POPULATION DYNAMICS AND STOCK ASSESSMENT, OF KOTH 
(OTOLITHOIDES BIAURITUS, CANTOR, 1850) 
ALONG THE NORTH-WEST COAST OF INDIA 
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ABSTRACT 
MSY, growth, selection and mortality parameters of Otolithoides biauritus have been worked out from data collected by MFV Saraswati of CIFE, and length frequency data from Ferry Wharf, Sasson dock, and Versova fish landing centres of Bombay. Values of $L_\infty$, $K$, and $t_0$ obtained from length frequency study are 1572mm, 0.2633/yr and 0.0289 yr respectively, and of weight growth parameters are $W_\infty = 10067g$, $K= 0.03904/yr$ and $t_0 = 0.0137yr$. Selection parameters are $L_r + 150$mm, $t_r + 0.4167$ yr $L_c + 240$mm and $t_c = 0.6367yr$. Selection factor (K) for codend worked out to be 12. Based on $Z=0.6486$, the MSY of Otolithoides biauritus off northwest coast of India is assessed as 1,802 tons which is slightly higher than the current catch level of 1,634 tons.

INTRODUCTION 
Otolithoides biauritus which is one of the important species of sciaenids, locally called as 'Koth' contribute about 3% of the sciaenid landing. In fishmarkets, Koth is generally sold in fresh condition without processing. It fetches higher price than all other species of Sciaenids except 'Ghol' (Pseudosciadinae diaicanthus). Although some basic aspects of its taxonomy and biology have been studied by early workers, such as Kutty (1967) on the biology, Jayaprakash (1973, 1974 & 1976) on vertebrae, food and feeding habit and age and growth of Koth, studies on population biology, which is so much required for the management of the fishery resources of this species is very limited. The present studies deal with the aspects of stock assessment of this species off northwest coast of India.

MATERIAL AND METHODS 
The length frequency data of 2,072 specimens of Otolithoides biauritus recorded at weekly intervals from Ferry Wharf, Sasson dock and Versova landing centres of Bombay, beside data collected from MFV Saraswati while on cruises, during the year 1987 - 1988 also have been utilised for this paper.

Age has been determined following Devaraj (1983) by tracing the modal progression of monthly length frequency scatter diagram. The empirical age-weight relationships were estimated by employing von Bertalanffy Growth Function (VBGF), converting length to weight from length relation. The total of mortality coefficient ($Z$) was estimated from age composition data following Jackson (1939) and also applying Beverton and Holt (1956) method as supportive estimates to have better 'Z'. The natural mortality coefficient ($M$) was estimated following the empirical equation of Pauly (1980). Yield/recruit was estimated by using the incomplete beta function yield tables (Beverton and Holt, 1966). Since the entries in the table are independent of units of yields and numbers, E, C and $M/K$ were estimated for the equation (i) following Gulland’s computational procedure. Rafail’s iterative equation (1973) also was applied to have better L-C value.

The quantity of $Y/R$ computed in the tables was converted into grams/recruit at age $t_r$ by using the formula

$$\frac{R o W}{R} = W_\infty e^M (t_r - t_0) = W_\infty \frac{(1 - L_r)}{L_c}^{M/K-(1)}$$
The parameters 'E', 'C' and 'M/K' (ratio of co-efficients determining the relative rate of natural change in numbers and length with age) of age yields equation are purely algebraic and have functional interpretations.

The optimum age of exploitation (t) and potential yield per recruit (Y) were estimated according to Kutty and Quasim, (1968). The age at recruitment (tr) and age at first capture (tc) were determined arbitrarily from annual length frequency polygons for commercial and exploratory catches.

For the inshore fishery (in the 0 to 50 m deep grounds) operating on inshore section of total stock, the annual yield data (Y) was used for the estimation of (1) total stock P (P=Y/E where E=F/Z), (2) recruits, (Rc) at Lc (Rc=Y+Y/R), (3) Mean number YN (YN = Rc X YN/R) as postulated by Beverton and Holt (1957). The maximum sustainable yield (MSY) for the inshore ground was computed by calibrating the current catch on to the YIR curve. Length cohort analysis was performed as per Jones (1984).

The yield per recruit (Y/R) as function of fishing mortality co-efficient (F) was estimated as per the analytical model of Beverton and Holt (1957).

The sample frequencies were raised to total catches for the year ended 1987-1988 and average number caught in each class was used for mortality analysis.

RESULTS AND DISCUSSIONS

The length frequency plot (Fig.1) reveals appearance of three main broods in January-February, June-July and September-October in a year. There is not much variation in the origin of broods during the successive years. This fish attains a length of 353mm in the first year, 646mm in the second year and 790mm in the third year of its life (Fig.2). The maximum size was 806mm.

Length growth parameters have been estimated to be L = 1572 mm, K = 0.2633/yr t0 = 0.0289 yr. Weight growth parameters have been found to be W = 10067 g, K = 0.3904/yr, t0 = 0.0137 yr while, application of Rafail's iterative equation (1973) for better L and K values indicated L and K values to be 1533,173mm and 0.27876/yr respectively, which are very close to values obtained by VBGE.

Length at recruitment (Lr) and length at first capture (Le) have been worked out to be 150mm, and 240mm respectively, corresponding to 0.4167 year and 0.6367 year (Fig.3).

The selection factor (K) for trawl codend mesh (m=20 to 30mm stretched kont to knot in most commercial trawlers) has been estimated to be 12 (K=240/20=12), the optimum age of exploitation and potential Yield/Recruit (Y/R) were estimated to be 3.24yr and 2206g respectively.

The Yield/Recruit (Y/R) attains a maximum of 698.4g at F=0.411 for the present tc of 0.6367yr (keeping tc constant) (Fig.4) while optimum Yield/Recruit (Y/R) found to be 1178g at corresponding Lc=1132mm (keeping F constant) above F as depicted in Fig.5.

The maximum catch exploited from the NW coast inshore grounds (Gujarat and Maharashtra), during the period 1987-1988 belonged to 45.0 to 48.0cm length group which constituted 14.55% (111.019 tons) to annual catch of 765.385 tons. Length cohort analysis for year 1987-1988 reveals that the group 45.0 to 48.0cm suffered the maximum fishing mortality (F=3.9911) and the maximum exploitation ratio (F/Z=0.9068) (Table1).

The natural mortality rate (M) obtained by Pauly’s empirical equation (1986) at a mean temperature of 27.5° C gave annual m=0.41029, fishing mortality (F) was estimated as 0.2384, hence F/Z=0.3676

Four broods were found each year, three
The parameters 'E', 'C' and 'M/K' (ratio of co-efficients determining the relative rate of natural change in numbers and length with age) of age yields equation are purely algebraic and have functional interpretations.

The optimum age of exploitation ($t_2$) and potential yield per recruit ($Y$) were estimated according to Kutt and Quassin, (1968). The age at recruitment ($t_1$) and age at first capture ($L_c$) were determined arbitrarily from annual length frequency polygons for commercial and exploratory catches.

For the inshore fishery (in the 0 to 50m deep grounds) operating on inshore section of total stock, the annual yield data ($Y$) was used for the estimation of (1) total stock $P$ ($P=Y/E$ where $E=F/Z$), (2) recruits, ($R_c$) at $L_c$ ($R_c=Y+Y/R$), (3) Mean number $Y/N$ ($Y/N=R_cXYN/R$) as postulated by Beverton and Holt (1957). The maximum sustainable yield (MSY) for the inshore ground was computed by calibrating the current catch on to the $Y/R$ curve. Length cohort analysis was performed as per Jones (1984).

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Length growth parameters have been estimated to be $L = 1572$ mm, $K = 0.2633/yr$ $t_o = 0.0289$ yr. Weight growth parameters have been found to be $W = 1006.7$ g, $K = 0.3904/yr$, $t_o = 0.0137$ yr while, application of Rafael's iterative equation (1973) for better $L$ and $K$ values indicated $L$ and $K$ values to be 1533.173mm and 0.27876/yr respectively, which are very close to values obtained by VBGE.

Length at recruitment ($L_r$) and length at first capture ($L_c$) have been worked out to be 150mm, and 240mm respectively, corresponding to 0.4167 year and 0.6367 year (Fig.3)

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Four broods were found each year, three
Fig. 1: Growth of individual broods on the basis of the modes in the length frequency distribution for successive months.
Fig. 2: Growth curve indicating the mean length at successive age in month.
Fig. 3: Determination of the length at recruitment (L_r) and the length at first capture (L_c) from symmetrical 'O give' curve.

Fig. 4: Estimation of MSY and annual yield for various levels of exploitation from current yield and exploitation for the Northwest coast.
main broods and one auxiliary brood. On the basis of the growth in length study it has been observed that it grows 353mm, 646mm, and 848mm in the first, second and third year respectively. The maximum size specimen (798mm) sampled was 3yrs old. Length at infinity (Li) and corresponding weight worked out to be 1573.8mm and 10067g respectively. Growth co-efficient K for weight was found to be 0.39039/yr and corresponding length was found to be 0.26234/yr. Growth co-efficient value shows that growth of O. biouritus off NW coast of India is not fast except in the first two years.

Fig. 5 : Yield isopleth diagram depicting Y/R as function of length at first capture (Lc) and exploitation ratio (E)
Table I: Length Cohort analysis of the Koth, Otolithoides biauritius, caught off North-west Coast

<table>
<thead>
<tr>
<th>Length group (cm)</th>
<th>Number caught (in 000)</th>
<th>Exploitation ratio (F/Z)</th>
<th>Total mortality</th>
<th>Catch landed (tons)</th>
<th>Biomass (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0-09.0</td>
<td>745.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>9.0-12.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>12.0-15.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>15.0-18.0</td>
<td>9,687</td>
<td>0.1242</td>
<td>0.4684</td>
<td>0.421</td>
<td>91.439</td>
</tr>
<tr>
<td>18.0-21.0</td>
<td>45,453</td>
<td>0.4053</td>
<td>0.6898</td>
<td>3.079</td>
<td>137.014</td>
</tr>
<tr>
<td>21.0-24.0</td>
<td>29,060</td>
<td>0.3113</td>
<td>0.5956</td>
<td>2.901</td>
<td>190.765</td>
</tr>
<tr>
<td>24.0-27.0</td>
<td>50,669</td>
<td>0.4492</td>
<td>0.7447</td>
<td>7.048</td>
<td>252.750</td>
</tr>
<tr>
<td>27.0-30.0</td>
<td>1,11,770</td>
<td>0.6556</td>
<td>1.1910</td>
<td>20.879</td>
<td>318.378</td>
</tr>
<tr>
<td>30.0-33.0</td>
<td>1,87,774</td>
<td>0.7819</td>
<td>1.8942</td>
<td>46.305</td>
<td>373.660</td>
</tr>
<tr>
<td>33.0-36.0</td>
<td>1,63,920</td>
<td>0.7839</td>
<td>1.8982</td>
<td>50.802</td>
<td>400.943</td>
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<tr>
<td>36.0-39.0</td>
<td>1,38,595</td>
<td>0.7820</td>
<td>1.8812</td>
<td>53.580</td>
<td>419.320</td>
</tr>
<tr>
<td>39.0-42.0</td>
<td>1,91,499</td>
<td>0.8588</td>
<td>2.9051</td>
<td>90.790</td>
<td>430.210</td>
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<tr>
<td>42.0-45.0</td>
<td>1,75,597</td>
<td>0.8808</td>
<td>3.4413</td>
<td>101.172</td>
<td>392.118</td>
</tr>
<tr>
<td>45.0-48.0</td>
<td>1,61,694</td>
<td>0.9608</td>
<td>4.4013</td>
<td>111.019</td>
<td>330.070</td>
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<tr>
<td>48.0-51.0</td>
<td>97,612</td>
<td>0.8998</td>
<td>4.0938</td>
<td>78.764</td>
<td>246.630</td>
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<tr>
<td>51.0-54.0</td>
<td>53,650</td>
<td>0.8787</td>
<td>3.3819</td>
<td>50.586</td>
<td>185.912</td>
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<tr>
<td>54.0-57.0</td>
<td>3,88,447</td>
<td>0.8811</td>
<td>3.4502</td>
<td>42.331</td>
<td>148.710</td>
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<tr>
<td>57.0-60.0</td>
<td>16,393</td>
<td>0.8091</td>
<td>4.6485</td>
<td>20.541</td>
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<tr>
<td>60.0-63.0</td>
<td>20,886</td>
<td>0.3831</td>
<td>0.6649</td>
<td>2.865</td>
<td>98.706</td>
</tr>
<tr>
<td>63.0-66.0</td>
<td>19,373</td>
<td>0.8744</td>
<td>3.2662</td>
<td>31.522</td>
<td>108.103</td>
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<tr>
<td>66.0-69.0</td>
<td>1,88,412</td>
<td>0.8761</td>
<td>3.3103</td>
<td>24.617</td>
<td>81.279</td>
</tr>
<tr>
<td>69.0-72.0</td>
<td>2,235</td>
<td>0.6032</td>
<td>1.0338</td>
<td>4.604</td>
<td>59.677</td>
</tr>
<tr>
<td>72.0-75.0</td>
<td>5,961</td>
<td>0.8315</td>
<td>2.4346</td>
<td>13.714</td>
<td>58.134</td>
</tr>
<tr>
<td>75.0-78.0</td>
<td>2,980</td>
<td>0.7619</td>
<td>1.7233</td>
<td>7.622</td>
<td>46.288</td>
</tr>
<tr>
<td>78.0-81.0</td>
<td>5,216</td>
<td>0.3676</td>
<td>0.6446</td>
<td>0.145</td>
<td>40.179</td>
</tr>
</tbody>
</table>

Annual fishing mortality (F=0.2384) is comparatively low since annual natural mortality and total mortality were found to be 0.41034 and 0.6986 respectively. According to Beverton and Holt (1956), Z=1.982933.

The optimum age of exploitation was 3.24yr; at this optimum age of exploitation and fishing mortality at highest rate of exploitation (E=1) the potential Yield/Recruit was found to be 1178g (Fig.5) which is not very close to the potential Yield/Recruit (2206.3g) following Kutty and Quasim (1968), hence yet to be increased by undertaking management measures an intermediate yield of these two yields should be taken.

The stock of O.biauritius along the NW coast of India is 4416 tons, present yield from this stock along the NW coast is 1634 tons and average annual yield of the fish along the NW coast of India at an exploitation rate of 0.37 is close to its maximum sustainable yield of 1,802 tons. Scope for increasing efforts for more exploitation of this species is very less.
REFERENCES


Jones, R., 1984 Assessing the effects of changes in exploitation pattern using length composition data (with notes on VPA and cohort analysis). FAO Fish. Tech.paper No.256.


