Population dynamics of sciaenid *Johnius macrorhynus* (Pisces/Perciformes/Sciaenidae) from Bombay waters

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Received 5 July 1993; revised 21 March 1994

von Bertalanffy's growth equation was used to describe growth of *Johnius macrorhynus* (Mohan). The values estimated were \( L_{\infty} = 331 \text{ mm} \), \( K = 0.5415 \) (annual) and \( t_0 = -0.07876 \) y and \( W_{\infty} = 323 \text{ g} \). This species reached 143, 224 and 270 mm at the end of I, II and III years of its life respectively. The average total, natural and fishing mortality coefficients were 2.87, 1.18 and 1.69 respectively. Exploitation rate and ratio were 0.555 and 0.588 respectively. Yield per recruit study showed that at the present level of age of capture \( t_c \) of 0.9261 years and fishing mortality \( F \) 1.69, the \( Y/R \) is 17.71 g. Average total and standing stocks were estimated as 2286.50 and 750.89 ton respectively as compared to the present average yield of 1269.01 ton.

Sciaenids roughly contributes 8-10% of the total fish catch at Bombay. Various aspects of sciaenids have been studied from different localities of India. The present communication deals with the age, growth, mortality, yield per recruit and stock assessment of *Johnius macrorhynus* (Mohan) from Bombay coastal waters.

Materials and Methods

The study is based on the length frequency data collected from 7007 specimens (length range 90-310 mm) from the commercial landings. Data were grouped in 10 mm class intervals for the study of growth parameters and raised for the day and subsequently for the month. For the study of growth modal progression analysis was used. Growth was expressed by von Bertalanffy's equation:

\[
L_t = L_{\infty} [1 - e^{-K(t-t_0)}]
\]

\( L_{\infty} \) and \( K \) were estimated by Ford-Walford plot and \( t_0 \) was calculated by regression of \( \text{log}(L_t/L_{\infty})/(Y) \) against age \( t(X) \). The instantaneous rate of total mortality coefficient \( Z \) and the natural mortality rates \( M \) were calculated. Fishing mortality rate was calculated by subtracting \( M \) from \( Z \). The exploitation ratio \( E \) and exploitation rate \( U \) were calculated following Beverton and Holt.

Total and standing stocks were derived from the formula \( Y/U \) and \( Y/F \) respectively. The maximum sustainable yield (MSY) was calculated. Here a multiplicative factor of 0.4 was used instead of 0.5. Asymptotic weight \( W_{\infty} \) was calculated at asymptotic length \( L_{\infty} \) using the length weight relationship. The smallest fish recorded in the catch was taken as length at recruitment \( L_r \). Using VBGF the same was converted to age at recruitment \( t_r \). The length at first capture was derived as per Beverton and Holt. The yield in weight per recruit \( Yw/R \) was calculated by Beverton and Holt's formula given as

\[
Yw/R = Fe^{-M(t_r-t_c)}W_{\infty}\left(\frac{1}{Z} - \frac{3S}{Z+K}\frac{Z+2K}{Z+3K}\right)
\]

where \( S = e^{-K(t_r-t_c)} \).

The selection factor (SF) of the gear in question was calculated as per Jones formula given as SF = present length at first capture \( L_{\text{rec}} \)/present cod end mesh size. The cod end mesh size of the shrimp trawl in operation was 25 mm.

Results and Discussion

Eleven growth curves of almost identical shapes were obtained in the scattergram (Fig. 1). Taking average of the same, growth was read at quarterly intervals for fitting the Ford-Walford plot. By applying the method of least square the \( L_{\infty} \) and \( K \) were calculated as 331 mm and 0.5415 (annual).
The $t_b$ was calculated as $-0.07876$ years. This species attains 143, 224 and 270 mm at the end of I, II and III years respectively of its life. The VBGf formula for this species could thus be written as

$$L_t = 331 \left[ 1 - e^{-0.5415t} \right]$$

The Ford-Walford plot and growth curve of this species are presented in Figs 2 and 3.

The total mortality coefficient ($Z$) varied from 2.19 to 3.78 with average being 2.87. The natural mortality coefficient ($M$) was calculated as 1.18. Fishing mortality coefficient varied from 1.01 to 2.60 with an average of 1.69. The average exploitation rate and ratios were 0.555 and 0.588 respectively. Average total and standing stocks were estimated as 2286.50 and 750.89 ton respectively, as compared to the present yield of 1269.01 ton and MSY of 862.02 ton (Table 1).

The length at first capture were 90 mm and 135 mm at which, employing VBGf, the ages were calculated as 0.561 and 0.9261 $Y$ respectively.

<table>
<thead>
<tr>
<th>Year</th>
<th>$Z$</th>
<th>$M$</th>
<th>$F$</th>
<th>$U$</th>
<th>$E$</th>
<th>Yield (ton)</th>
<th>Total stock (Y/U) (ton)</th>
<th>Standing stock (Y/F) (ton)</th>
<th>MSY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979-80</td>
<td>2.72</td>
<td>1.18</td>
<td>1.54</td>
<td>0.528</td>
<td>0.566</td>
<td>1239.20</td>
<td>2346.97</td>
<td>804.67</td>
<td>875.48</td>
</tr>
<tr>
<td>1980-81</td>
<td>2.19</td>
<td>1.18</td>
<td>1.01</td>
<td>0.409</td>
<td>0.461</td>
<td>1325.79</td>
<td>3241.54</td>
<td>3209.44</td>
<td>2045.17</td>
</tr>
<tr>
<td>1981-82</td>
<td>2.87</td>
<td>1.18</td>
<td>1.69</td>
<td>0.555</td>
<td>0.588</td>
<td>1746.59</td>
<td>3147.00</td>
<td>1862.13</td>
<td>1577.56</td>
</tr>
<tr>
<td>1982-83</td>
<td>2.77</td>
<td>1.18</td>
<td>1.59</td>
<td>0.538</td>
<td>0.574</td>
<td>1173.67</td>
<td>2181.54</td>
<td>1372.03</td>
<td>1117.06</td>
</tr>
<tr>
<td>1983-84</td>
<td>3.78</td>
<td>1.18</td>
<td>2.60</td>
<td>0.672</td>
<td>0.688</td>
<td>888.48</td>
<td>1322.14</td>
<td>508.51</td>
<td>595.41</td>
</tr>
<tr>
<td>1984-85</td>
<td>2.94</td>
<td>1.18</td>
<td>1.76</td>
<td>0.566</td>
<td>0.598</td>
<td>1240.33</td>
<td>2191.39</td>
<td>1245.10</td>
<td>1083.82</td>
</tr>
<tr>
<td>Average</td>
<td>2.87</td>
<td>1.18</td>
<td>1.69</td>
<td>0.555</td>
<td>0.588</td>
<td>*1269.01</td>
<td>2286.50</td>
<td>750.89</td>
<td>862.02</td>
</tr>
</tbody>
</table>

*Average is for $Z$ and yield only

$Z$, $M$ and $F$ are the instantaneous rates of total, natural and fishing mortality coefficients.

$E$ and $U$ are the exploitation ratio and exploitation rate respectively.

Standing and total stocks have been derived from the relationship $Y/F$ and $Y/U$ where $Y$ is the yield in ton.

MSY is the maximum sustainable yield in ton.
Yield ed. From Kakinada waters 7 M of which is within the values of M/K ratios suggest­
been estimated as 1.

changing the cod end mesh size at

YjR by

1-2.5. In the present study it was found to be 2.18
capture. By raising the mesh size at 10% of the

fected at th e present level of F at of 1.69.

30 %

30 mm resulting in increase of age at first

capture. By raising the mesh size at 10% of the

pre s ent thereby increasing the age at first capture

1.118 Y by changing the cod end mesh size . by

30% of the present there is a decline in the YjR by 0.14 g. All these changes in mesh size were ef­
fected at the present level of F at of 1.69.

In tropical multispecies multigear systems esti­
mation of M is the most difficult one. As precise
data on effective efforts of a particular species is
not available the conventional method of estimation
of natural mortality by Z against efforts often
gives erroneous results including negative ones39.
The rough generalization is that fish with a high
K value would have high M and vice versa. The argument behind this concept is that slow growing
(fish with a low K) cannot bear high natural mor­
tality and if it happens the species would soon be extinct39.

The M/K ratios of a fish21 mostly range from 1-2.5. In the present study it was found to be 2.18
which is within the values of M/K ratios suggest­
ed. From Kakinada waters7 M of J. carutta has
been estimated as 1.

That species has L∞ of 333 mm which is very
close to that of 331 mm obtained for J macrorhy­
nus in the present study.

The selection factor of 5.4 obtained in the pre­
sent study is within the range of 2-6 suggested by
Jones18. From the Gulf of Thailand18 the selection
factor of 3.2 was obtained for J. carutta with a
cod end mesh size of 3.2. However, if SF of 3.2 is
taken for the present study Lc would come to 80
mm which would be less than the length of rec­
cruitment obtained in the present study.

Increasing the F to 2.6 results in increase of
yield per recruit by only 0.457 g or 2.58% and
changing cod end mesh size thus resulting in age
at first capture also does not raise the YjR appre­
ciably.

Gulland22 suggested that a species appears opti­
mally exploited (Eopt) if the exploitation ratio is
upto 0.5. The E of this species is 0.588 which is
already beyond the Eopt and increasing F and tc.
does not result in corresponding higher yields.
Thus it would be better if the fishing efforts are
brought down slightly from the present level so
that there is no detrimental effect to the stock of
this species.

Acknowledgement

The author expresses his deep gratitude to Dr.
(Mrs.) P.V. Kagwade for guidance during the
course of study. Thanks are also due to Dr. E.G.
Sillas and Dr. P.S.B.R. James, former and present
Directors of CMFRI for their encouragement.
The technical assistance provided by Mr B.B.
Chavan is gratefully acknowledged.

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