

ASSESSMENT OF THE GEMFISH (*REXEA SOLANDRI*) STOCK USING A "CUSTOMISED" AGE STRUCTURED ANALYSIS

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We have heard a lot in previous talks about 'new age' biologists, about their openness, and the need for critical review. Well right now, out there in the real world, in response to management actions taken as a result of a biological assessment, such a review is being undertaken. Gemfish fishers and a consulting scientist are involved in a stratified trawling study aimed at assessing the validity of the size composition data on which the assessment of the state of the eastern gemfish stock is based. Unfortunately, I can't report on the results of the study at this meeting as they are yet to be released, but I will try to give a brief summary of the model that has been used in the assessment of eastern gemfish, and how that assessment relates to the management of the gemfish fishery.

In his 'retrospective' paper yesterday, Dr. K. R. Allen referred to an excellent review of age-structured stock assessment models by Bernard Megrey (1989), and I would recommend this review to anyone with a desire to learn more of the methodology and terminology of age-structured analysis (especially those biologists amongst us who may not be ready exponents of matrix algebra and calculus). Megrey (1989, Table 5) identified eleven separate techniques under the broad heading of age-structured population analysis. The cohort analysis which has been purpose written for the eastern gemfish stock by Dr. Allen is based on one of these techniques - specifically Pope's (1972) approximation of the Baranov catch equation.

As outlined in the data requirements session (Session 3) of this Workshop yesterday, all of the age-structured methods use similar data inputs - a matrix of catch / age information. The basic data utilised in the gemfish model (summarised in Figure 1) are time series of estimated landings from the winter 'spawning-run' and the summer 'by-catch' fisheries for the period from the early 1970s to the present, and a series of biennial age determinations commencing in 1980, with a total sample size of over 6,000 for the period to 1990. The availability of an unbroken series of annual length composition data from 1975 allows interpolation of the age compositions for those intervening years when no aged sample was available. The cohort analysis model was first run and reported on in 1988 (see Allen 1989), and was re-run in later years (1990 and 1992) as further data became available.

The cohort analysis model for eastern gemfish was developed by Dr. Allen while under contract to the Demersal and Pelagic Fish Research Group and the Australian Fisheries Management Authority. I don't propose to go into the mathematical derivation of the model in great detail, however I have summarised the main features of the model in Figure 2. The main point to note regarding the 'customisation' of the gemfish cohort analysis is that the model deals with the male and female segments of the population separately. This was necessitated by the very different size and age structures observed for each sex, and is a facility which, as far

as I am aware, is not readily available in any of the "off the shelf" cohort analysis packages. The model also takes into account the differing age compositions of the 'summer' and 'winter' components of the catch.

From Figure 2 it can be seen that the main outputs from the gemfish cohort analysis are biomass estimates of any specified segment of the population, and an index of recruitment strength for individual cohorts (arbitrarily designated for gemfish as the number of three year olds). It should be noted that cohort analysis only provides for the reconstruction of the stock history according to the input data - a dynamic population model based on the results from the cohort analysis and other population parameters needs to be constructed to estimate potential yields under different exploitation scenarios.

The specific assumptions made in the development of the cohort analysis are not excessive, and are as follows:

1. Age and size composition data obtained from market sampling are representative of the age and size composition of the exploited population (the validity of this assumption is currently being tested by the industry-based survey);
2. The 'summer' fishery is instantaneous and occurs at the start of each year;
3. The 'winter' fishery is instantaneous and occurs at a point 0.55 through the year (approximately July 20th which is near to the mid point of the winter gemfish season);
4. Fully recruited females are all mature, and for partially recruited ages the proportion mature is equal to the proportion of the age class recruited to the exploited population;
5. The method used to estimate 'terminal F' values (iterative, with initial values derived from estimates of CPUE) produces reasonable values.

The results from the different runs of the cohort analysis are presented in Figures 3 and 4. The results for the 1992 run have yet to be reviewed or discussed in detail by the Research Group, so at this stage they should be regarded as preliminary. However they do illustrate the point that the results for recent years from a cohort analysis change slightly with each successive update of the analysis. Figure 3 shows the estimated mid-season mature biomass for males and females combined. After a significant decline until the early 1980s (which is very consistent between the three runs and also mirrors a similar decline in standardised CPUE), some recovery in the stock until the late 1980s is suggested by the recent runs of the model, and it is in this respect that assumptions made about recent CPUEs really need to be carefully assessed. Figure 4 shows the magnitude of the decline in recruitment which has occurred in recent years, and is currently the cause of major concern in this fishery - however it should again be remembered that the most recent points in the analysis result from the least amount of information. A general conclusion that can be drawn from these results is that the application of cohort analysis in the assessment of a fish stock is rarely a simple 'one-off', and needs to be an ongoing process with regular review.

I said earlier that gemfish is a good example of a fishery where management action has been based largely on the results of a population assessment, and for the record, I have summarised the course of those management actions and resulting developments since the introduction of a catch quota on eastern gemfish in 1988 (Table 1). The dramatic nature of the impact of management on the fishery is evident from this summary. Because of this significant impact, and the high level of concern amongst industry, there is considerable external review and re-analysis of the gemfish model currently underway, but thus far the model and its implications for management appear to be holding firm, and I am not aware of anything that might

lead one to seriously question the results from the model. However at this time it is probably fair to say that the debate will continue . . . at least into the near future!

References

- Allen, K. R. (1989). A cohort analysis of the gemfish stock of southeast Australia. Background paper, Demersal and Pelagic Fish Research Group Meeting No.28, Hobart 7-10th November, 1989. South Eastern Fisheries Committee, DPI, Canberra.
- Megrey, B. A. (1989). Review and comparison of age-structured stock assessment models from theoretical and applied points of view. *American Fisheries Society Symposium* No.6, 8 - 48.
- Pope, J. G. (1972). An investigation of the accuracy of virtual population analysis using cohort analysis. *International Commission for the Northwest Atlantic Fisheries Research Bulletin* No.9, 65-74.

Table 1. Summary of developments in the eastern gemfish fishery since quota restrictions were introduced in 1988.

Year	Total Allowable Catch	Developments
1988	3,000 tonnes (competitive)	Aim to stabilise catch at about 3,000 t per annum. TAC exceeded by 500 t, after fishery re-opened mid August. Industry critical of 'market' data used in assessment.
1989	3,000 tonnes (individual vessel quotas)	First indications of recruitment problems (4-year-old fish). Landings only 2,200 t for whole season. 'Observer' program to collect size composition data at sea.
1990	1,750 tonnes (reduced due to poor recruitment) (individual vessel quotas)	Real time assessment of size/age composition of landings. Continued poor recruitment of 4 & 5-year-old fish. Landings only 1,200 t, taken during a very short season. Increased public debate about veracity of the assessment.
1991	500 tonnes (individual vessel quotas)	Less than 300 t reported landed. Grave concern at continuing poor recruitment. Dramatic increase in mean size of fish in the catch.
1992	190 tonnes (allocated to individual vessels on same basis as before)	Many fishers exceeded their vessel quotas. Total kill about 700 t, including some discarding. Very open confrontation between industry and managers. Prosecutions pending.
1993	Zero TAC	'By-catch' arrangements to discourage targeting on gemfish. Total kill about 300 t; significant proportion discarded. Industry-based research program to test the validity of size composition data used in the assessment.

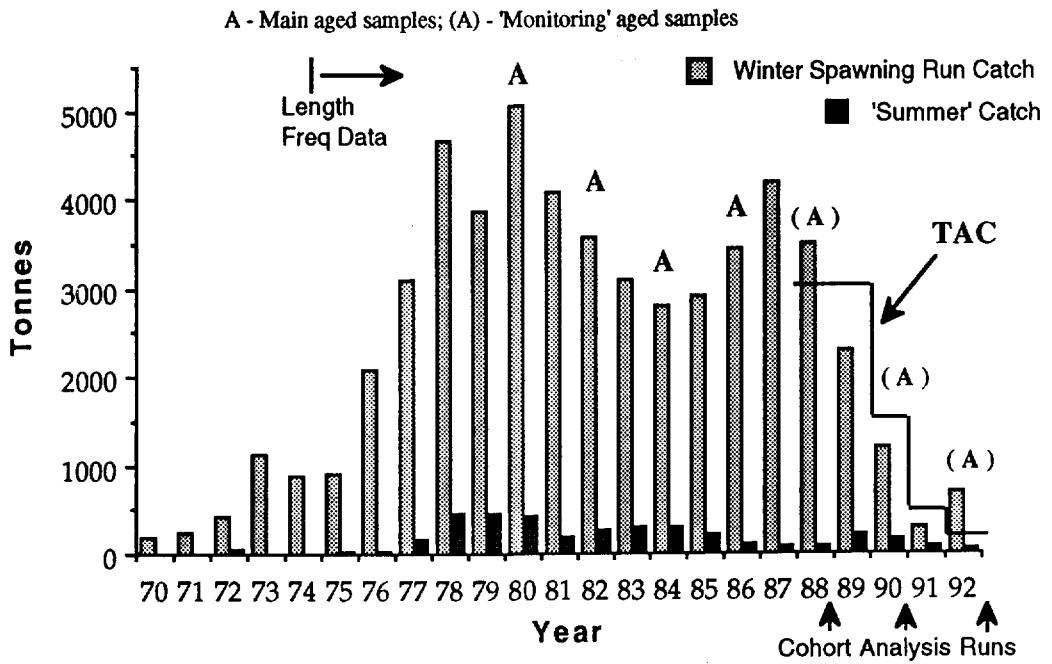


Figure 1. Summary of data used in gemfish cohort analysis.

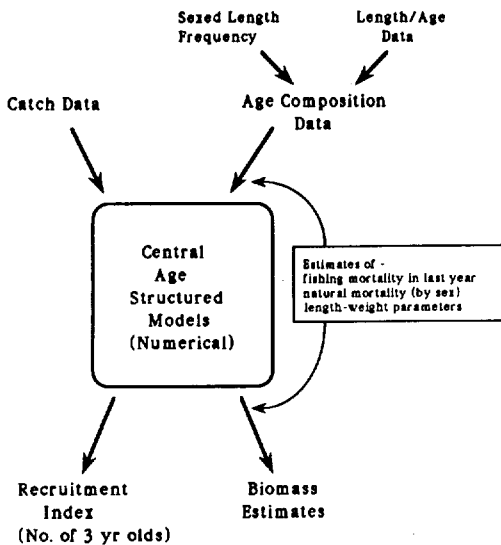


Figure 2. Gemfish Cohort Analysis.

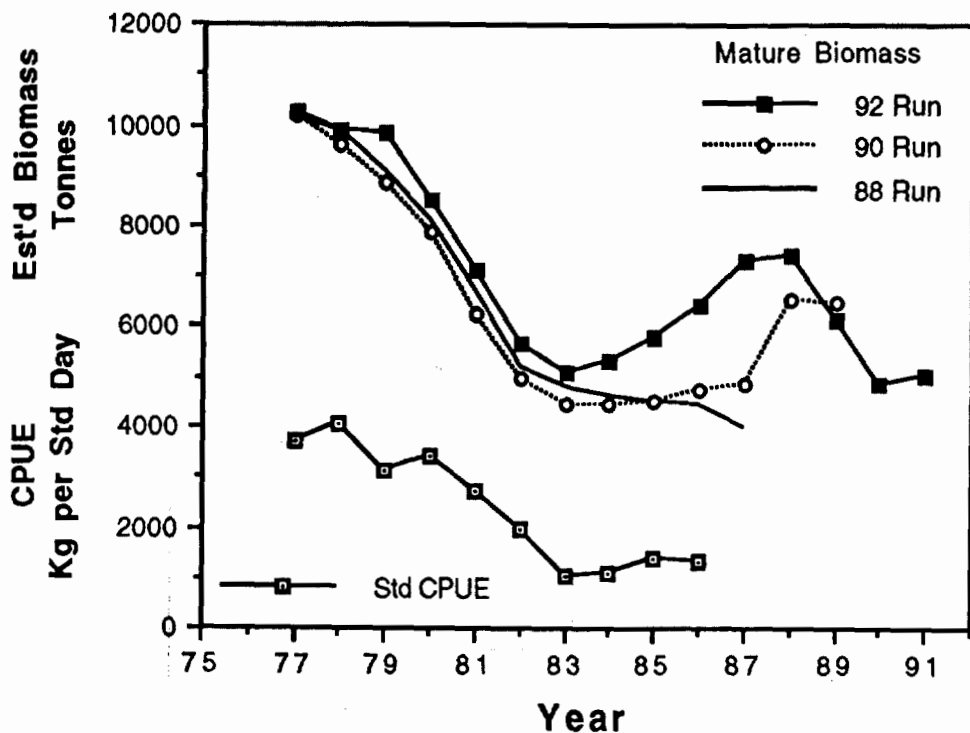


Figure 3. Mid-season mature biomass estimates for gemfish from cohort analysis runs, and standardised CPUE.

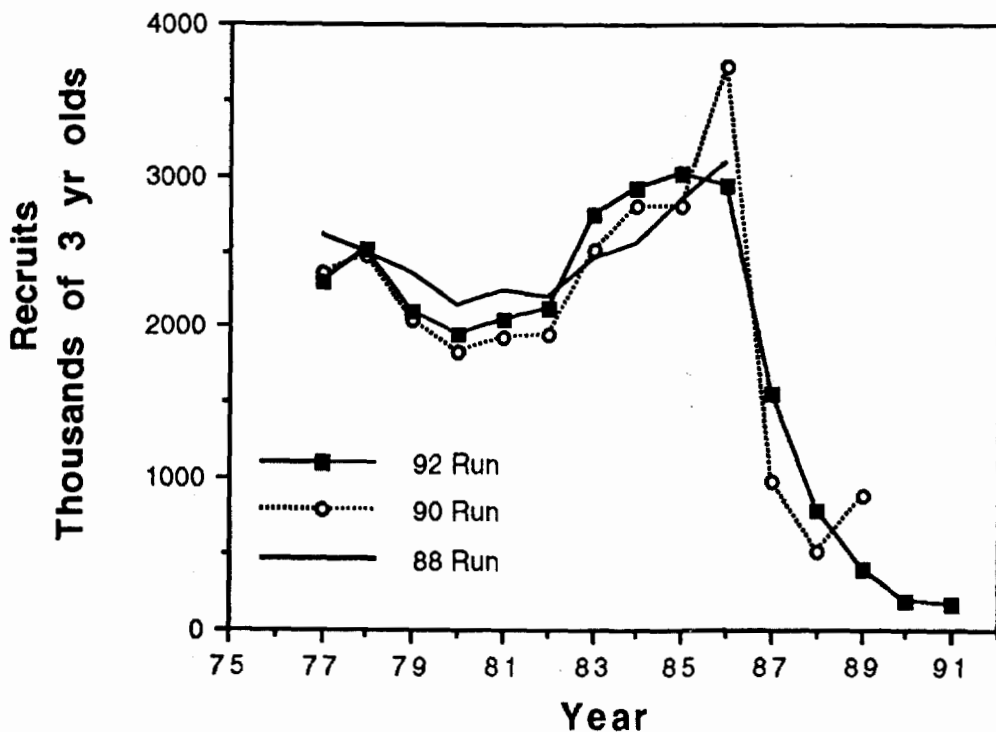


Figure 4. Estimated number of gemfish recruits from cohort analysis runs.