Finish time: ..... Shot Duration: .....

Sorting of gemfish: ☐ NO ☐ YES

Size criteria: .....

CATCH DETAILS:

RETAINED Species/Weight (Sample weight)

DISCARDED Species/Weight (Sample weight)

Comments: .....

.....

GEMOBS4.3

Length Frequency Data

Date: .... Vessel: ....Obs: ....

Shot No.: ....out of ......

Cms					Cms					Cms				
0					0					0				
1					1					1				
2					2					2				
3					3					3				
4					4					4				
5					5					5				
6					6					6				
7					7					7				
8					8					8				
9					9					9				
0					0					0				
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APPENDIX 2. Linear regression analysis statistics for regressions against depth and latitude.
n.s. - not significant

	% Female		Mean LCF	
DEPTH (m)	300-440	340-420	300-440	340-420
Parameter				
r^2	0.268	0.015	0.297	0.001
A_o	-13.46	27.47	50.49	71.85
A_i	0.192	0.078	0.061	0.001
$t_{(A_i)}$	4.06	0.717	4.41	0.029
$d.f._{(n-2)}$	46	33	46	33
p	<0.001	0.2<p<0.5 n.s.	<0.001	>0.5 n.s.

LATITUDE BLOCK	Catch Rate	% Female	Mean LCF
Parameter			
r^2	0.113	0.172	0.001
A_o	-1645.7	204.5	73.15
A_i	50.92	-4.04	-0.009
$t_{(A_i)}$	2.41	-3.09	-0.021
$d.f._{(n-2)}$	46	46	46
p	<0.05	<0.005	>0.50 n.s.