ESTIMATION OF MORTALITY RATES OF THE OIL SARDINE, *SARDINELLA LONGICEPS* VAL.

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ABSTRACT

The mortality rates of oil sardine, *Sardinella longiceps* from Karwar have been estimated based on the age composition of the fishery by adopting the method of Beverton and Holt. The values obtained are 2.43, 1.57, 3.70 and 2.96 for instantaneous total mortality and 0.98, 0.12, 2.25 and 1.51 for the fishing mortality durig 1965-66, 1966-67, 1967-68 and 1968-69 seasons respectively. The natural mortality obtained in the final iteration process is 1.45. The estimation shows considerable changes from year to year in the values of both total and fishing mortalities due to short-term changes in abundance of fish.

INTRODUCTION

Several workers (Balan, 1959; Radhakrishnan, 1969 and others) on the oil sardine, *Sardinella longiceps*, have opined that the average length attained by this species at the end of the first, second and third years of life is 135-140 mm, 160-165 mm and 185-190 mm respectively. Similar conclusions have been arrived at by the author at Karwar (Annigeri, 1972). Based on this and on the assumption of homogeneity in the populations, different year-classes are separated into different age-groups as O, I+, II+ etc., and the catch per-unit effort in numbers for various ages is utilised for estimating the mortality rates. Utilising the data on the age composition of the fishery for four seasons from 1965-66 to 1968-69, the mortality rates are estimated.

METHODS

As far as possible the samples were drawn on all days of oil sardine fishery. The total catch in numbers was calculated based on the observations of all the units made in a month and the season's catch in numbers was then obtained by summing up catch in numbers of all the months for the season (August to July). The estimations of effort and catch per unit effort were made by taking the fishing hours of 'rampan' net as a natural unit and summing up the total for the season when there was fishery. The catch per unit effort is expressed in terms of a standard fishing unit as recommended by Banerji (1967) when the fishery is exploited by various types of gears. The

standard fishing unit is taken as 'rampan' and the catch per unit effort is presented in Table 1.

Beverton and Holt (1957) have derived from the catch equation the formula;

$$qf_i + M = \log_e \left(\frac{Cl_i/f_i}{C2_{i+1}/f_{i+1}} \right) + \log_e \left(\frac{Z_i\,(1-e^{-Zi+1})}{Z_{i+1}\,(1-e^{-Z_i})} \right)$$

where 'qfi' is the fishing mortality rate, 'M' is the natural mortality rate and Z_i is the total mortality rate, Cl_i, f_i, $C2_{i+1}$, and f_{i+1} are catch and effort for the first and second seasons respectively. This is the linear equation in 'f_i, whose slope is the catchability (q) and whose 'Y-intercept' is the natural mortality (M). The right hand side of the equation is an estimate of Z_i; it depends upon $C1_i$, $C2i_{+1}$ f_i, f_{i+1}, (catch and effort) as well as q and M. The values of q and M can be solved by iterative procedure as explained later.

Estimation of Mortality Rates

The catch per unit effort for different age groups during different years was calculated and utilised for arriving at mortality rates. As higher age groups tend to form a minor percentage, the combination of 0 and I+, and I+ and II+ is utilised to illustrate this method as indicated in Table 1.

Table 1. *Catch and effort data combined for different age groups during different seasons for standard fishing unit.*

Seasons	1965-66	1966-67	1967-68	1968-69
Effort	423	52	968	653
Catch/unit effort for ages:				
i) O	173.92	171.59	946.18	642.87
ii) I +	353.23	38.67	24.42	29.69
iii) II +	2.57	15.65	0.61	1.13
iv) O and I +	527.15	210.26	970.60	672.56
v) I + and II +	—	54.32	25.03.	30.82
Z_i values	2.27	2.13	3.45	—

(i) *Total instantaneous mortality rates*

The total instanteneous mortality rates calculated for different years are shown in Table 1. The total mortality values plotted against efforts give the slope as the catchability $q_i = 0.0015$ and the Y-intercept at 1.90 as an estimate of natural mortality, M_1. These values of q and M are used to calculate new values of Z_i and a

new regression line of Z_i on f_i is got for the improved values. The slope of the line and intercept at q_2 and M_2, which are 0.0020 and 1.60 respectively are the new estimates of q and M. Substituting these new values of q and M in the Z_i an improved estimate of Zi_2 is obtained. The final iteration yields $q_5 = 0.0023$ and $M_5 = 1.45$ and again an improved set of Z_i values are calculated. The values of last iteration when there is little change in the Z_i values, are the final set of improved values of catchability and natural mortality rates. These values are presented in Table 2 and Fig 1.

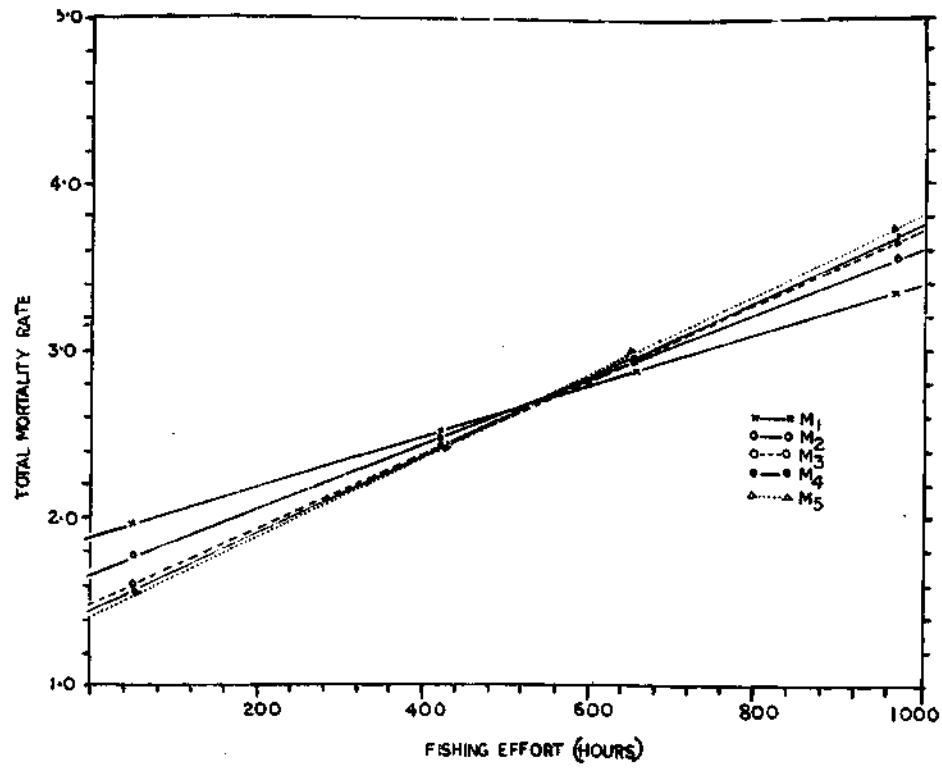

FIG. 1. The regression of total mortality on the fishing effort; M_1-M_5 indicate natural mortality rates intersecting the Y-axis in 5 iteration processes, giving the refined value M=1.45 in the final iteration process.

(ii) *Instantaneous natural mortality rates*

The total mortality may be partitioned into natural mortality and mortality due to fishing. The natural mortality has been estimated as already stated under total instantaneous mortality rates. These rates thus derived are presented in Table 2 and Fig. 1.

(iii) *Fishing mortality rates*

Fishing mortality is the component of total mortality and may be determined by using the catchability rate (q) and the associated fishing effort for different fishing seasons. These rates are shown in Table 2.

TABLE. 2. *Total instantaneous rates of mortalities* (Z_{i1}, Z_{i2}, Z_{i3}, Z_{i4}, Z_{i5}), *fishing mortalities* (qf_{i1}, qf_{i2}, qf_{i3}, qf_{i4}, qf_{i5}), *natural mortalities* (M_1, M_2, M_3, M_4, *and* M_5) *and catchability rates* (q_1, q_2, q_3, q_4 *and* q_5) *in the five iteration processes.*

Seasons	Z_{i1}	Z_{i2}	Z_{i3}	Z_{i4}	Z_{i5}
1965-66	2.53	2.46	2.44	2.43	2.43
1966-67	1.98	1.71	1.61	1.58	1.57
1967-68	3.35	3.57	3.66	3.68	3.70
1968-69	2.87	2.93	2.95	2.96	2.96
Seasons	qf_{i1}	qf_{i2}	qf_{i3}	qf_{i4}	qf_{i5}
1965-66	0.63	0.86	0.94	0.97	0.98
1966-67	0.08	0.11	0.12	0.12	0.12
1967-68	1.45	1.97	2.16	2.22	2.25
1968-69	0.98	1.33	1.46	1.50	1.52
	M_1	M_2	M_3	M_4	M_5
	1.90	1.60	1.48	1.46	1.45
	q_1	q_2	q_3	q_4	q_5
	0.0015	0.0020	0.0022	0.0023	0.0023

REMARKS

Even though tagging experiments on oil sardine were conducted at Karwar the survival and mortality estimates were not made due to inadequate data. The mortality rates derived here are based on the age composition of the fishery in different years. The formula derived by Beverton and Holt for varying effort has been utilised here in arriving at the mortality rates. Ricker (1968) calculates mortality rates from the surival rates and the principle involved in arriving at these rates by both is the same.

The gears employed in most of the months of the year were 'yendi' and 'rampan'. However, in some years cast nets are operated on a smaller scale. In computing the effort data 'rampan' is taken as a common net and the catch per unit is expressed in terms of a standard fishing unit as shown in Table 1 for different years. As judged from this table the higher age groups are not represented uniformly in all

the seasons. Since the fishery itself is of a fluctuating nature certain seasons show very low abundance of fish. The mortality rates show wide fluctuations from year to year on account of short-term annual changes in the available stocks.

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