Asian Fisheries Science **10**(1998):241-250
Asian Fisheries Society, Manila, Philippines

https://doi.org/10.33997/j.afs.1998.10.3.007

Population Dynamics of Shortnose Ponyfish *Leiognathus brevirostris* (Valenciennes) from Portugal Bay in the Puttalam Estuary, Sri Lanka

P.A.A.T. JAYAWARDANE AND P. DAYARATNE

National Aquatic Resources Research and Development Agency
Crow Island, Mattakkuliya, Colombo 15
Sri Lanka

Abstract

Population parameters of *Leiognathus brevirostris* from the trawl catches of the Portugal Bay area, Puttalam Estuary, Sri Lanka were investigated based on length frequency data, analyzed with LFSA and Compleat ELEFAN computer programs. The asymptotic length (L_∞) and growth constant (K) were estimated to be 13.8 cm (total length) and 0.9 year $^{-1}$, respectively. Based on these growth parameters, the total mortality coefficient (Z) during the study period was estimated to be 4.62. The estimated value for natural mortal-ity (M) was 2.07 and hence the fishing mortality coefficient (F) was 2.42. The estimated values for the exploitation rate (E) using the length converted catch curve and Virtual Population Analysis were 0.54 and 0.27 respectively. The recruitment was continuous with two peaks per year. The estimated sizes of *Leiognathus brevirostris* at 25, 50 and 75 per-cent probabilities of capture were 8.47, 8.75 and 9.03 cm respectively.

The estimated length weight relationship for males was $W = 0.0164\ L^{2.89}$ and for females $W = 0.0093\ L^{3.15}$. The maximum sustainable yield (MSY) was estimated at 287 MT year $^{-1}$ while the maxi-mum sustainable economic yield (MSE) was 280 MT year $^{-1}$.

Introduction

The members of the family Leiognathidae are close inshore perciform fishes generally not reaching total length more than 15 cm. Leiognathids are commonly known as slipmouths, silverbellies, dollarfish and ponyfish, the last name referring to the extremely protractile mouth parts, which give a head a horse like appearance (Jones 1985).

The ponyfish *Leiognathus brevirostris* (Valenciennes) is a small bottom living fish species found in the coastal waters of the West Indian Ocean (along the coasts of India and Sri Lanka), in the Eastern Indian Ocean and the Western Central Pacific, including Australia. It inhabits shallow waters to a depth of about 40m, predominantly near the bottom and is more often found in schools (Fischer and Bianchi 1984).

Although some members of the family Leiognathidae are taken in the catches of drift gillnets (Karunasinghe and Fonseka 1985), purse seines (Joseph

1974), beach seines (Canagarathnam and Medcof 1956), trawl trials (Siddeek 1986) and the shrimp trawlers that operate in the coastal waters of Sri Lanka, information on *Leiognathus brevirostris* is scanty as this species is only a by-catch of all these fisheries. However, *Leiognathus brevirostris* is one of the major contributors to the trawler by-catch in the Portugal Bay area of the Puttalam Estuary (Jayawardane and Dayaratne, in preparation).

Although *Leiognathus brevirostris* is one of the most abundant ponyfish species in the coastal waters of the West Indian Ocean, except for the studies carried out by James and Badrudeen (1975) and Dwiponggo et al (1986), a detailed study on the population dynamics of this species has not been attempted so far.

In the present study, the population parameters of *Leiognathus brevirostris* were estimated to assess the *Leiognathus brevirostris* stocks in the Portugal Bay area and make recommendations for the management of the resource.

Materials and Methods

Collection of data

Length frequency data of *Leiognathus brevirostris* were collected from trawler catches in the Portugal Bay area during the period August 1991 to July 1993 by making regular fortnight field visits to the major fish landing centre in Kalpitiya Peninsula (Fig. 1). More than 20% of the trawlers operated were sampled randomly. The average number of trips made to the trawling ground during each month was taken as the fishing effort of that month. The catch in kg/haul was considered as the catch per unit effort. On each sampling day, total lengths of 150-200 fish obtained by random sampling were measured to the nearest 0.1 cm using a measuring board. The corresponding weight of each individual was determined to the nearest 0.01 g.

Analysis of data

Monthly length frequency distribution of *Leiognathus brevirostris* for each month was analyzed using Compleat ELEFAN computer program (Gayanilo et al 1988). The program was also used to estimate the parameters of the Von Bertalanffy growth equation. The fitting of the best growth curve was based on the ELEFAN I program, which allows the line to pass through the maximum number of peaks of the length frequency distribution. With the aid of the best growth curve the growth constant (K) and the asymptotic length (L_∞) were estimated.

The instantaneous total mortality coefficient (Z), natural mortality coefficient (M), fishing mortality coefficient (F) and the exploitation rate (E) were estimated using the length converted catch curve method which has been incorporated into the Compleat ELEFAN computer program (Gayanilo et al 1988).

Using Pauly's empirical equation for theoretical age at length zero (t_o) (Pauly 1979), a very approximate estimate of theoretical age at length zero was obtained. The equation used is as follows:

$$\log(-t_o) = -0.392 - 0.275 \log L_\infty - 1.038 K$$

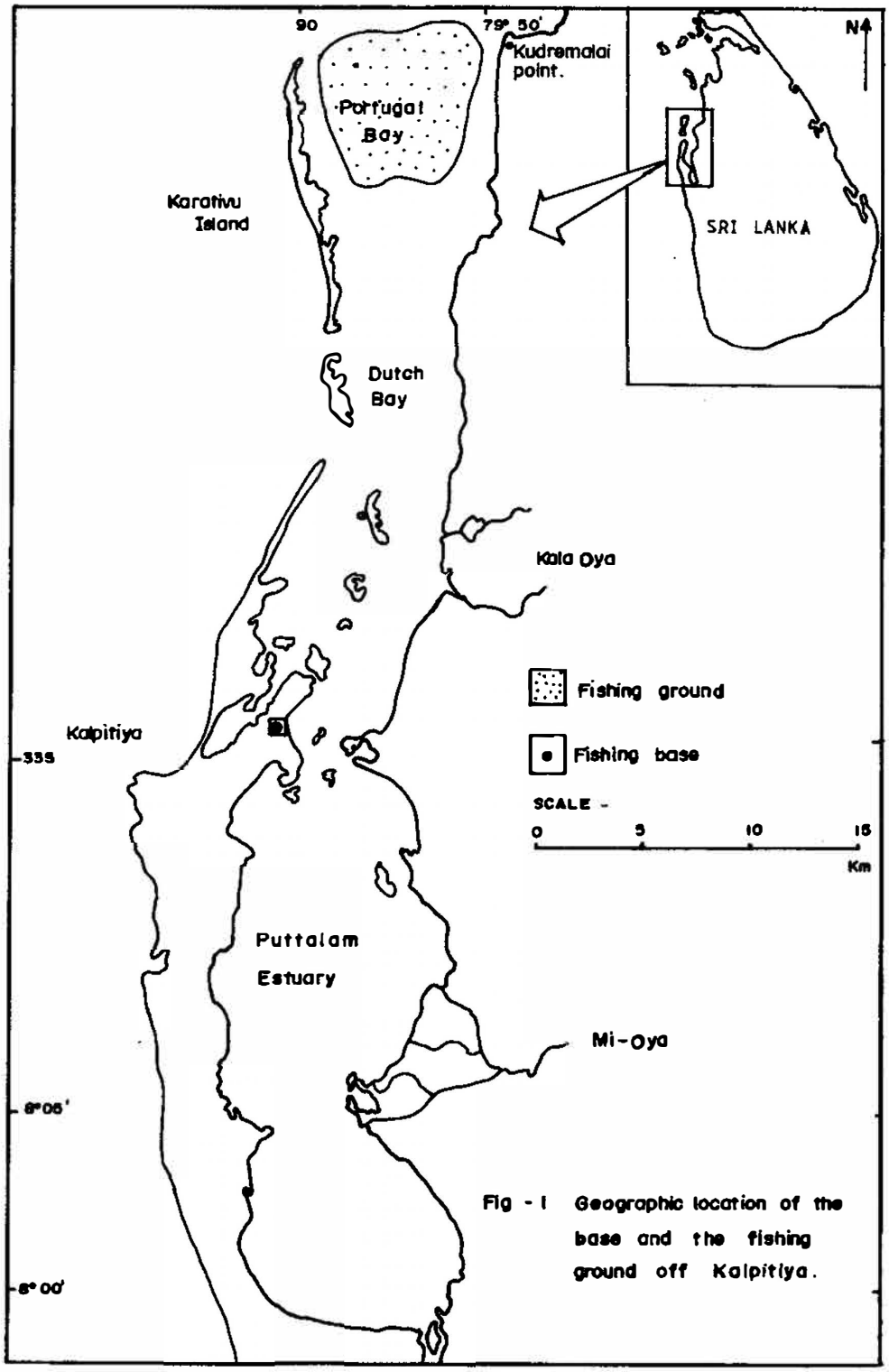

Fig. 1. Geographic location of the base and fishing ground off Kalpitiya.

The recruitment pattern was also derived using the Compleat ELEFAN computer program (Gayanilo et al 1988).

The probabilities of capture of *Leiognathus brevirostris* were estimated by calculating the ratio between the points of the extrapolated descending arm and the corresponding ascending arm of the length converted catch curve.

Length weight relationships were estimated for males and females separately using simple linear regression analysis (Zar 1984).

The length frequency data was used to carry out Virtual Population Analysis using the compleat ELEFAN computer program (Gayanilo et al 1988). The Thompson and Bell method which has been incorporated into the LFSA package of microcomputer programs (Sparre 1987) was used to estimate the maximum sustainable yields and optimum effort values.

Results

Growth parameters (L_∞,K)

The length range obtained in the fishery was 6.8-12.8 cm. In addition, the length range which contributed significantly to the fishery was 8.0-10.4 cm.

The length frequency distribution of *L. brevirostris* for two years studied are shown in Fig. 2. The best growth curves estimated by the Compleat ELEFAN computer program (Gayanilo et al 1988) are also shown in this

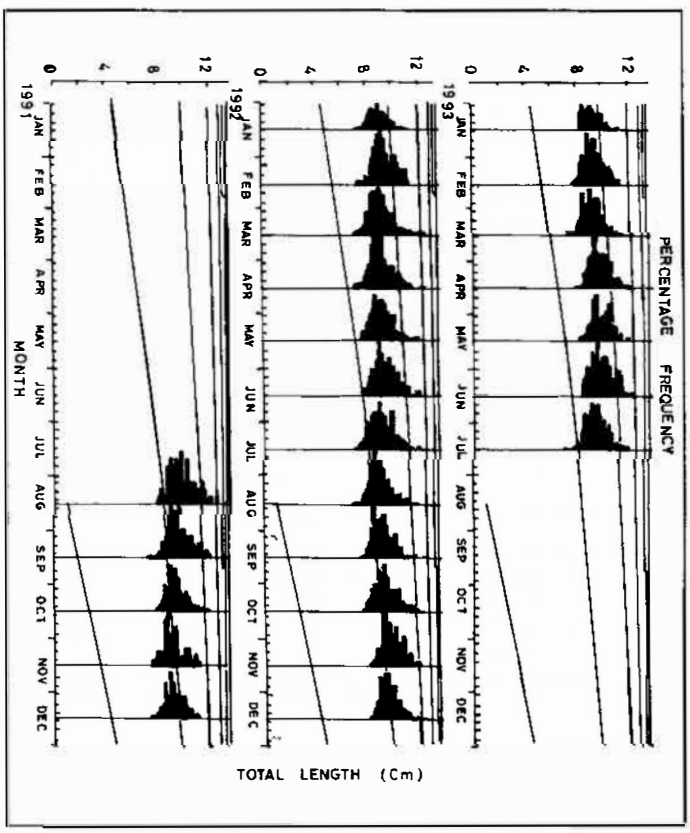

Fig. 2. Monthly length frequency distributions of *Leiognathus brevirostris* during the study period with the estimated growth curves.

figure. The values for asymptotic length (L_∞) and the Von Bertalanffy growth coefficient (K) estimated for the stock were 13.8 cm and 0.9 year $^{-1}$, respectively.

Total mortality (Z), natural mortality (M), fishing mortality (F) and exploitation rate (E)

The length converted catch curve of *Leiognathus brevirostris* is shown in Fig. 3. The values for instantaneous total mortality coefficient (Z), natural mortality coefficient (M), fishing mortality coefficient (F) and the exploitation rate (E) calculated from the data points of the figure were 4.62, 2.07, 2.42 and 0.54, respectively.

Theoretical age at length zero (t_o)

The estimated value for t_0, using Pauly's empirical equation for t_0 (Pauly 1979) was -0.2 years.

Recruitment pattern

Results of the analysis of the recruitment pattern of *Leiognathus brevirostris* during the study period are shown in Fig. 4. This can be interpreted as a recruitment pattern with two peaks, different in magnitude, one around April and the other around October. The means of two pulses of recruitment are separated by an interval of five months. The first pulse produced 27.8 % of the recruits while the other produced 72.2%.

Probabilities of capture

The probabilities of capture pattern of *Leiognathus brevirostris* is shown in Fig. 5. The estimated sizes of *Leiognathus brevirostris* at 25%, 50% and 75% probabilities of capture were 8.47 cm, 8.75 cm and 9.03 cm, respectively.

Length weight relationship

Length weight relationships for the males and females are shown in Fig. 6. The estimated length weight relationships for the males and females were $W = 0.0164L^{2.89\ (n=93,\ r=0.9384)}$ and $W = 0.0093L^{3.1754\ (n=93,\ r=0.9477)}$, respectively. The statistical analysis indicates that, in males and females, the value for constant b in the relationship $W = a L^b$ was not significantly different from 3 ($P<0.05$).

Virtual Population Analysis

The results of the length structured Virtual Population Analysis of *Leiognathus brevirostris* carried out using the Compleat ELEFAN computer program are shown in Fig. 7. The values for the mean fishing mortality and the mean exploitation rate estimated by the analysis were 0.77 and 0.27, respectively. In addition, the estimated value of the mean fishing mortality from the Virtual Population Analysis for the fully vulnerable length range to the gear was 2.07.

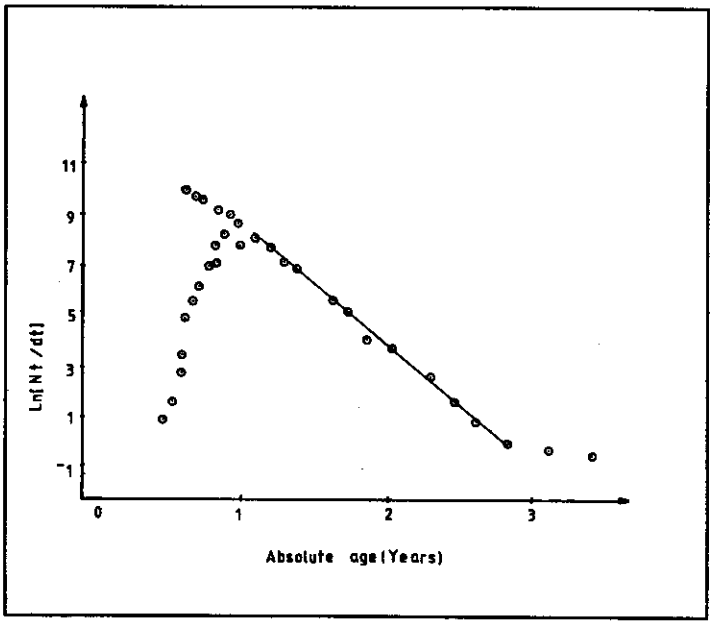

Fig. 3. Length-converted catch curve of *Leiognathus brevirostris*.

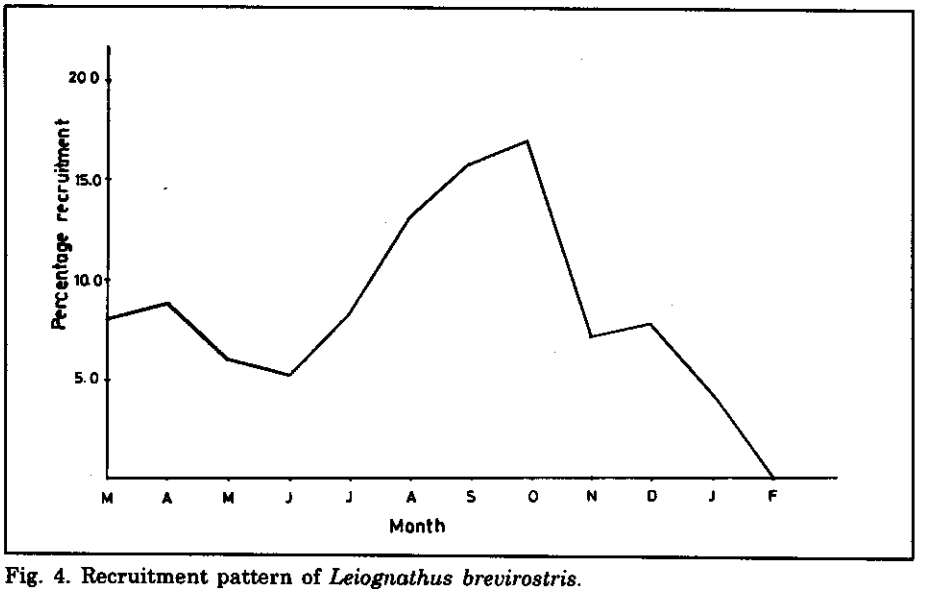

Fig. 4. Recruitment pattern of *Leiognathus brevirostris*.

Maximum sustainable yield and optimum effort levels

A graphic presentation of the Thompson and Bell analysis carried out using the LFSA computer program (Sparre,1987) is shown in Fig. 8. The maximum sustainable yield (MSY) and the maximum sustainable economic yield (MSE) estimated using the Thompson and Bell analysis were 287 MT year $^{-1}$ and 280 MT year $^{-1}$, respectively. According to the analysis, maximum sustainable yield (MSY) and the maximum sustainable economic yield (MSE) could be obtained at the F - factor values of 8.82 and 3.41, respectively.

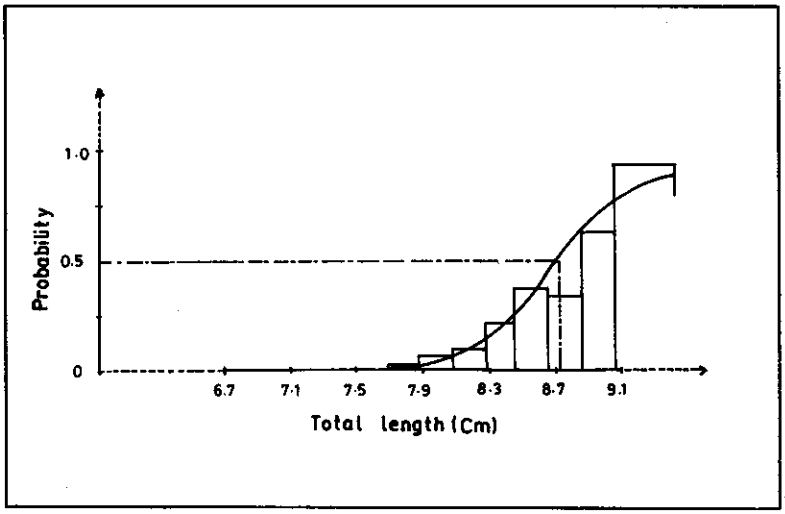

Fig 5. Probabilities of capture pattern of *Leiognathus brevirostris*.

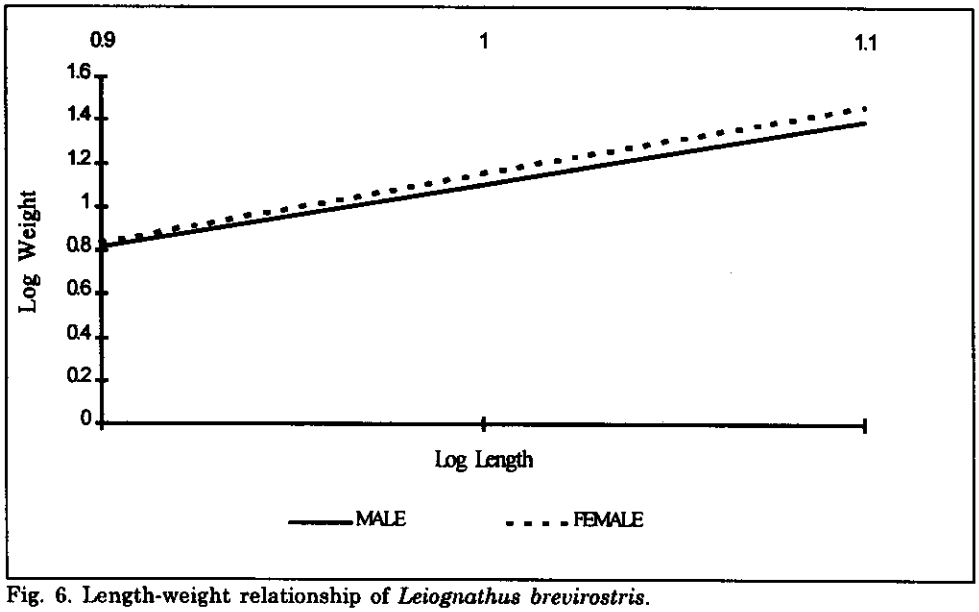

Fig. 6. Length-weight relationship of *Leiognathus brevirostris*.

Discussion

The estimated values for growth parameters, L_∞ and K for *Leiognathus brevirostris* from the Portugal Bay area for the study period were 13.8 cm and 0.9 year^{-1}, respectively. These values have not shown much difference when compared to the L_∞ and K values estimated for the same species off Java Sea, which were 12 cm and 0.95 year^{-1}, respectively (Dwiponggo et al 1986). In addition, as revealed during the present investigation, *Leiognathus brevirostris* attains a size of 91 and 119 mm at the end of its first and second years, respectively. However, according to James and Badrudeen (1975), the life span of *L. brevirostris* is around two years, with the fish attaining a size of 60 and 120 mm, respectively, at the end of the first and second years. According to James and Badrudeen (1975), the estimated rate of growth of *Leiognathus*

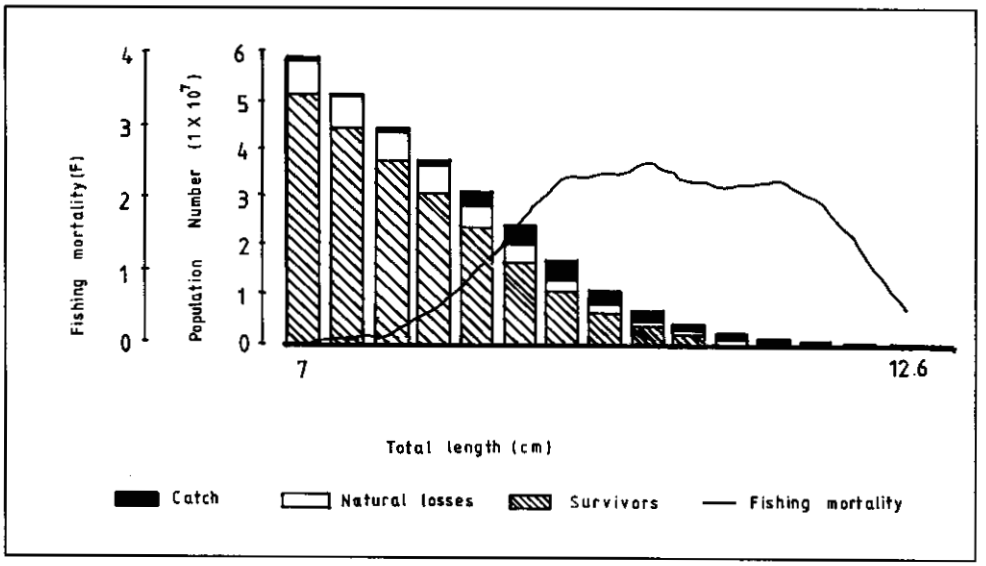

Fig. 7. Length-structured virtual population analysis of Leiognathus brevirostris.

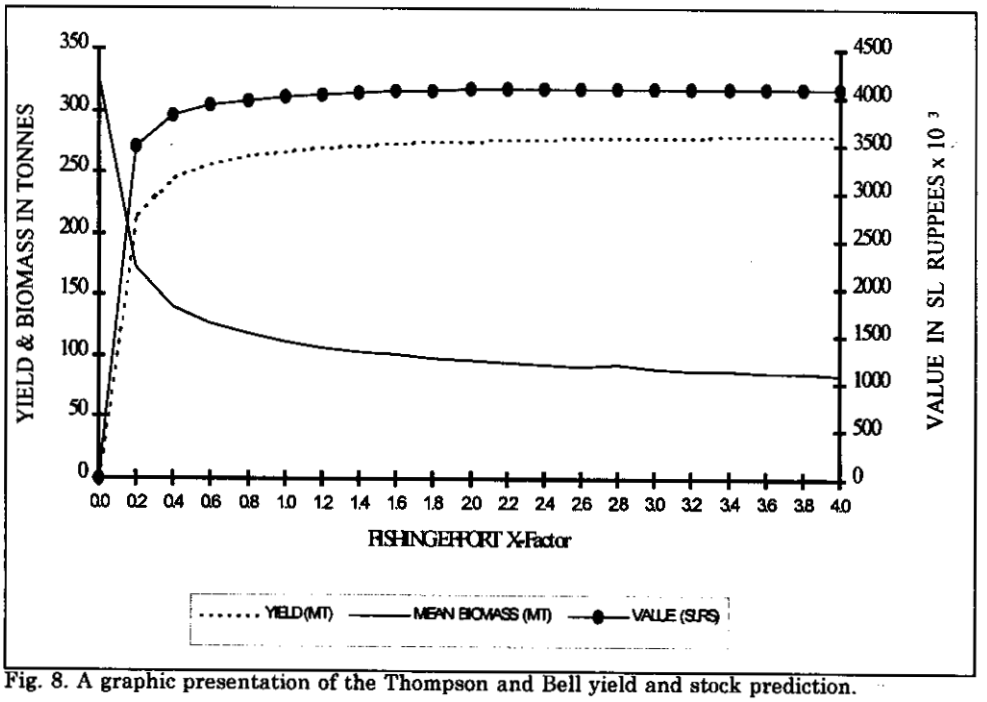

Fig. 8. A graphic presentation of the Thompson and Bell yield and stock prediction.

brevirostris from the Palk Bay and Gulf of Mannar regions was 5 mm per month.

The instantaneous total mortality coefficient (Z) estimated using the length converted catch curve method during the present study was 4.62. This value is comparatively high when compared to the Z value estimated for the same species off Java Sea, which was 2.79 (Dwiponggo et al 1986). This could have been

probably due to the high fishing mortality of *Leiognathus brevirostris* (F =2.42) observed in the present study.

The instantaneous natural mortality coefficient (M) estimated using the length converted catch curve method during the present study was 2.07.This did not show much difference when compared to the instantaneous natural mortality coefficient (M) estimated for the same species off the Java Sea, which was 2.2 (Dwiponggo et al 1986). In addition, the instantaneous fishing mortality coefficient (F) estimated by subtracting natural mortality coefficient (M) from the instantaneous total mortality coefficient (Z) during the present investigation (F=2.42) was comparatively high when compared to the estimation of the fishing mortality coefficient of *L. brevirostris* off the Java Sea (F =0.59) made by Dwiponggo et al (1988). However, this is understood since the estimations of population parameters and mortality rates of the same species could vary depending on stock and geographic location.

The estimated values for the exploitation rate (E) using the length converted catch curve and Virtual Population Analysis were 0.54 and 0.27, respectively. Since the estimations made on mean exploitation rates using the Virtual Population Analysis are known to be more reliable (Sparre et al 1992), it is reasonable to accept the fact that *Leiognathus brevirostris* stocks in the Portugal Bay area are in a healthy state, although relatively high fishing pressure is already being exerted on the stocks.

The results of the analysis carried out using the Thompson and Bell method indicate that the maximum sustainable yield of *Leiognathus brevirostris* is around 287 MT year $^{-1}$ and this could be obtained at the F - factor value of 8.82. Therefore, the Thompson and Bell analysis indicates the possibility of increasing the fishing effort on *Leiognathus brevirostris*.

However, it is understood that the trawl fishery in the Portugal Bay area targeting prawns is a multispecies one. Therefore, regulation of effort, including mesh regulation, has to be practiced more carefully since such an exercise may adversely affect the other species taken in this gear, especially the prawns. Therefore, it is advisable to introduce a new gear which could exploit *Leiognathus brevirostris* since the trawl gear takes in valuable prawns as well as many finfish species in addition to the *Leiognathus brevirostris*.

It was also understood that females predominate over males in certain months and that more females belong to the larger length groups and contribute more to the commercial catches than males (Jayawardane and Dayaratne, in press). Therefore, it is advisable to conduct trial and error experiments to understand the above observations prior to any commercial-scale activity to exploit the resource since the over-exploitation of females may lead to the collapse of the entire fishing industry in the area.

Acknowledgments

The authors wish to thank the National Aquatic Resources Research and Development Agency (NARA) for providing facilities to conduct this study. Financial assistance provided by the Swedish Agency for Research Cooperation with Developing Countries (SAREC) is gratefully acknowledged.

Special thanks are also due to Messers H.A.R.E. Perera, T.A. Rajapakse, M.G.K. Gunawardane, A. Gamage and S.C.V.U. Senavirathne of NARA for their assistance in the field work.

References

Canagaratnam, P. and J. C. Medcof. 1956. Ceylon's beach seine fishery. Bulletin Fisheries Research Station Ceylon 4.

Dwipponggo, A., T. Hariati, S. Banon, M. L. Palomares and D. Pauly. 1986. Growth, mortality and recruitment of commercially important fishes and penaeid shrimps in Indonesian waters. ICLARM Technical Report 17:43

Fischer, W. and G. Bianchi. 1984. FAO Species identification sheets for fishery purposes, western Indian Ocean (fishing area 51). Prepared and printed by the Food and Agricultural Organization of the United Nations. 6 vols.

Gayanilo, F. C., Jr., M. Soriano, and D. Pauly. 1988. A draft guide to Compleat ELEFAN software. International Center for Living Aquatic Resources Management, Manila.

James, P. S. B. R. and M. Badrudeen. 1975. Biology and fishery of *Leiognathus brevirostris* (Valenciennes) from the Palk Bay and Gulf of Mannar. Indian Journal of Fisheries. 28(1/2):154-182.

Jones, G. 1985. Revision of the Australian species of the fish family Leiognathidae. Australian Journal of Marine and Fresh Water Resources 36:559

Joseph, B. D. L. 1974. Preliminary report on experimental fishing with purse seine and lampara nets for small pelagic fish varieties. Bulletin Fisheries Research Station Sri Lanka (Ceylon). 25(1/2):1-13.

Karunasinghe, W. P. N. and M. Fonseka. 1985. A preliminary analysis of small mesh gillnet fishery in the inshore waters of Sri Lanka. Journal of National Aquatic Resources Agency 32(1/2):25-32.

Pauly, D. 1979. Theory and management of tropical multi-species stocks. A review, with emphasis on the Southeast Asian Demersal Fisheries. ICLARM Studies and Reviews 1:35.

Siddeek, M. S. M. 1986. Mesh selectivity and biological impact studies on a new fish cum shrimp trawl in Palk Bay, Sri Lanka. Proceedings of the First Asian Fisheries Forum :417-420.

Sparre, P. 1987. Computer programmes for fish stock assessment. Length based fish stock assessment for Apple II computers. FAO Fisheries Technical Paper. (101) Supplement 2:218.

Sparre, P. and S. C. Venema, 1992. Introduction to tropical fish stock assessment. FAO Fisheries Technical Paper. (306/1) Rev. 1.

Zar, J. H. 1984. Biostatistical analysis. Prentice-Hall Inc. Englewood Cliffs, N.J.

Manuscript received 22 July 1996; accepted 8 October 1997.