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An Assessment of Kawakawa *(Euthynnus affinis)* Stock on the West Coast of Sri Lanka

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Abstract

The kawakawa *(Euthynnus affinis)* stock on the west coast of Sri Lanka was assessed by using length data collected from the drift gill net fishery. Sampling was carried out at three major landing sites from August 1986 to July 1987. Data were analyzed using the compleat ELEFAN computer package.

Two sets of estimates of parameters K and L_∞: 0.78 year^{-1}, 61.5 cm and 0.52 year^{-1}, 76.8 cm were obtained. The natural mortality (M) was estimated at 1.46 year^{-1}. The present level of exploitation estimated using the catch curve and cohort analysis was E = 0.24 and 0.14, respectively. A relative yield-per-recruit analysis showed that a higher yield could be obtained if effort were increased. These results together with catch data analysis suggest that the kawakawa stock on the west coast of Sri Lanka is not fully exploited.

Introduction

Kawakawa *(Euthynnus affinis)* is the dominant species among the small tunas caught in Sri Lankan waters. The present annual production of kawakawa is around 1,500 tonnes, about 51% of the small tuna and 7% of all tuna landed on the island. The production of kawakawa from the west coast of Sri Lanka was about 680 tonnes in 1987.

The bulk of this production now comes from drift gillnets and multiple-hook troll lines (Maldeniya et al. 1987). Pole and line fishing has declined in the recent past, but is still responsible for some production of small tunas in the south.

Previous studies on kawakawa have mainly considered the fishery, distribution and growth (Sivasubramanium 1970; Joseph et al. 1986). The present analysis is based on monthly length-frequency distributions for estimates of growth parameters, mortality rates and the present level of exploitation, with a view to understanding the status of this stock.

Materials and Methods

Field officers of the tuna sampling program, conducted jointly by the Indo-Pacific Tuna Programme (IPTP) and the National Aquatic Resources Agency (NARA) of Sri Lanka, collected length-frequency data from three landing sites on the west coast of Sri Lanka, namely Kandakuliya, Negombo and Beruwala, from August 1986 to July 1987.

Sampling was carried out every other day of each month. Samples of kawakawa landed by all types of crafts and gear were measured to the nearest centimeter. The length-frequency distributions of the fish sampled were later raised to the total production.

Length measurements were grouped into 2-cm intervals and the monthly length data were then analyzed using the compleat ELEFAN package (Gayanilo et al. 1988). This computer package provides a curve-fitting routine which allows one to examine the goodness of fit of a growth function for many different sets of parameters. The growth parameters K and L_∞ of the von Bertalanffy growth equation were estimated by ELEFAN I. Total mortality was estimated from a length-converted catch curve which makes use of growth parameters and length-frequency data (ELEFAN II).

Two alternate methods were used to estimate natural mortality (M). One is Pauly's (1980) formula which use growth parameters and mean environmental temperature. The other formula is that of Rikhter and Efanov given in Garcia and Le Reste (1981) which uses mean age at first maturity, i.e., the length at 50% maturity, which was obtained from the literature. Several studies indicate that kawakawa attains maturity at about 40 cm (Klinmuang 1978; Cheunpan 1984; Muthiah 1986). The age corresponding to this length (40 cm) was obtained using the estimated growth parameters in the von Bertalanffy growth equation and assuming t_0 equal to zero. The recruitment pattern of kawakawa was obtained by projecting the length-frequency data backward into a one-year time axis.

The level of exploitation rate which maximizes yield per recruit was estimated using the relative yield/recruit (Y'/R) model of Beverton and Holt (1964) as modified by Pauly and Soriano (1986). Jones' length-cohort analysis (Jones 1981) was performed to estimate the fishing mortality and mean population sizes at different length classes.

Results

The production of kawakawa in Sri Lanka has declined since 1982, mainly due to the change in the fishing patterns over the past few years.

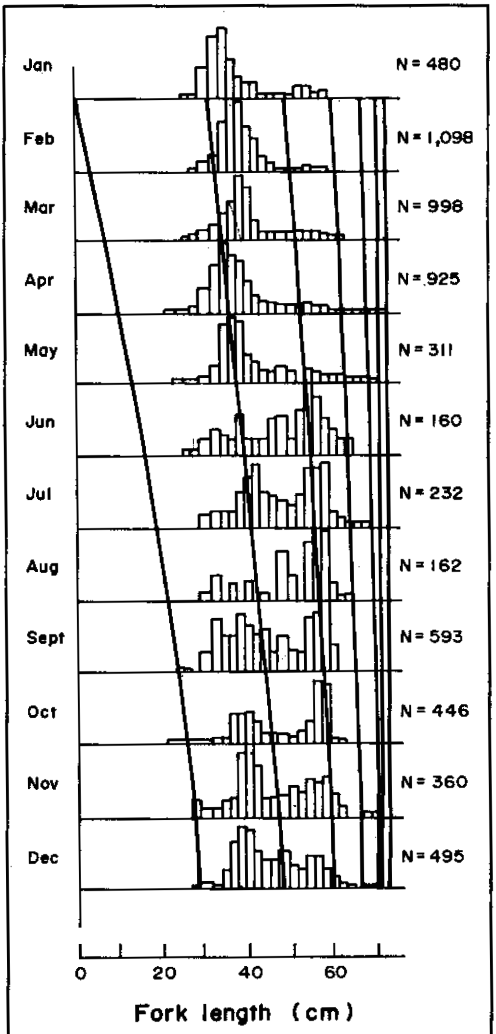

Fig. 1. Length-frequency distribution of *Euthynnus affinis* with the growth curve estimated by ELEFAN I.

The pole and line and the trolling fisheries, which were the main kawakawa fishing methods, have declined due to the popularization of drift gillnets which target instead skipjack and yellowfin tuna in the offshore areas. The production dropped from 1982 (5,380 tonnes) to 1987 (1,541 tonnes).

Monthly lengths of kawakawa, obtained from all gears, ranged from 21 to 74 cm fork length (Fig. 1). Two sets of parameters which best fit the length-frequency data were obtained. They are:

(1) L_∞ = 61.5 cm
K = 0.78 $year^{-1}$

(2) L_∞ = 76.8 cm
K = 0.52 $year^{-1}$

It was decided to use the second set of growth estimates for further analysis because the value of L_∞ (76.8 cm) appears more realistic. In the present analysis, there were few fish greater than 62 cm, but larger fish are well represented in other parts of the Indian Ocean region (Thailand, Indonesia) (Yesaki 1989).

Total mortality (Z) estimated by the length converted catch curve for the set of parameters $L_\infty = 76.8$ and $K = 0.52$ was 1.89 $year^{-1}$ (Fig. 2). Natural mortality (M) estimated with the same parameters using Pauly's formula was 0.90, while M estimate made by considering the mean age at first maturity was 1.46 $year^{-1}$. The reliability of the natural mortality estimates made by Pauly's formula for schooling pelagic fish

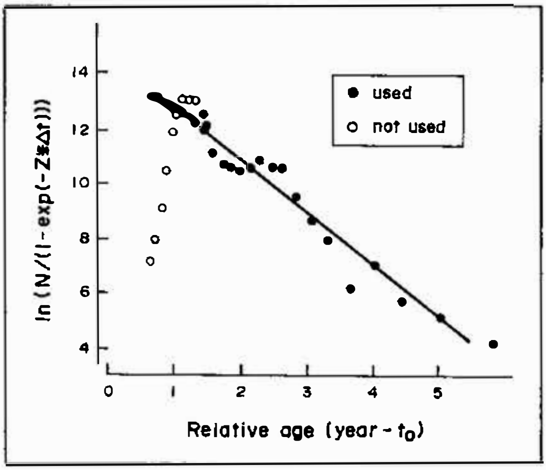

Fig. 2. Length-converted catch curve for *Euthynnus affinis* estimated by ELEFAN II.

such as kawakawa is questionable. The M value estimated by the said formula for schooling fish such as clupeids has shown significant deviations (Pauly 1980). Therefore the M value estimated by considering the age at first maturity was used in further analyses.

The parameters Z estimated by the catch curve and the M estimated by considering the age at 50% maturity were used to calculate the exploitation rate E = F/Z as 0.24.

Fig. 3 shows the recruitment pattern for kawakawa. Recruitment occurs throughout the year with one major peak and another minor peak separated by a period of about 4 months.

According to the results of this analysis, the maximum yield per recruit could be obtained at an exploitation rate of 0.6 (Fig. 4). Compared to this value and to Gulland's optimal value of exploitation rate, where E is set to 0.5 (Gulland 1971), the kawakawa stocks on the west coast of Sri Lanka can be considered to be lightly exploited.

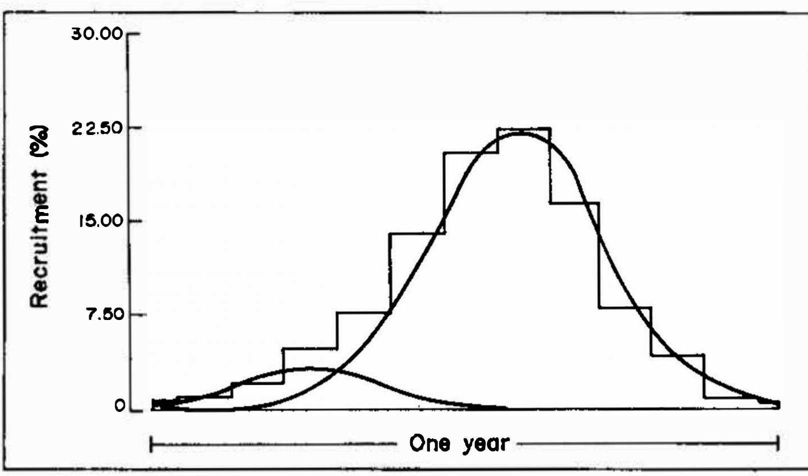

Fig. 3. Recruitment pattern for *Euthynnus affinis* as obtained from ELEFAN II.

The catch at length data were used to calculate the fishing mortality for different length groups, with M = 1.45. The terminal fishing mortality was set at $F_t = 0.1$ year^{-1}. The results of the analysis are shown in Table 1 and Fig. 5.

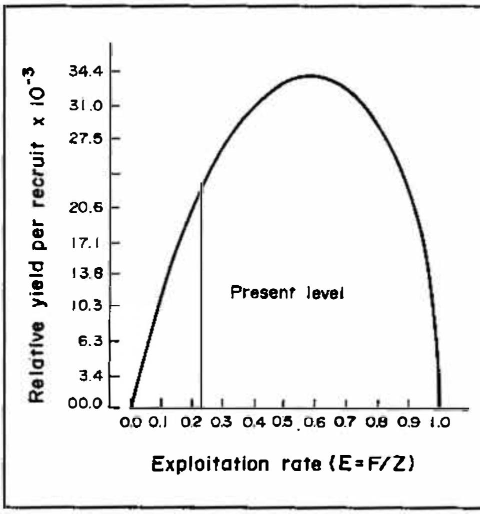

Fig. 4. Relative yield-per-recruit of *Euthynnus affinis*. Arrow indicates the present level of exploitation.

Discussion

The commercially exploited size range of kawakawa from the western coast of Sri Lanka is 21-74 cm. Previous studies have also shown that the commercial fisheries for kawakawa exploited mainly fish within this size range (Sivasubramanium 1970; Joseph et al. 1986). Since there has been a decline in the pole and line and trolling fisheries, the number of fish caught below 30 cm has decreased. These gears are operated mainly in nearshore waters where small kawakawa are found.

The available information on age and growth of kawakawa are all based on length-frequency data. Yoshida (1979) reviewed available information on age and growth of kawakawa mainly from Seychelles, Aden and Red Sea areas. The length-at-age values were 25-35, 45, 50-65, 65-80 for one, two, three, four and five-year-old fish. Similar estimates of length at age were obtained for kawakawa from Indian waters (Silas 1985). The approximate length-at-age values computed by Joseph et al. (1986) for kawakawa from Sri Lankan waters were 28-39, 42-45, 51-53, 55-58 for one, two, three and four years, respectively. According to the present analysis, the estimated lengths at age 1, 2, 3 and 4 year were 31, 50, 62 and 59-67 cm, respectively. Yesaki (1989) examined length-frequency data of kawakawa collected from Thailand and found that the growth estimates depend on the time interval used in grouping data (i.e., monthly vs. 10-day intervals). The growth curve for kawakawa for data grouped by 10-day intervals suggested faster growth rate with a length of 47 cm at one year. Essentially the same data when grouped in monthly intervals suggested a slower growth rate, with a length of 33 cm at age one year.

Table 1. Length cohort analysis of *Euthynnus affinis* with M = 1.45 $year^{-1}$.

Length class (lower limit)	Catches (N)	Population	F ($year^{-1}$)
21.00	1.33	33,956.82	0.006
23.00	2.85	30,666.65	0.0013
25.00	9.69	27,586.90	0.0049
27.00	38.69	24,706.48	0.0210
29.00	156.97	21,998.90	0.0923
31.00	295.20	19,376.94	0.1900
33.00	519.29	16,829.03	0.3718
35.00	559.65	14,284.46	0.4534
37.00	551.91	11,935.10	0.5126
39.00	387.86	9,822.12	0.4152
41.00	263.78	8,073.88	0.3248
43.00	104.83	6,638.50	0.1474
45.00	72.59	5,502.63	0.1161
47.00	73.38	4,523.44	0.1345
49.00	68.94	3,659.07	0.1466
51.00	80.37	2,908.23	0.2015
53.00	111.62	2,249.61	0.3399
55.00	96.54	1,661.88	0.3689
57.00	94.41	1,185.94	0.4691
59.00	41.75	799.71	0.2751
61.00	19.11	537.90	0.1668
63.00	9.91	352.64	0.1167
65.00	2.02	219.61	0.0331
67.00	5.18	128.99	0.1263
69.00	1.63	64.31	0.0663
71.00	1.10	26.93	0.0876
73.00	0.49 (C_t)	7.61 (N_t)	0.1000 (F_t)

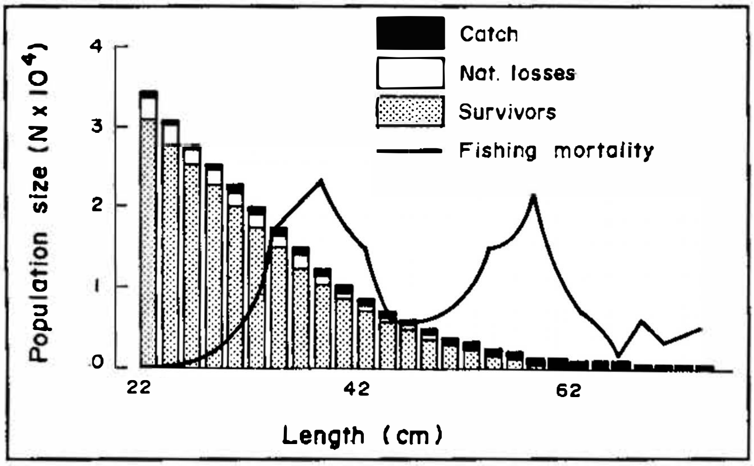

Fig. 5. Length cohort analysis of *Euthynnus affinis* (L_∞ = 76.75 cm, K = 0.52, M = 1.45, F_t = 0.1. Mean E = 0.11, Mean F = 0.17/year).

It can be seen that there are inconsistencies in length-at-age estimates obtained by length-frequency analyses. Castro and Erzini (1988) pointed out the possible errors that occur when length-frequency analysis is used for growth and mortality estimates, without other supporting biological information on growth, mortality and recruitment pattern.

Another independent estimate and other relevant information were also gathered to compare with the present findings. A preliminary study carried out by the first author on daily growth rings in otoliths of kawakawa has supported the fast growth estimate. Ring counts made on about 20 otoliths of juvenile kawakawa (up to 25 cm FL) indicate an age of about 5 months for 25-cm fish (Dayaratne, unpublished data). Accordingly, the present level of low exploitation is reasonable.

The fishing mortality (F) at length array (Fig. 5) shows two peaks at 38 and 58 cm and a low in the 42-52 cm length interval (F = about 0.1). The drop in fishing mortality for this length range could be a reflection of a behavioral pattern rather than a reflection in gear efficiency, as gillnets with a combination of stretched mesh size 7-16 cm are used by the majority of boats. According to the fast growth estimate, fish in the 42-52 cm range are around one year old, the age at which this species spawns. Spawning migration towards nearshore waters, away from the fishing ground, could be the reason for the low fishing mortality in this size group. The mean fishing mortality estimated by the cohort analysis was 0.23 with a mean exploitation rate of 0.14.

According to Castro and Erzini (1988), the catch-curve analysis in ELEFAN II tends to overestimate the total mortality Z. If this is so, the actual fishing mortality is even lower than our estimates. This further supports the view that the stocks of kawakawa on the west coast of Sri Lanka are not fully exploited. There may be a potential for the expansion of this fishery. Further studies to obtain more reliable estimates of growth such as by daily growth rings, should be carried out to confirm this conclusion.

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