Ecological implications of *Rastrineobola argentea* (omena) fishery: A rapid assessment of bycatch diversity at Dunga Beach, Lake Victoria, Kenya

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Abstract

Rastrineobola argentea (omena) is the second most important species in the fisheries of Lake Victoria after Nile perch. However, its fisheries have negative impacts on the ecology of the lake especially due to the high numbers and diversity of bycatch resulting from the fishery. This study conducted a rapid assessment in Dunga beach in Kisumu, Kenya to identify and quantify the bycatch as well as to collect information on the fishermen's perceptions of the bycatch from the omena fishery. The results revealed that all the 10 boats sampled reported bycatches of different species and different sizes. The bycatches comprised of *Lates niloticus, Haplochromis spps, Clarias gariepinus*, *Protopterus aethiopicus, Synodontis*. The smallest bycatch recorded was *Haplochromis spp* (3.3 cm; 3g) while the largest fish bycatch was *Protopterus aethiopicus* (1.5 m; 2.4 kg). Other bycatch recorded were freshwater shrimps and molluscs. 80% of the fishermen suggested the provision of alternative livelihoods as a measure to reduce the pressure on omena fishery while 12% recommended stricter rules on gears implemented. A total of 99% of the fishermen reported that they do not return bycatch into the lake but rather sell them together with the main catch (omena). The implications of this on the ecological functioning of the lake is predicated on the negative impacts on the trophic interactions in the ecosystem.

Key words: *Rastrineobola argentea*, Omena, Lake Victoria, Bycatch, Ecological functioning

Introduction

In the past, Lake Victoria was extremely rich in fish and contained a vast number of endemic fish species consisting of cichlids and cyprinids (Njiru et al., 2018). Currently, it is estimated that 90% of the endemic species of Lake Victoria have gone extinct in the past 50 years

(Sayer et al., 2018; Witte et al., 1991). This rapid extinction is attributed to several causative factors including habitat loss and degradation, eutrophication, predation, and competition from introduced non-native fish species (Nile perch and Nile tilapia) and, in some cases, the unsustainable use of the lake from overfishing or the use of improper fishing gears (Outa, et al., 2020; Ogello et al., 2013). The demand for omena has been on the rise over the past years as it undoubtedly remains the cheapest available source of protein for the lake region community (Ayuya et al., 2021). Most studies on the fisheries of Lake Victoria have focused on the legal aspects particularly on use of illegal gears and not the ecological influence of these gears including the indiscriminate omena fishing nets. Therefore, the bycatch associated with the omena fishing nets and their ecological implications on the lake's ecology remains largely under documented. It precisely on this premise that the current rapid assessment was conducted in Dunga beach to assess the diversity of bycatch associated with omena fisheries. The study draws inferences into the possible ecological implications of the bycatch and suggests possible mitigation measures.

Materials and methods

Study Area

The study was conducted at Dunga beach of Kisumu County. Dunga beach is located on the southern shore of Lake Victoria. The Beach is located in Dunga Village, a fishing village in Kenya, situated on a peninsula in Bay Lake Victoria, 6 Km south of Kisumu City on latitude -0.144622S and longitude 34.7366801E. At an altitude of 1134 meters above sea level, the Beach stands to be one of the largest and busiest beaches around Kisumu city and Kenya's shores of Lake Victoria.

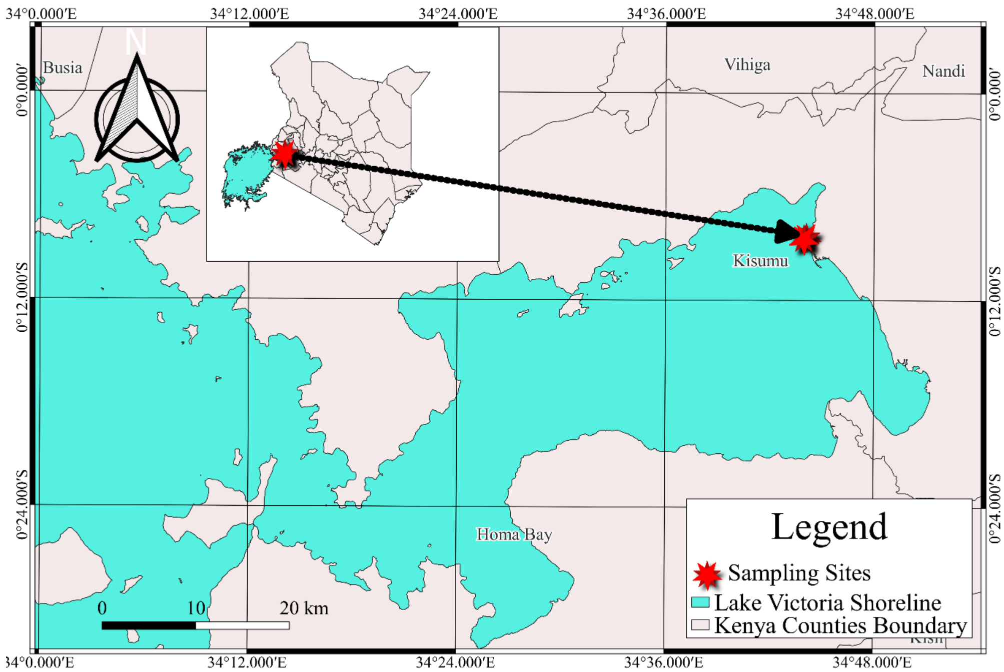

Figure 1: Location of Dunga Beach

Data collection

Ten boats were randomly selected from the BMU's record of active omena fishers. The different types of nets and the relative mesh sizes for each net was also determined to know the actual mesh sizes of the nets used for omena fishing. A total of 10 kg sample was taken from each boat's total catch, to analyze further the bycatch species, size (weight and length), and number. The bycatch was sorted and counted and the various species composition identified, and their lengths and weights measured and recorded. To find more on the perceptions on the impacts of omena fishery on other fish species, the fishermen were interviewed following a Key Informant Interview Guide. The questions also focused on the handling of the bycatch by the fishermen (whether they return them into the lake or not) and what they think can be done to reduce the amount of bycatch resulting from the omena fishery.

Results

All the 10 boats sampled reported bycatch in the fish landed. The quantity and diversity of bycatch varied among the boats. About 99% of the fishermen interviewed reported that they don’t return the bycatch into the lake and that they sell them alongside the omena. Some reported that sometimes, the bycatch fetches more money than omena.

The fishermen reported that bycatch is usually sorted from the main catch (omena) and placed separately. This is done when still in the fishing grounds to reduce the pressure that the huge bycatch species would exert on the omena and thus reducing the omena quality and even leading to spoilage.

‘*Other fishes would destroy omena if left with them in the same pile until landing’*, one fisherman said.

A total of 95% of the fishermen interviewed said that they did not know the possible impacts of omena fishery on other fish species within the lake. On mitigation measures, most fishermen (80%) preferred alternative livelihood activities provided especially to the youth to relieve pressure off omena fishery. Another 12% also recommended stringent rules and enforcement of fisheries policies and regulations on fishing gears within the lake.

The haplochromines and the lungfish (*Protopterus aethiopicus*) made the highest number of species collected on the beach on the ten boats put together. The shrimps and molluscs tied with catfish in abundance followed by Nile perch and synodontis as the Nile tilapia, snout fish and freshwater eel made the least number of recorded aquatic species (Figure 3).

The lung and the haplochromines recorded the highest average counts in the by-catch of more than 10 per boat. The shrimps and the mollusks followed with 9 species count per boat. The average count for juvenile Nile perch was 8 per boat, *Synodontis spp* 7 counts and Luambwa barb (*Enteromius cercops*) recorded 3 species counts per boat. The snout fish, Nile tilapia and freshwater eels occurred in lowest counts of than 2 per boat on average (Figure 1).

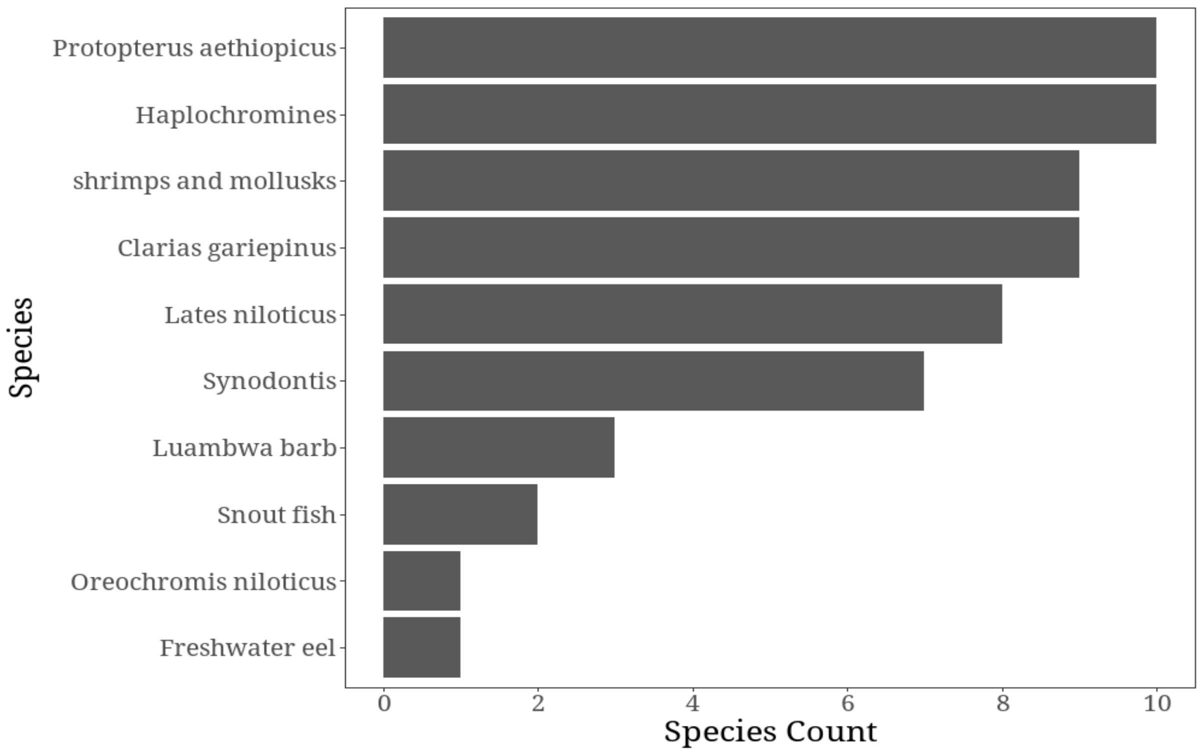

Figure 1: Counts of fish species caught as by catch at the landing beach

Minimum Length

The minimum length of recorded fish species indicated that longest and largest species to be caught were the lung fish 45 cm, followed by the freshwater eel 30 cm, catfish 25 cm, snout fish 18 cm, Luambwa barb 15 cm while other species caught were of smaller lengths below 5 cm in length (Figure 3).

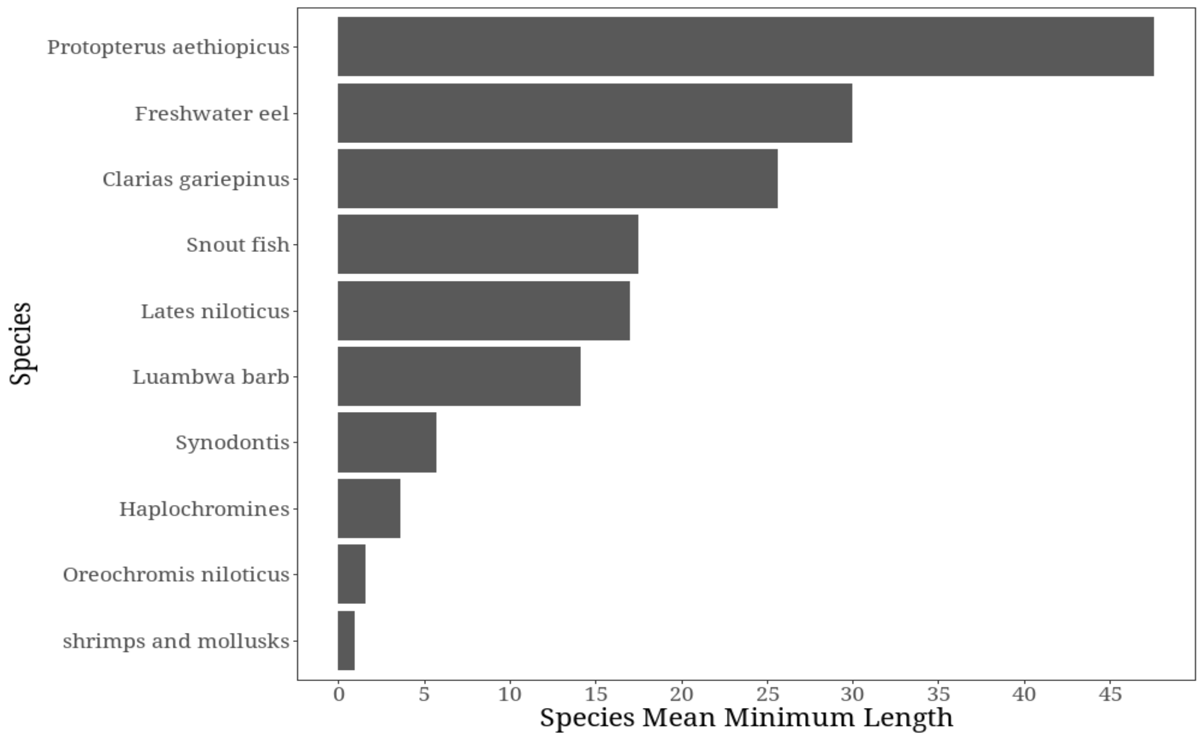

Figure 2: Largest Minimum lengths of species caught as by at the Dunga landing beach

The minimum weights of caught fish were recorded and the results showed that Nile perch had the greatest weight 650g followed by the lung fish 600g then catfish 400g and the other aquatic species recorded smaller weight of less than 50g with the haplochromines recording the smallest weight of about 1g (Figure 3).

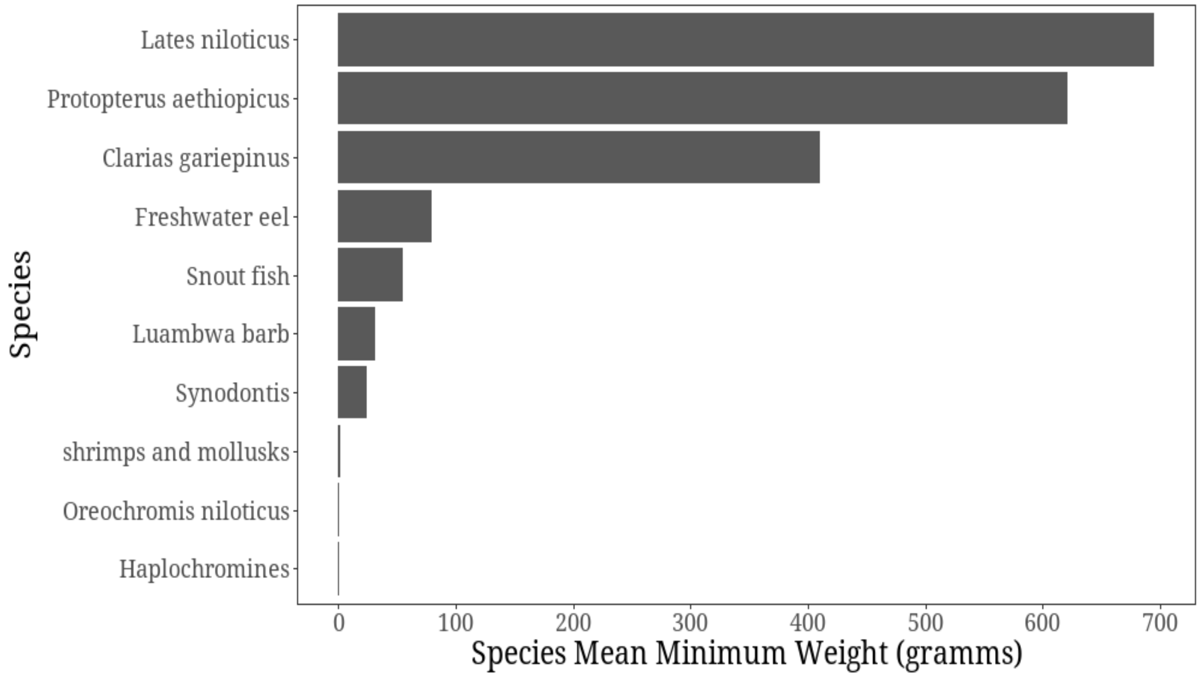

Figure 3: Minimum weight of fish caught as by catch landed at the Dunga beach

Discussion

The pelagic cyprinid, omena plays a crucial role in the disrupted ecosystem of Lake Victoria. This is because omena remains the main utilizer of zooplankton, thus influencing the plankton communities within the lake (Yongo & Outa, 2016). Therefore, omena plays an important role in the nutrient cycling and turnover within the lake ecosystem by regulating the zooplankton and by extension the phytoplankton communities. This, therefore, influences the overall functioning of the lake especially regarding eutrophication associated with algal blooms which have negative implications on the water quality and the communities around the lake.

R. argentea is also a major prey for the introduced Nile perch and other piscivorous fish species within the lake (Outa et al., 2017). Nile perch is an apex predator in the lake and has been speculated to have led to the reduction in the number of many fish species within the lake. The perch has for example been cited to have led to the extinction of over 200 species of Haplochromines within the lake (Marshall, 2018).

Since Nile perch of different sizes featured prominently in the bycatch of omena fishery, it implies that the fishery is detrimental to the general perch population within the lake. If not checked, this would have serious negative consequences on the population of Nile perch in the ecosystem. This can have serious ecological consequences due to the top-down control on the trophic aspects of the ecosystem (Goto et al., 2020). By increasing pressure on the top predator (Nile perch), the lower trophic levels, especially the planktivorous species would increase leading to overgrazing of the zooplankton communities within the lake (Moosmann et al., 2021). The implications of this would be increased pressure on the zooplankton community that could lead to an upsurge in phytoplankton populations within the lake resulting in eutrophication. An increase in the phytoplanktivorous species especially the tilapines and some Haplochromine species occasioned by the reduction in Nile perch population would lead to a decrease in the phytoplankton populations which would negatively affect the zooplankton community and ultimately the zooplantivorous fish species. The cycle would continue and could lead to an eventual collapse of the lake ecosystem and its ecological functions.

Conclusion

From the study, the high numbers and diversity of bycatch recorded from the Omena fishery implies a disrupted lake ecosystem. The implications of this on the ecological functioning of the lake is envisaged to have negative impacts on the trophic interactions due to the top-down control on the trophic aspects of the ecosystem. This can be averted through enforcement of fisheries policies and regulations on fishing gears within the lake such as the use of selective fishing gears and adoption of preferred alternative livelihood activities like aquaculture practices (cage culture) to relieve pressure off omena fishery in Lake Victoria.

References

Ayuya, O. I., Soma, K., & Obwanga, B. (2021). Socio-economic drivers of fish species consumption preferences in kenya's urban informal food system. *Sustainability (Switzerland)*, *13*(9). https://doi.org/10.3390/su13095278

Goto, D., Dunlop, E. S., Young, J. D., & Jackson, D. A. (2020). Shifting trophic control of fishery–ecosystem dynamics following biological invasions. *Ecological Applications*, *30*(8), 1–15. https://doi.org/10.1002/eap.2190

Marshall, B. E. (2018). Guilty as charged: Nile perch was the cause of the haplochromine decline in Lake Victoria. *Canadian Journal of Fisheries and Aquatic Sciences*, *75*(9), 1542–1559. https://doi.org/10.1139/cjfas-2017-0056

Moosmann, M., Cuenca-Cambronero, M., De Lisle, S., Greenway, R., Hudson, C. M., Lürig, M. D., & Matthews, B. (2021). On the evolution of trophic position. *Ecology Letters*, *24*(12), 2549–2562. https://doi.org/10.1111/ele.13888

Njiru, J., van der Knaap, M., Kundu, R., & Nyamweya, C. (2018). Lake Victoria fisheries: Outlook and management. *Lakes and Reservoirs: Research and Management*, *23*(2), 152–162. https://doi.org/10.1111/lre.12220

Ogello, E. O., Obiero, K., & Munguti, J. M. (2013). LAKE VICTORIA AND THE COMMON PROPERTY DEBATE : IS THE TRAGEDY OF THE COMMONS A THREAT TO ITS FUTURE ? *Lakes Reservoirs and Ponds*, *7*(2), 101–126.

Outa, N. O., Yongo, E., & Keyombe, J. A. (2017). Ontogenic Changes in Prey Ingested by Nile perch (*Lates niloticus*) Caught in Nyanza Gulf of Lake Victoria, Kenya. *Lakes & Reservoirs: Research & Management*, *22*(1), 43–47. https://doi.org/10.1111/lre.12163

Outa, N. O., Yongo, E. O., Keyombe, J. L. A., Ogello, E. O., & Namwaya Wanjala, D. (2020). A review on the status of some major fish species in Lake Victoria and possible conservation strategies. *Lakes & Reservoirs: Research & Management*, *25*(1), 105–111. https://doi.org/10.1111/lre.12299

Sayer, C. A., Máiz-Tomé, L., & Darwall, W. R. T. (2018). Freshwater biodiversity in the Lake Victoria Basin: Guidance for species conservation, site protection, climate resilience and sustainable livelihoods. In *Freshwater Biodiversity Observation Network (FW BON)* (Issue April). IUCN, International Union for Conservation of Nature. https://doi.org/10.2305/IUCN.CH.2018.RA.2.en

Witte, F., Wanink, J. H., Ligtvoet, W., Van Oijen, M. J. P., Goldschmidt, T., & Goudswaard, P. C. (1991). Species Extinction and Concomitant Ecological Changes in Lake Victoria. *Netherlands Journal of Zoology*, *42*(2), 214–232. https://doi.org/10.1163/156854291X00298

Yongo, E., & Outa, N. (2016). Growth and population parameters of Nile tilapia, Oreochromis niloticus (L.) in the open waters of Lake Victoria, Kenya. *Lakes & Reservoirs: Research & Management*, *21*(4), 375–379. https://doi.org/10.1111/lre.12154