Gillnets Selectivity of Cichlidae Sarotherodon Galilaeus (Linne 1758) in Iwo Reservoir, South West Nigeria

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Abstract: Catch-length frequency of Sarotherodon galilaeus using gillnets of different mesh sizes (63, 69, 76, 82 and 89 mm) in Iwo Reservoir were used to assess the selectivity parameters of the nets and the impact on cichlidae population. The reservoir was divided into two strata and fish sampling was randomly carried out fortnightly. Collected samples ranged from 13 to 23.5 cm (TL) depending on the mesh size. The selection factors were within 2.59 and 2.89. The standard deviation for optimum catch length ranged between 1.42 and 2.18. The optimum catch lengths for all the meshes were higher than the reported length at maturity for the species. A management strategy incorporating resource control and benefit to stakeholders were recommended for the fishery.

Key words: Gillnets %catch-length %cichlidae %selectivity %reservoir

INTRODUCTION

Fisheries management emphasis in recent years is tending towards conservation of biodiversity and the maintenance of a balanced environment. In line with this, there is the need to evaluate the response of stock to catch through gear selectivity. Moreso that as fishing effort targets smaller sized species and increases in magnitude, most taxa become rare and exploitation produces only a few species for which average catch length are small, thus even if total yield is constant, fish biomass and catch per unit effort is small. Though fisheries managers interest are increasingly focusing on the protection, conservation and surveillance of natural inland waters and large man-made lakes, little scientific interest has been given to small/community reservoirs especially in Nigeria. However, these habitats are well suited to provide response to emerging scientific challenges in fisheries/stock management because they are often fully or over exploited by multi specific and multi gear fisheries.

Gillnets are widely used in artisanal fisheries in developing countries because they are efficient, relatively inexpensive and capable of catching higher amount of commercially valuable species than other peasant gears [1].

The use of appropriate mesh size in gillnet fishery prevents the catch of juveniles and make it possible to catch fish of desirable narrow size range because of its high selectivity [2, 3].

This is because fish catchability and size selection by gillnet are influenced by factors which are related either to the characteristics of the fishing net or of the fish. Selectivity of gillnets has attracted the attention of various workers in different areas of the world [2, 4-7]. This is not so for Nigeria, despite promotion of selective fishing gear as one of the major strategy for inland fishing regulation [8].

Iwo reservoir southwestern Nigeria, like most reservoirs in the region, is cichlid dependent, however, due to dwindling unit catch and catch per unit effort of the species, fishers have resorted to exploiting the hitherto under exploited species; mormyrids, heptid and chryischthys, which has led to the use of small mesh gillnets. This study therefore investigates the effect of the small mesh gillnets on the length at capture vis-a-vis the effect on rejuvenation and economic survival of the fishers with a view to proffering appropriate management strategy for the fishery.
MATERIALS AND METHODS

Iwo reservoir is located in Iwo, Osun State, Southwest Nigeria between Lat. 07° 38’ and Long. 04° 11’ E. It is about 245 m, above seal level, with a surface area of about 28.75 ha and a catchments area of about 70 ha. It was built in the early fifties primarily for provision of potable water. It has river Ayiba as its major tributary. The reservoir drains into Osun River via Oba River and attains its flood level peak between June and July yearly. The amplitude of the reservoir is about 1 m. Its dry and wet season Mean Sea Level (MSL) is between 6.8 and 7.7 m.

The reservoir was stratified into two major strata of approximately equal areas; each stratum was further divided into shoreline and open water. Gillnet fleets comprising of ten nets with stretch mesh length 63, 69, 76, 82 and 89 mm of one gang each of mono and multifilament webbings were set randomly and simultaneously by three fishermen at about 15.00 h Universal Time (UT) according to individual fisherman’s preference fortnightly in each of the strata for two wet and dry seasons. Each net had a fishing area of 69 m² (30×2.3); with fleet area of 690 m². Hanging ratio for all the nets was 40% as recommended by Sparre and Venema [9]. Hauling was done at about 6.00h U.T., which gave an average soaking time of 15 h per net.

Soak time difference, between nets was minimized by hauling in order of setting [10, 11]. Leading effect on efficiency of nets/mesh was prevented by arranging the nets hap-hazardly and by creating gaps of 6 and 3 m between and within nets and meshes respectively, as described by Petrokis and Stergious [12]. Gears were changed seasonally to eliminate the effect of age/wear on seasonal efficiency.

Fish were removed from the net immediately they were hauled and sorted into species, according to net and mesh sizes. Fifty percent of fish caught per haul of each fisherman for the different net types, mesh sizes and the species were picked randomly and kept in separate containers for measurement.

Catch were measured to the nearest 0.5 cm Total Length (TL). Fish caught were grouped into 1-cm length class for the determination of the selectivity parameters for the gear.

Model for selectivity: Selectivity parameters for the study were estimated using the indirect method of Holts [13]. It assumed that given that catches (c_i/c_j) of two successive mesh sizes (m_i,m_j) overlap, their common standard deviation and estimates of optimum selection length for each of the mesh sizes can be obtained through a linear regression of the form:

\[ \ln(c_i/c_j) = a + bL \]

Where, ‘L’ is the length-class mid point and ‘a’ and ‘b’ are the intercept and slope of the linear regression respectively.

The mathematical formula for the model is given thus:

\[ \ln(c_i/c_j) = a + bL \]

\[ L_{m_i} = -2[(am_i)/(b(m_i + m_2))] \]

\[ L_{m_2} = -2[(am_2)/(b(m_i + m_2))] \]

\[ S.F = \left( \sum_{i=1}^{n_1} (ai/bi)(m_i + m_1 + 1)^2 / \sum_{i=1}^{m_1} (m_i + m_1 + 1)^2 \right) \]

\[ S.D = \sqrt{\frac{1}{n-1} \left( \sum_{i=1}^{n_1} -2ai(mi + 1 - mi) \right) / \sum_{i=1}^{n_1} bi^2(mi + m_1 + 1) } \]

\[ L_m = (SF)m \]

\[ P = \exp[-(L-L_m)^2/(2(SD)^2)] \]

In \( C_i/C_j = \log \) ratio, \( L_{m_i}, L_{m_2} = \) Optimum catch length for meshes \( m_i \) and \( m_2 \), SF = selection factor, S.D = common standard deviation for meshes \( m_i \) and \( m_2 \), p = probability of capture.

RESULTS

Catch length frequency distribution: A total of fifty hauls were made. However net/mesh, analyses of catch length frequency distribution were possible only for three different mesh sizes for the two net types (63, 69 and 76 mm) stretch length, due to limitations imposed by small number of individuals per net/mesh sizes. For the 82 and 89 mm mesh gillnets Fig. 1a and 1b) showed the length frequency distribution for fish caught by the different net types and mesh sizes. In general, the three mesh sizes caught relatively wide ranges of lengths and the modal lengths of the species caught gradually increased with increasing mesh sizes (Fig. 1a and 1b). The modal length for \( S.galilaeus \) increased from 15 cm total length TL, for 63 mm net to 17cm TL for the 76 mm net for the monofilament net (Fig. 1a), for the multifilament net. The modal length increased from 15 cm TL in the 63 mm
Assessment of gillnet selectivity: The values obtained for the successive pairs of gillnets were used for regression analysis. The slopes and intercepts of the regression of the natural logarithms of catch ratio for the different mesh size combinations against length-class mid-points, the optimum length and selection factor per mesh size combination and estimate values of standard deviation of catch ratios are presented in Table 1. The $R^2$ values (Table 1) were all statistically significant ($p<0.05$).
Table 1: Regressions values of log-transformed catch ratios for *S. galilaeus* on length-class mid points for different gillnet combinations

<table>
<thead>
<tr>
<th>Webbing</th>
<th>m₁</th>
<th>m₂</th>
<th>A</th>
<th>B</th>
<th>SE</th>
<th>r²</th>
<th>N</th>
<th>L₁</th>
<th>L₂</th>
<th>SF</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monofilament</td>
<td>63</td>
<td>69</td>
<td>-13.212</td>
<td>0.774</td>
<td>0.386</td>
<td>0.97</td>
<td>5</td>
<td>16.30</td>
<td>17.80</td>
<td>2.59</td>
<td>1.42</td>
</tr>
<tr>
<td></td>
<td>69</td>
<td>76</td>
<td>-8.097</td>
<td>0.405</td>
<td>0.342</td>
<td>0.78</td>
<td>4</td>
<td>19.04</td>
<td>20.97</td>
<td>2.76</td>
<td>2.18</td>
</tr>
<tr>
<td>Multifilament</td>
<td>63</td>
<td>69</td>
<td>-14.941</td>
<td>0.830</td>
<td>0.924</td>
<td>0.86</td>
<td>4</td>
<td>18.20</td>
<td>20.00</td>
<td>2.89</td>
<td>1.48</td>
</tr>
<tr>
<td></td>
<td>69</td>
<td>76</td>
<td>-14.175</td>
<td>0.712</td>
<td>0.905</td>
<td>0.75</td>
<td>5</td>
<td>18.90</td>
<td>20.90</td>
<td>2.74</td>
<td>1.64</td>
</tr>
</tbody>
</table>

N = Number of points used in the regressions, L₁ and L₂ = Estimated catch lengths (cm TL) for nets of mesh sizes m₁ and m₂ respectively, SE = Standard Error, SF = Selection Factor, SD = Standard Deviation

Fig. 2a: Selection curve for *S. galilaeus* caught with monofilament gillnets (69/63) mm

Fig. 2b: Selection curve for *S. galilaeus* caught with multifilament gillnets (76/69) mm

Fig. 2c: Selection curve for *S. galilaeus* caught with multifilament gillnets (69/63) mm

Fig. 2d: Selection curve for *S. galilaeus* caught with multifilament gillnets (76/69) mm

The optimum selection length for the monofilament gillnets combinations increased from 16.30 to 17.80 cm TL for 63, 69 and 18.92 to 20.84 cm for 69 and 76 mm. For the multifilament gillnets it increased from 18.20 to 20.00 cm and 18.90-20.00 cm for 63, 69, 69 and 76 mm combination, respectively.

The values of the parameters as shown in Table 1 were used for the estimation of probabilities of capture for the species for the different mesh sizes and length class mid-points. The probability of capture varied

**DISCUSSION**

The low number of fish catches in the larger mesh sizes (82 and 89 mm) obtained in this study agreed with
Psuty and Borowski [7] who reported similar catch pattern for the Polish part of the Vistula lagoon that have been under exploitation since 1948. This indicates that period of exploitation tends to affect net/mesh catchability. The relative variability in catch length including increase in modal length as mesh size increases as obtained in the study corroborates with results of Acosta and Appeldoorn [14], Petrokis and Stergious [12] and Psuty and Borowski [7]. The bimodal mode displayed for the 69 mm multifilament net might be due to relatively low number of individual fish caught or masked seasonal effect or the presence of two cohorts.

The selection length which is the likelihood of a fish of a particular length being retained in a net of a given mesh size increases with increasing mesh size. The result agreed with earlier studies [7, 12]. The mode of the observed length distribution was by 8.66, 11.66 and 23.35% lower than the estimated optimum catch length for 63, 69 and 76 mm monofilament nets. For the multifilament nets the estimated optimum catch length was 21.00, 18.08 and 4.3%, higher than the observed length distribution mode for the 63, 69, 76 mm mesh. These results with the exception of 63 mm multifilament and 76 mm monofilament agreed with the earlier observation that fish size differing more than 20% below or above the optimum length will hardly be retained in the gillnet mesh [2, 15].

The upper and lower probabilities of capture for the different mesh sizes increased with increasing mesh size combination. For the different nets, the probabilities of capture per length class for the multifilament nets were higher than that of the monofilament nets. This might be due to efficiency which increases the volume and diversity of catch of monofilament nets.

The unimodal selection curve obtained in this study agreed with earlier works of Koike and Takeuchi [16], Pauly [17] and Sparre and Venema [9].

Though the optimum catch length for the three mesh sizes were higher than the length at maturity (15.5 cmTL) reported by Akintunde [18] for the species, the use of 63 mm mesh size gillnet for fishing operations on the reservoir should be discouraged. However, to balance resource control with benefits to stakeholders, the use of 69 mm mesh size gillnet could be allowed as against the 76 mm stipulated in inland fishing regulation act as minimum mesh size for gillnet fishing [8]. Ita [19] reported that most cichlids would have long matured before being big enough to be caught in the 76 mm mesh. The use of the 69 mm mesh for fishing operation on the reservoir might thus prevent loss of stock to the ecosystem through natural mortality. It might also enhance productivity through efficiency in reproduction and food conversion as a result of removal of old and less efficient stock. Ricker [20] thus enhancing sustainability of the fisheries resources of the reservoir.

REFERENCES