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The Nabugabo Ramsar Site
THE VALUE OF NABUGABO LAKES IN THE CONSERVATION OF OREOCHROMIS ESCULENTUS

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Abstract

The wide-spread impact of exotic fishes especially Oreochromis niloticus and Lates niloticus together with over fishing in the Victoria and Kyoga lake basins during the 1950s and 1960s, caused endemic species such as the previously most important Oreochromis esculentus to become virtually extinct in the two lakes by the 1970s. Based on reports of presence of this native species in some satellite lakes within the two lake basins, a set of satellite lakes in the Victoria basin (Nabugabo lakes: Kayanja and Kayugi), were sampled between 1997-2002 with an objective of assessing their value as conservation sites for O. esculentus. Other satellite lakes (Mburo and Kachera) also in the Victoria basin, and Lemwa, Kawi and Nabisojjo, in the Kyoga basin, were sampled for comparison.

Among the Nabugabo lakes, O. esculentus was more abundant in Lake Kayanja (20.1 %) of the total fish catch by weight compared to Lake Kayugi (1.4 %). The largest fish examined (38.7 cm TL) was caught in Lake Kayugi, (also the largest in all satellite lakes sampled), while the smallest (6.6 cm TL) was from Lake Kayanja. Fish from Lake Kayugi had a higher condition factor K (1.89± 0.02) than that from Lake Kayanja (1.53±0.01), which was the second highest (compared with other satellite lakes) to Lake Kawi (1.92±0.2).

Diatoms, especially Aulacoseira, which were previously known to be the best food for O. esculentus in Lake Victoria were mostly encountered (93.2 %) in fish stomachs from Lake Kayangi. In Lake Kayanja the dominant food item was the blue green algae (Planktolyngbya) while Microcystis was the most abundant diet item in fish from other satellite lakes. There were more male than female fish (ratio 1:0.91 and 1: 0.79 in lakes Kayugi and Kayanja respectively). This is comparable to the situation in Lake Victoria before the species got depleted. The highest mean fecundity was (771±218 eggs) recorded in Lake Kayugi compared to Lake Kayanja (399±143). Based on the results from Lake Kayugi, where diatoms dominated the diet of O. esculentus and where the largest, most fecund and healthy fish were found, this lake would be a most valuable site for the conservation of O. esculentus and the best source of fish, for restocking and for captive propagation. This lake is therefore recommended for protection from over exploitation and misuse.

Key words: Condition factor, Fecundity, Satellite lakes
Introduction

Fish introductions in the lakes Victoria and Kyoga Africa have resulted into the disappearance of endemic species (Fryer, 1961; Welcomme, 1968; Lowe Mc Connell, 1987 and Ogutu-Ohwayo, 1990) especially *Oreochromis esculentus*. Up to the 1900s *O. esculentus* together with *O. variabilis* were the most important commercial fish species and Lake Victoria then contained large stocks of *O. esculentus* (Graham, 1929). About the period 1905 to 1916, when gill nets were introduced into different parts of Lake Victoria, coupled with the growth of urban centers and communication routes around the lake, the fishing industry assumed a commercial status with *O. esculentus* as one of the main target species (Mann, 1969; Miles & Keenleyside, 1991; Balirwa, 1992). From the 1930s to the 1950s fish catches dropped and fish size declined due to increased fishing pressure (Fryer & Iles, 1972; Fryer, 1973) and increasing use of small mesh sized gill nets (Witte & van Densen, 1995). This made *O. esculentus* one of the most endangered and threatened fish species and deprived the people who depended on it for food and employment. A survey carried out in the satellite lakes showed that the species still existed in some satellite lakes including the Nabugabo lakes. The study of the satellite lakes (Nagayi et al. unpublished report), showed that the catches mostly comprised haplochromines (59.9 %), followed by *O. esculentus* (26.3 %). The rest of the species contributed less than 5 % each.

Graham (1929), recorded *O. esculentus* of 30 cm TL in Kavirondo Gulf and 31 cm TL in the open lake. And according to Greenwood (1966), the modal adult size was 30-32 cm TL in Lake Victoria. However, recent studies on some satellite lakes (Mbuero and Kachera in the Victoria basin; Lemwa, Kawi and Nabisojo in Kyoga basin), recorded fish of 7-29.8 cm TL with a modal size of 16.0-20.9 cm TL. The largest (29.8 cm) was caught in Lake Mbuero (Nagayi et al. unpublished report). In addition, fish from the sample satellite lakes had an overall mean value of the condition factor K of 1.78±0.01. Lake Kawi recorded the highest (1.92±0.01), followed by Lake Kachera (1.87±0.02) and the lowest in Lake Nabisojo (1.65±0.02) (Nagayi et al. unpublished report), compared to a historical value of 2 in Lake Victoria (Graham, 1929).

Studies in the satellite lakes showed the species to be a phytoplankton feeder with the blue green algae, especially *Microcystis* as the most abundant (26.2 %), food item in fish from lakes Kachera, Mbuero and Lemwa. *Aulacoseira*, which was known to be the best food of the species in Lake Victoria (Graham, 1929; Fish, 1951, 1955; Lowe-McConnell, 1956; Welcomme, 1966; Payne, 1971; Bail, 1972), fish stomach analysis showed a high concentration of food item. The satellitlakes are smaller lakes: which had no a reduction in fisheries.
Materials and methods

Study area

There are four water bodies close to each other and collectively referred to as the Nabugabo lakes. These comprise the main Lake Nabugabo, and three other smaller lakes: Kayanja, Kayugi and Manywa (Fig. 1). Apart from Lake Manywa, which had no accessible route to it, the other three lakes were sampled.

Fecundity was proportional to the size of the fish with an overall mean fecundity of 457 ± 14 eggs in the satellite lakes. The highest fecundity (507 ± 32 eggs) was recorded in Lake Kawi while the lowest (351 ± 19) was from Lake Mburo (Nagayi et al., unpublished). In Lake Victoria, fecundity ranged from 324 eggs in a fish of 17 cm TL to 1672 eggs in fish of 36 cm TL (Graham, 1929) indicating a reduction in the species reproductive potential in the satellite lakes.

The satellite lakes study showed that there were generally more males than females (Nagayi et al., unpublished report). The data gathered showed a ratio of 1:0.93 in Lake Kachera, 1:0.52 in Lake Kawi, 1:0.74 in Lake Lemwa and 1:0.69 in Lake Nabisojjo. In Lake Mburo however, there were more females than males (1:1.03). Likewise, Lowe-McConnell (1956), had reported a male to female sex ratio of 1:1 in Lake Victoria, even though in most areas males were more than females. For example, there were, 1:0.72 in Pilkington Bay, 1:0.64 in Hannington Bay and 1:1.01 Ekunu Bay.

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1971; Bailey et al., 1978), was mostly found in Lake Kawi (46.8%). In Lake Victoria, *Aulacoseira* would form 48.75% of the total algal cells present in all fish stomachs (Payne, 1971). Schools of *O. esculentus* were reported to follow concentrations of diatoms in suspension (Gee & Gilbert, 1967; Fryer & Iles, 1972), suggesting that, diatoms were its most preferred food item.

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Nabugabo area has been selected as one of the RAMSAR Sites in Uganda. Some lakes in this area (for example lakes Kayanja and Kayugi) contain *O. esculentus*, which used to support a commercial fishery in Lakes Victoria and Kyoga before the species disappeared from these two main lakes. This study therefore, is aimed at evaluating the importance of these lakes in the conservation of *O. esculentus* compared with other lakes where the species exists. The evaluation is aimed at reaching a decision on how best to conserve the surviving populations, to improve their stocks and whether the Nabugabo lakes should be given priority in conservation efforts.

Materials and methods

Study area

There are four water bodies close to each other and collectively referred to as the Nabugabo lakes. These comprise the main Lake Nabugabo, and three other smaller lakes: Kayanja, Kayugi and Manywa (Fig.1). Apart from Lake Manywa, which had no accessible route to it, the other three lakes were sampled.

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Lake Kayanja has a surface area of about 1.2 km² with a maximum depth of about 3.0 m. Apart from the eastern shoreline, Lake Kayanja is surrounded by an extensive swamp, which is dominated by *Loudenia phragmites*oides. Nzonsemu and Kikoma streams drain into the swamp around this lake from the North-west and drains eastwards through Kanwa stream, into Nakiga Bay of Lake Victoria. Lakes Kayugi and Manywa are about 0.5 km apart with a total combined area of about 0.2 km². These two lakes are separated by a thick papyrus swamp, which is connected to Lake Nabugabo via River Juma. Lake Kayugi has a maximum depth of about 3.0 m. The swamp around these two lakes (Kayugi and Manywa) is served by River Kagona from the Northwest as shown in Figure 1 in the introduction chapter (Pg. 5).

Sampling of *O. sculentus* in the Nabugabo satellite lakes was done using three fleets of identical multifilament nylon gill-nets. Fish were measured (total and standard lengths) in centimetres and weighed in grams. The specimens were then dissected and, the stomach fullness and the sex of the fish determined. Female gonads at maturity stage V and VI and stomachs, which contained food, were removed and preserved in 50% Ethanol and 5% Formalin solution respectively, in separate numbered bottles. In the laboratory, the stomach contents were allotted points according to the scheme modified from Hynes (1950) and the food categories were rated in proportion to their relative percentage volumes. The importance of each food item was obtained from the points allotted by calculating the percentage relative importance of the food in the stomachs. Eggs in the gonads of an individual fish were counted to generate data of 'absolute fecundity'.

**Results**

**Relative abundance**

Out of all the fish caught, *O. sculentus* was relatively more abundant in Lake Kayanja (20.1%) while it was very scarce in Lake Kayugi (1.4%). However, when all other lakes are compared the species was most abundant in Lake Nabisojojo (58.1%), in the Kyoga basin where the species was successfully stocked.

**Length frequency distribution of Oreochromis sculentus**

The largest fish in Lake Kayugi was 38.7 cm TL and the fish in this lake had a modal size of 16-21 cm TL, while in Lake Kayanja the largest fish was 28 cm TL with a modal size of 19cm TL. The fish in these lakes were taken together.

**Condition factor**

The condition factor increased with the condition factor. However, the length of Lake Kayangi

**The food of fish**

The stomachs of fish were taken and the stomachs were examined by the diatom, *O. sculentus* in the recorded vi (46.8%). In the innermost food McConnelit, 19

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The food of Oreochromis esculentus

The condition factor of the species in lakes Kayanja and Kayugi generally increased with size of fish (Figure 2). The fish from Lake Kayugi had a higher condition factor K (1.89 ± 0.02) than those from Lake Kayanja (1.53 ± 0.01). However, the K value of the fish in Lake Kayugi was the second highest to that of Lake Kawi (1.92 ± 0.01), in the Kyoga basin area.

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The largest fish in Lake Kayugi (38.7 cm TL) was also the biggest specimen compared to all the sampled satellite lakes. The fish in Lake Kayugi were generally much bigger than the rest put together.

**Condition factor K**

The stomach contents of *O. esculentus* from Lake Kayugi were dominated by the diatom *Aulacoseira* (93.1 %), and compared with other satellite lakes, the recorded value in Lake Kayugi was the highest, followed by Lake Kawi (46.8 %). In the available historical data, this diatom was regarded as the most important food of *O. esculentus* in Lake Victoria (Fish, 1951, 1955; Lowe-McConnell, 1956; Welcomme, 1966; Bailey et al., 1978). In Lake Kayanja,
the diet was dominated by blue-green algae especially *Planktolyngbya* (33.5 %). The study carried out in other satellite lakes revealed, blue-green algae especially *Microcystis* as the most abundant food item in fish stomachs (Appendix IV). Blue green algae are, however, considered to be a poor food quality and therefore, Lake Kayugwi would provide the best source for *O. esculentus* seed because it contains the diatoms, considered to be the best food resource for the species.

**Sex ratio and fecundity**

The Nabugabo lakes had more males than females (M:F is 1:0.91 in Lake Kayugwi and M:F is 1: 0.79 in Lake Kayanja) as observed in other satellite lakes. Available historical data on Lake Victoria also showed that there were more males than females. Fecundity in this regard i.e. the total egg count per fish (absolute fecundity) indicates the reproductive potential of the fish. Lake Kayugwi had a higher mean value of fecundity (772 ± 218) than Lake Kayanja (399 ± 143). The study of the satellite lakes examined gonads of fish ranging between, 14.6 and 30.2 cm TL. The mean fecundity in Lake Kayugwi was the highest compared to all other satellite lakes while that of Lake Kayanja was the second lowest overall (Table 1.)

**Table 1.** Comparing the variations in mean fecundity, size, and fecundity per size (length or weight) of *O. esculentus* between Nabugabo lakes and others.

<table>
<thead>
<tr>
<th>Means</th>
<th>Kayanja</th>
<th>Kayugi</th>
<th>Kachera</th>
<th>Kawi</th>
<th>Lemuwa</th>
<th>Mbuoro</th>
<th>Nabisojjo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (cm TL)</td>
<td>17.9±1.5</td>
<td>24.4±3.2</td>
<td>21±0.3</td>
<td>20±0.7</td>
<td>21±0.66</td>
<td>20±0.39</td>
<td>22.9±0.2</td>
</tr>
<tr>
<td>Wt (gm)</td>
<td>125±50.1</td>
<td>358±124</td>
<td>178±9.4</td>
<td>159±13.5</td>
<td>190±16.6</td>
<td>137±9.43</td>
<td>206±5</td>
</tr>
<tr>
<td>Fecundity</td>
<td>399±143</td>
<td>772±218</td>
<td>502±19.5</td>
<td>507±32.4</td>
<td>532±28</td>
<td>351±19</td>
<td>430±10.8</td>
</tr>
<tr>
<td>Fecundity/Length</td>
<td>20±4.6</td>
<td>33±9</td>
<td>24±0.73</td>
<td>26±1.19</td>
<td>25±1</td>
<td>17.7±0.7</td>
<td>18.8±0.4</td>
</tr>
<tr>
<td>Fecundity/Weight</td>
<td>3.8±0.64</td>
<td>4.3±2.85</td>
<td>3±0.1</td>
<td>3.5±0.37</td>
<td>2.9±0.19</td>
<td>2.75±0.1</td>
<td>2.1±0.1</td>
</tr>
<tr>
<td>No. of Fish specimens</td>
<td>8</td>
<td>4</td>
<td>56</td>
<td>13</td>
<td>9</td>
<td>36</td>
<td>29</td>
</tr>
</tbody>
</table>

**Discussion and Conclusion**

The Nabugabo lakes i.e. Kayanja and Kayugwi are some of the few satellite lakes where *O. esculentus* survives today. Research in the satellite lakes showed that the population characteristics varied between these lakes when the various aspects (relative ratio, and fecundity to be the most at Kyoga, is in danger of being protected. planktonic matter (Fryer & Iles, 1966; Bailey et al. 1970) shift in the diet, *Microcystis* and the algal community result in a lower blue green algae. Heerkloss et al. 1966 are known to be the diatom *Aulacoseira* fish in this lake at the highest condition of *O. esculentus* in the Nabugabo lake, protected first by government systematic regulation. Kayugwi is being prohibited to operate and must seek permission to use the lake using sooty samples level of fishing effort and supported as one of the *O. esculentus* species.

**Recommendation**

*O. esculentus* is common wherever it occurs especially in the characteristics are for the lake followed by controlled culture the fish and contribute to conserve...
Recommendations

O. esculentus is considered an endangered fish species and should be protected wherever it occurs especially in Lake Kayugi, where fish with the best population characteristics are found. Protection should initially be through gazetting of the lake followed by controlling access to the lake. Efforts should also be made to culture the fish and stock it in selected small water bodies especially dams to contribute to conservation and improvement of the stocks.
Acknowledgement

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References


