utilize a variant of the classic "Production Models" that avoids many of the problems listed before. If neither total yield data nor total effort are available, it is even possible to fit a "Surplus Production Model" utilizing overall instantaneous mortality rates (Z) as a direct index of fishing mortality (Csirke and Caddy, 1983) and an annual estimate of catch rate. An index of abundance (cpue) and estimates of Z could be obtained from the analysis of trawl survey data on species composition in the catches and their structures by length or by age.

The problem of the lack of historical data sets could be solved by utilizing a recently developed approach (Munro, 1980; Caddy and Garcia, 1982). Briefly, this approach consists of replacing the cpue and effort time series by couples of these data derived from different areas exploited at different rates, in the same period of time (assuming previously similar basic productivity and similar evolution under fishing pressure for the whole areas).

This approach, a combination of a "semianalytical production model" with a "composite production model," should represent the simplest one that might be utilized for a preliminary assessment of the resources in the area. In this way, we can estimate the total production that may be harvested by fishermen or removed by natural mortality (e.g. by predation) and should permit us to know which is the situation of each species in each fishery of the area in relation to the maximum biological production.

References

Caddy, J.F. and S. Garcia. 1982. Production modelling without long data series. FAO Fish. Rep. (278) Suppl.: 309-313.

Csirke, J. and J.F. Caddy. 1983. Production modelling using mortality estimates. Can. J. Fish. Aquat. Sci., 40:43-51.

Munro, J.L. 1980. Stock assessment models: applicability and utility in tropical small-scale fisheries. p 35-47. In Salla, S.B. & P.H. Roedel (Eds.) Stock Assessment for Tropical Small-scale Fisheries. Proc. Internat. Workshop Sept. 1979. Univ. Rhode Island, Int. Cent. Mar. Resource Dev. Kingston, R.I. 198 pp.

A SIMPLE MATHEMATICAL MODEL FOR DETERMINING EGG SURVIVAL AND PRERECRUITMENT MORTALITY OF *COILIA DUSSUMIERI* (CUV. AND VAL.) FOR 1982-1983

by

I. Fernandez

Central Institute of Fisheries Education, Indian Council of Agricultural Research, Bombay 400 061 India

(Correspondence address: University Settlement, Dr L Melville Road, Bombay Central, Bombay 400 008, India

Introduction

The number of eggs produced by mature females of a population that enter the prerecruit stage plays an important role in the determination of the number of recruits that enter a fishery. Earlier studies on the estimation of prerecruitment mortality were made by Pauly (1980) and Navaluna (1982). The present study on the survival rate of eggs per mature female has been undertaken on the gold spotted grenadier anchovy, Coilia dussumieri, from the northwest coast of India.

Materials and methods

Samples of C. dussumieri were collected randomly at weekly intervals from three major fish landing centres of Bombay from Dakti Dahanu and the Central Institute of Fisheries Education's research vessels MFV SARASWATI

and MFV NARMADA from December 1982 to December 1983. The fish were caught by pelagic or bottom trawl nets. *C. dussumieri* is present to a depth of 40 m. In a total of 5,514 specimens, sampled for length frequency analysis, 1,248 mature females were present. The average length, weight and age for mature females was 16.55 cm, 13.50 g and 0.96 year.

The ovaries of mature female specimens were preserved in 10% formalin for ova-diameter studies. 300 eggs were counted and weighed for fecundity studies and annual fecundity was calculated using the formula:

$$\text{Fecundity} = \frac{\text{total weight of ovary}}{\text{weight of sampled ova}} \times 300$$

The procedure for estimating the survival rate of eggs per female was as follows: On random sampling, a number of mature females (P_M), were obtained from within a sampled population X. Using Pope's (1972) cohort analysis the number of fish present for each age group (N_+) was estimated. The 0+ and 1/2+ year classes were considered to be the recruits (R) and 1+ and 1/2+ year classes, the parent stock (S). P_T would be the number of mature females present within a total stock as determined by the sex ratio of the mature specimens of X, for that particular year, and the average fecundity for the same period would be F. Then,

$$\text{Number of eggs produced} = P_T \cdot F \quad (1)$$

The resultant total mortality for eggs, larvae and prerecruits (M_T) would be

$$M_T = (P_T \cdot F) - R \quad (2)$$

Therefore, the computed mortality from the egg to the recruit stage (M_R) (per female) would be:

$$M_R = M_T/P_T \quad (3)$$

Hence, the number of eggs surviving (S_E) (per female) would be:

$$S_E = F - M_R \quad (4)$$

Results and Discussion

Using Eq. (1) with $P_T = 3.11 \times 10^8$ and F = 3000, the total number of eggs produced by the mature females within the total stock of 40,058.65 tonnes for the period 1981-1982 was estimated to be 9.33×10^{11}.

The number of recruits (R) was 1.39×10^{10}. Therefore, the resultant total mortality (M_T) for P_T was 9.19×10^{11}. Hence, the mortality (M_R) from egg to the recruit stage per female was 2,955 in 1982 and the egg survival per female was 45. On an average, chances of egg survival per female fish was 1.49% and the remaining 98.51% of eggs, larvae and prerecruits die, from natural causes, before reaching the size at which they become liable to capture by the fishery.

Acknowledgements

I wish to acknowledge Dr S.N. Dwivedi, Director, Central Institute of Fisheries Education (ICAR), Bombay, for his permission to use the data obtained from the Institute's research vessels, MFV SARASWATI and MFV NARMADA and the facilities at the Institute.

References

Navaluna, N.A. 1982. Morphometrics, biology and population dynamics of croaker fish, *Otolithes ruber*. p 38-55 In D. Pauly and A.N. Mines, (Eds.) Small-scale fisheries of San Miguel Bay, Philippines: biology and stock assessment. ICLARM Technical Reports 7: 124 p.

Pauly, D. 1980. A new methodology for rapidly acquiring basic informations on tropical fish stocks: growth, mortality and stock recruitment relationship. p 154-172 In S.B. Saila and P.M. Roedel (Eds.) Stock assessment for tropical small scale fisheries. Int. Centre for Marine Resource Development, Univ. Rhode Island, Kingston.

Pope, J.G. 1972. An investigation of the accuracy of virtual population analysis using cohort analysis. ICNAF Research Bulletin 9: 65-74.