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Review Article

The current status of *Barbus* species in Lake Victoria Basin, Kenya: A review

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Abstract

Lake Victoria is known for its rich fish biodiversity having been home to over 500 fish species. However, over 200 species have become extinct and as a result, it is classified as a world hotspot of species loss. Some of the examples of endemic species that disappeared from the lake and are endangered include the Haplochromines and the *Barbus* species. The *Barbus* species is currently not seen in the fish landings from Lake Victoria. It is deemed to have sought refuge in the riverine ecosystems, dams and the adjacent satellite lakes within the Lake Victoria Basin. This has resulted in several gaps emerging including its current status as its taxonomical identification still remains a puzzle to many scientists. This paper, therefore, tries to unearth the foregoing by reviewing the already available literature with an emphasis on the LVB Kenyan part. The *Labeobarbus altianalis* is still named *Barbus altianalis* even in the most recent publications thus complicating further. In its distribution, the *Barbus* species does not occur in the lake currently but is a common candidate in the rivers, dams and satellite lakes within the basin. Some of the cited reasons for its disappearance: are predation by *Lates niloticus*, overfishing, competition from exotic species, pollution and climate change. However, different studies try to pinpoint its presence in some rivers and this according to an observation made in this study is due to biased sampling, which excludes some rivers in the basin. It is concluded that the taxonomic identification of *Barbus* species in LVB Kenya remains elusive and this has been blamed on skewed sampling with little regard to all ecosystems in the basin. The paper recommends that an elaborate simultaneous study be done in all the rivers within the LVB, Kenya to collect reliable data for use in *Barbus* species taxonomy and general biology. Further, county governments in the basin should develop sound policy frameworks on how to sustainably manage riverine fisheries including the domestication of the species in aquaculture.

Introduction

Lake Victoria is currently regarded as a biodiversity hotspot having lost over 200 endemic fish species. The lake supported an extraordinary array of fish species including Haplochromines, *Labeo victoriarus* Boulenger, *Brycinus* species and *Barbus* species [1-3], among many others that were the main food for the riparian communities. Because of the enormous erosion of these fishes in Lake Victoria, the lake and its entire basin became and up to date have seen the scientific community turn into a laboratory of biological, socio-economic and taxonomic studies worldwide.

Several reasons have been associated with the extinction and threat of the endemic fish species in Lake Victoria. The increase in human population in the basin has been associated with the rapid increase in economic activities such as agriculture, industrialization, urbanization, irrigation and mining. All these forms of pressure have had an effect on water quality that ends up in the lake. As result eutrophication has been witnessed in Lake Victoria that to a larger extent has changed the ecology of the lake. Due to eutrophication, anoxic conditions have taken a higher toll thus affecting the native fish species.

One of the main factors for the disappearance of the native fish species of Lake Victoria is the introduction of exotic species. This happened in the years between 1950 and 1962 when such species as *Oreochromis niloticus* (L.), *O. leucostictus*

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(Trewavas), *T. zillii* (Gervais) and *Lates niloticus* (Linnaeus) were introduced Whereas such fish as *L. niloticus* is assumed to have predated on the endemic species, the rest of the alien species took advantage of the new environment and exploited the habitats at the expense of the native ones. It is reported that the introduction of exotic and/or alien species [4-9] leads to increased population, use of wrong gears and fishing methods [10] and aggressive and efficient use of new habitats thus destroying breeding and nursery grounds for the native fish species resulting into an ecological change of the environment [11,12]. It is against the foregoing backdrop that many of the native fish species are rare to find in the lake with some being threatened with extinction [12-16]. Many of these fish have sought refuge in wetlands within the Lake Victoia basin (LVB). This is because the wetlands within the basin are not highly impacted in terms of water quality as the lake; they have thick emergent and sub-emergent macrophytes that act as barriers to *L. niloticus* [17].

It is in view of the above that this paper reviews the status of the *Barbus* species, one of the endemic fish species in the LVB (i.e. one of its species, the *Barbus altianalis* is listed in the IUCN Red List of Threatened Species [18] for the purposes of its sustainable exploitation, management and conservation. This fish has been of great interest among researchers and managers because its taxonomy has not been studied fully and to date, there is confusion in its identification [19]. For example, the *B. altianalis* has recently been named *Labeobarbus altianalis*, which is the larger-bodied *Barbus*. The rest are small in body size. Although 14 *Barbus* species have been identified and reported to exist in the LVB [20], identifying them by species may not be appropriate for this study. However, recent studies by Schmidt and co-workers [21] demonstrated that there is more diversity (new species) in the East Africa region compared to past data.

This paper examines its current status in terms of distribution and taxonomy. Recommendations on its sustainable exploitation, management and conservation are provided. To dispel any form of confusion, therefore, this paper will use the term *Barbus* species instead of specifying the exact species.

Study area

The Lake Victoria basin: The LVB, Kenya is part of the larger LVB (Figure 1) measuring 251 000 km2 with about 1135 m asl as the lowest surface and over 4000 m a.s.l. as the highest point occurring on Mt Elgon. Other riparian countries that make up the basin include Tanzania, Uganda, Rwanda, and Burundi. The entire lake basin combined with Lake Victoria has an economic value of about US$ 12.4 billion. The Lake Victoria basin in the Kenyan part is a multi-river basin comprising eight rivers of significant size (Sio, Nzoia, Yala, Nyando, Sondu, Miriu, Migori and Mara Rivers). These rivers drain nearly half of Kenya's runoff, carrying it westward into Lake Victoria. Their catchment comprises the area west of the Rift Valley, delineated by Mount Elgon in the North. The basin is the largest (i.e. constitutes

Figure 1: Map of Lake Victoria and its catchment (EAC, 2007).

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42%) and therefore the single most important among the five catchments draining into Lake Victoria hence a major contributor to the lifeline downstream countries of Sudan and Egypt via River Nile. The LVB, Kenya covers the entire Nyanza and Western Provinces and drains extensive sections of the eastern slopes of the Rift Valley, an area that extends from Cherangani Hills to the Mau Forest, including the Masai Mara Game Reserve in the Rift Valley Province.

The basin is important to the entire East African region because of its immense resources that include fisheries, rich biodiversity, water, land, natural forests, wildlife, minerals, different means of transport and communication as well as tourism [22]. It, therefore, offers environmental, cultural, scientific, sociopolitical and economic investment potential. It is because of these features that the EAC [22] termed the LVB an "economic growth zone". The many rivers that drain the LVB Kenya catchment discharge their waters into Lake Victoria supporting the largest freshwater fishery in the world worth an average of 900,000 MT with an estimate of US$ 500 million annually [23].

The LVB, Kenya supports a rich wildlife sanctuary mainly in the Maasai Mara and Serengeti National Parks where an array of diverse animal species exists in high populations. This according to UNEP (2006) fetches a whopping US$ 12 million annually from tourism alone. Other valuable resources include Signi natural forests and such minerals as gold and diamond. Rainfall in this basin is plenty thus supporting enormous agricultural and hydroelectric power generation activities. The diverse network of rivers in the basin also provides reliable clean fresh water for drinking, domestic, irrigation, and industrial applications for the populations in the rural and urban setups. The basin regulates and influences the weather and climatic conditions of the region [24]. It enjoys an average rainfall ranging between 600 mm and 2800 mm annually. The month of February is considered to be the hottest and long rains begin from mid-March.

The taxonomic status of the kenyan barbus fish species

The European ichthyographic region is regarded as the home of the genus *Barbus* (Cyprinidae). A small number of this species is said to inhabit parts of Northeast Africa. There are many African *Barbus* species lumped in this genus but which in strict terms are not related to *Barbus* taxonomically. Despite the existence of this gap, little has been done for an adequate nomenclature of the African forms. It is argued that many forms of the small barbs that range from 200 to 500 species are not yet fully known and they are lumped in "wide-ranging species complexes" [21,25,26]. Some recent efforts to classify this group of fish have failed. Works conducted by Yang and co-workers [27], who argued that all *Barbus* species are *Enteromius* were refuted. One reason that complicates the taxonomy is its big size such that many of its species are still unknown and for those species that are already described, very few samples are available for further studies [21]. Because of the widening disparities in the taxonomy of the African barbs [21,25,28-35,43]. This calls for elaborate studies of the *Barbus* species more so the small barbs. To avoid unnecessary ambiguity, the genus term *Barbus* will be used in this paper to describe the cyprinid fish species as described by [36] (Figure 2).

The taxonomic status of the Barbus species in Kenya is currently unresolved which requires intensive studies and formal description to clarify the misidentification that is witnessed in most cases. Because the main habitat of this fish is mainly riverine, more surveys are required to discover more about it in various hydrographic systems of Kenya. A few species are under description. Some of the *Barbus genuses* have been described in the East African region parts of Tanzania such as '*Barbus*' *usambarae* Lönnberg, 1907. The same has not been reported in the Kenyan part, but chances are that it can be found there because of the similarities in physical features. The '*Barbus*' *serengetiensis* Farm, 2000, is a small species that has been reported in the affluent rivers of Serengeti in Tanzania. This fish is also likely to occur in the Kenyan part of the Mara drainage because it is the one, which extends to the Tanzanian part. In addition to the above, '*Barbus*' *profundus* Greenwood, [2] has been described in the deeper waters of Lake Victoria in Uganda and Tanzania. Although the same has not been studied in Kenya, chances are the species might also occur in Kenyan waters.

Like the small 'Barbus', the taxonomy of the large 'Barbus' is not completely resolved either, despite a revision of the East and Central African forms [37]. A study on the Evolution of African barbs from the Lake Victoria drainage system, Kenya [38], confirms that the taxonomy and evolutionary history of the African barbs are still unclear recommending a wider sampling of the taxa that ought to cover wider geographic locations.

Barbus species distribution in lvb, Kenya

In a KMFRI unpublished data, the *Barbus* species are shown to occur in the lake and riverine ecosystems in LVB but are caught in very small numbers. Although they can be found more in rivers than in the lake still their numbers are worrying. As a result, for example, *B. altianalis* is listed in the IUCN Red List of Threatened Species [18]. This brings some bit of confusion because *B. altianalis* is what is currently referred to as *Labeobarbus altianalis*, which is not considered a threatened species by the IUCN. This fish species is only affected by such factors as human population growth, changes in agricultural practices in the basin and climatic change making their habitats unstable [39,40] and as a result, the population of this fish becomes difficult to account for [21].

When compared to other fish species caught in rivers, *Barbus* species are second in terms of biodiversity. According to

Figure 2: *B. altianalis* collected in River Sondu-Miriu ITEK in 2012 [43].

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Outa [18], they are normally witnessed in the catch composition of rivers Migori and the Mara and not in other rivers and lake landings. However, other *Barbus* species (i.e *Barbus jacksonii*, *Barbus cercops*, *Barbus nyanzae*, *Barbus neumayeri* and *L. altianalis*) have been reported in River Nzoia (Jepleting, et al., unpublished data). Barbus species is rarely reported in river Sondu-Miriu. According to studies done by Ochumba and Manyala, [41], the most abundant Barbus species in River Sondu-Mirui was replaced with the other riverine fishes such as *Clarias gariepinus*, *Schilbe mystus*, *Synodontis afrofischeri*, *Oreochromis variabilis*, *O. leucostictus*, and *Lattes niloticus*. Any endangered fish may adapt certain strategies for survival. This has been observed in some studies conducted in the lower LVB, Kenyan rivers [41]. Recent studies indicate that *Barbus altianalis*, which formed a major component of riverine fisheries, no longer migrates upstream to breed but comprises stationary populations concentrated at the mouths of the Nzoia, Sondu-Miriu, Yala and Nyando rivers in the Lake Victoria watershed [42].

Declines of species richness

In the last four decades one of the *Barbus* species, *L. altianalis* contributed 8,173 tons (the 1980s) and 152 tons (i.e. in the 1990s and early 2000) to the fish landings in Lake Victoria [18] (Table 1). The sharp decline in the lake is presumed to have been contributed by overfishing, predation by the *L. niloticus*, competition by exotic species such as the *O. niloticus*, environmental pollution and climate change. Currently, this species is hard to come by going by the fish landing data. There could have been a further decrease in the numbers since the fish has seldom been observed in current catches. Recent studies in the basin reported the presence of this species in the mid-and lower reaches of Kenyan rivers flowing into the lake [18]. This scenario continues to be the order of the day because from the current catches the fish is hardly observed [18].

Conservation

The loss of biodiversity of fish in Lake Victoria is due mainly to habitat degradation and loss, 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- ing or the use of improper fishing gears. If not appropriately checked and managed, these factors will doubtless lead to a further decline in the numbers of fish species and ultimately even their extinction [18].

Table 1: Contribution (tonnes) of various fish species in Lake Victoria fish catches (Adapted from Balirwa, et al., 2003).

Taxa	1966–1967	1976–1977	1986–1987	2000
Tilapiines	17,747	2,480	5,772	30,530
Bagrus	6,646	4,645	8,173	152
Protopterus	2,646	2,035	309	469
Barbus	813	330	85	0
Synodontis spp	122	305	28	127
Haplochromines	1,955	1,280	3	4
Labeo	204	20	0	0

Conclusion and recommendations

The *Barbus* species is one of the endemic fish of Lake Victoria. It is classified as endangered and occurs mainly in the riverine, dams and satellite lakes within the entire LVB. This fish is thought to have disappeared from the lake and can only be found in rivers, dams and satellite lakes. Of recent, there are no single Barbus species that is landed along all the landing beaches of Lake Victoria. In the Kenyan LVB, it is found in major rivers such as Sondu-Miriu, Migori/Kuja, Nzoia, dams and satellite lakes such as Kanyaboli, Sare, and Simbi. From this review, it is evident that studies on this fish have not been done conclusively. Very few rivers have been studied hence providing sketchy data to reasonably conclude its current status. Consequently, because of piecemeal research on this fish, its taxonomy, biology and general status are still at large. For example, the *L. altianalis* is still confused to be *B. altianalis* [18].

This study recommends enforcement in the protection of the riparian areas to minimize anthropogenic activities that may cause pollution to rivers, and destroy riparian vegetation and the overlying macrophytes that are essential in providing refuge to this fish. The enforcement of the EMCA Act on riparian protection therefore cannot be overemphasized here. River impoundment/dam construction should be discouraged at all costs. This is because these fish species breed upstream and should there be dams along the rivers then chances are that spawning will be hindered.

It is also recommended that an elaborate study be done in all the rivers within the LVB, Kenya simultaneously in order to collect reliable data that will be used to study *Barbus* species taxonomy and its general biology. This will avoid biased sampling of given rivers within the basin while ignoring others hence reporting on data that is not exhaustive thus resulting in misleading information about this fish. Now that the management of all fisheries activities is a devolved unit, county governments in the basin are encouraged to come up with sound policy frameworks on how to sustainably manage riverine fisheries. Such a management strategy is lacking and if at all it is there, then it is silent. This study also recommends the domestication of the *Barbus* species in order to conserve it.

References

1. Graham M. The Victoria Nyanza and its Fisheries: A Report on the Fishing Survey of Lake Victoria, 1927-1928, and Appendices. Crown Agents for the colonies; 1929.

2. Greenwood PH. The fishes of Uganda. In: East African Fisheries Research Organization. 1966; 403–403.

3. Ogari J. The Biology of Lates Niloticus (Linnaeus) In the Nyanza Gulf of Lake Victoria (kenya) With Special Reference to the Food and Feeding Habits. University of Nairobi; 1984.

4. Fryer G. The Lake Victoria fisheries: some facts and fallacies. Biological Conservation. 1973; 5(4):304-8.

5. Masai DM, Ojuok JE, Ojwang W. Fish species, distribution and abundance. Natural resources and the development of Lake Victoria Basin of Kenya. 1979; 390-406.

Citation: Chemoiwa EJ (2022) The current status of *Barbus* species in Lake Victoria Basin, Kenya: A review. Int J Aquac Fish Sci 8(3): 092-097.
DOI: https://dx.doi.org/10.17352/2455-8400.000083

6. Masai DM, Ojuok JE, Ojwang W. Fish species composition, distribution and abundance in Lake Victoria basin, Kenya. East African Community's institutional repository. 2004; (Lvemp I):14.

7. Mwalo OM. The biology and distribution of Haplochromis spp in the Nyanza Gulf prior to the total invasion of the Gulf of Nile perch. Lates niloticus (L). In: Proceedings of the Second EEC Regional Seminar on Recent Trends of Research on Lake Victoria Fisheries. NAIROBI. Nairobi: ICIPE SCIENCE PRESS; 1994; 73-83.

8. Njiru M, van der Knaap M, Taabu-Munyaho A, Nyamweya CS, Kayanda RJ, Marshall BE. Management of Lake Victoria fishery: Are we looking for easy solutions? Aquatic Ecosystem Health and Management. 2014;17(1):70-9.

9. Welcomme RL. Recent changes in the stocks of Tilapia in Lake Victoria. Nature. 1966; 212(5057):52-4.

10. Ogutu-Ohwayo R, Twongo T, Wandera SB, Balirwa JB. Suggestions to Set Mesh Size Limits and Restrict the Fishing Methods and the Types of Fishing Gears on Lakes Victoria and Kyoga. In: Okemwa E, Wakwabi EO, Getabu A, editors. Proceedings of the Second EEC Regional Seminar on Recent Trends of Research on Lake Victoria Fisheries. 1995; 139-52.

11. Njiru M, Okeyo-Owuor JB, Muchiri M, Cowx IG. Shift in feeding ecology of Nile tilapia in Lake Victoria, Kenya. African Journal of Ecology. 2004; 42:163-70.

12. Okemwa E, Wakwabi E, Getabu A. Proceedings of the Second EEC Regional Seminar on Recent Trends of Recent Trends in Research on Lake Victoria Fisheries. In: Recent Trends of Research on Lake Victoria Fisheries. ICIPE SCIENCE PRESS; 1991; 1-3.

13. Nyamweya C, Desjardins C, Sigurdsson S, Tomasson T, Taabu-Munyaho A, Sitoki L, Stefansson G. Simulation of Lake Victoria Circulation Patterns Using the Regional Ocean Modeling System (ROMS). PLoS One. 2016 Mar 31;11(3):e0151272. doi: 10.1371/journal.pone.0151272. PMID: 27030983; PMCID: PMC4816512.

14. Nyamweya C, Sturludottir E, Tomasson T, Fulton EA, Taabu-Munyaho A, Njiru M. Exploring Lake Victoria ecosystem functioning using the Atlantis modeling framework. Environmental Modelling and Software. 2016; 86:158-67.

15. Aura CM, Musa S, Yongo E, Okechi JK, Njiru JM, Ogari Z. Integration of mapping and socio-economic status of cage culture: Towards balancing lake-use and culture fisheries in Lake Victoria, Kenya. Aquaculture Research. 2018; 49(1):532-45.

16. Witte F, Goldschmidt T, Wanink J, Oijen M Van, Goudswaard K, Witte-maas E, et al. The destruction of an endemic species flock haplochromine cichlids of Lake Victoria.pdf. Environmental Biology of Fishes. 1992; 34(Wilson 1988):1-28.

17. Fish GR. Some Aspects of the Respiration of Six Species of Fish From Uganda. Journal of Experimental Biology. 1956; 33(1):186-95.

18. Outa NO, Yongo EO, Keyombe JLA, Ogello EO, Namwaya Wanjala D. A review on the status of some major fish species in Lake Victoria and possible conservation strategies. Lakes and Reservoirs: Research and Management. 2020; 25(1):105-11.

19. Seegers L, De Vos L, Okeyo DO. Annotated Checklist of the Freshwater Fishes of Kenya (excluding the lacustrine haplochromines from Lake Victoria). Journal of East African Natural History. 2003; 92(1):11-47.

20. Balirwa JS. Barbus species of Lake Victoria (Pisces, Cyprinidae). Datz, Aquar-Terr-Z. 1990; 43(6):349-54.

21. Schmidt RC, Bart HL Jr, Nyingi WD. Multi-locus phylogeny reveals instances of mitochondrial introgression and unrecognized diversity in Kenyan barbs (Cyplarininae: Smiliogastrini). Mol Phylogenet Evol. 2017 Jun;111:35-43. doi: 10.1016/j.ympev.2017.03.015. Epub 2017 Mar 18. PMID: 28323052.

22. EAC. Regional Transboundary Diagnostic Analysis of the Lake Victoria Basin. Regional Transboundary Diagnostic Analysis for the Lake Victoria Basin. 2007; 1-100.

23. LVFO EAC. Lake Victoria Water Budget and Circulation. In: Entebbe Declaration-The Regional Stakeholders Conference on the State of the Fisheries Resources. Entebbe: EAC; 2005; 113-123.

24. Okungu JO, Njoka S, Abuodha JOZ, Hecky RE. An introduction to Lake Victoria catchment, water quality, physical limnology and ecosystem status (Kenyan sector). In: Lake Victoria Water Budget and Circulation In: LVFO (2005): Proceedings of the Regional Stakeholders Conference. Lake Victoria Environment Management Project (LVEMP); 2005; 1-27.

25. Schmidt RC, Bart HL Jr, Nyingi WD. Two new species of African suckermouth catfishes, genus Chiloglanis (Siluriformes: Mochokidae), from Kenya with remarks on other taxa from the area. Zootaxa. 2015 Nov 17;4044(1):45-64. doi: 10.11646/zootaxa.4044.1.2. PMID: 26624701.

26. Hayes MM, Armbruster JW. The Taxonomy and Relationships of the African Small Barbs (Cypriniformes: Cyprinidae). Copeia. 2017; 105(2):348-62.

27. Yang L, Sado T, Vincent Hirt M, Pasco-Viel E, Arunachalam M, Li J, Wang X, Freyhof J, Saitoh K, Simons AM, Miya M, He S, Mayden RL. Phylogeny and polyploidy: resolving the classification of cyprinine fishes (Teleostei: Cypriniformes). Mol Phylogenet Evol. 2015 Apr;85:97-116. doi: 10.1016/j.ympev.2015.01.014. Epub 2015 Feb 16. PMID: 25698355.

28. Conway KW, Kubicek KM, Britz R. Morphological novelty and modest developmental truncation in Barboides, Africa's smallest vertebrates (Teleostei: Cyprinidae). J Morphol. 2017 Jun;278(6):750-767. doi: 10.1002/jmor.20670. Epub 2017 Mar 28. PMID: 28370364.

29. Eschmeyer WN, Fricke R, Van der Laan R. Catalog of fishes: Genera. 2020.

30. Armbruster JW, Stout CC, Hayes MM. An empirical test for convergence using African barbs (Cypriniformes: Cyprinidae). Evolutionary Ecology. 2016; 30(3):435-50.

31. Decru E, Moelants T, De Gelas K, Vreven E, Verheyen E, Snoeks J. Taxonomic challenges in freshwater fishes: a mismatch between morphology and DNA barcoding in fish of the north-eastern part of the Congo basin. Mol Ecol Resour. 2016 Jan;16(1):342-52. doi: 10.1111/1755-0998.12445. Epub 2015 Aug 6. PMID: 26186077.

32. Skelton PH. Name changes and additions to the southern African freshwater fish fauna. African Journal of Aquatic Science. 2016; 41(3):345-51.

33. Ren Q, Mayden RL. Molecular phylogeny and biogeography of African diploid barbs, 'Barbus', and allies in Africa and Asia (Teleostei: Cypriniformes). Zoologica Scripta. 2016;45(6):642–9.

34. Stiassny MLJ, Sakharova H. Review of the smiliogastrin cyprinids of the Kwilu River (Kasai Basin, central Africa), revised diagnosis for Clypeobarbus (Cyprinidae: Cyprininae: Smiliogastrini) and description of a new species. Journal of Fish Biology. 2016; 88(4):1394-412.

35. Stiassny MLJ, Liyandja TLD, Monsembula Iyaba RJC. A New Small Barb (Cyprininae: Smiliogastrini) from the N'sele and Mayi Ndombe Rivers in the Lower Reaches of the Middle Congo Basin (Democratic Republic of Congo, Central Africa). American Museum Novitates. 2016; (3848):1-15.

36. Berrebi P, Kottelat M, Skelton P, Ráb P. Systematics of Barbus: State of the art and heuristic comments. Folia Zoologica. 1996; 45(1):5-12.

37. Banister KE, Clarke MA. A revision of the large barbus (Pisces, cyprinidae) of lake malawi with a reconstruction of the history of the Southern African rift valley lakes. Journal of Natural History. 1980;14(4):483-542.

38. Ndeda VM, Mateos M, Hurtado LA. Evolution of African barbs from the Lake Victoria drainage system, Kenya. PeerJ. 2018 Oct 26;6:e5762. doi: 10.7717/peerj.5762. PMID: 30386696; PMCID: PMC6204829.

39. Thieme ML, Turak E, McIntyre P, Darwall W, Tockner K, Cordeiro J, et al. Freshwater ecosystems under threat: the ultimate hotspot. Fresh water: the essence of life. 2010; 123-51.

Citation: Chemoiwa EJ (2022) The current status of *Barbus* species in Lake Victoria Basin, Kenya: A review. Int J Aquac Fish Sci 8(3): 092-097.
DOI: https://dx.doi.org/10.17352/2455-8400.000083

40. Vörösmarty CJ, McIntyre PB, Gessner MO, Dudgeon D, Prusevich A, Green P, Glidden S, Bunn SE, Sullivan CA, Liermann CR, Davies PM. Global threats to human water security and river biodiversity. Nature. 2010 Sep 30;467(7315):555-61. doi: 10.1038/nature09440. Erratum in: Nature.2010 Nov 11;468(7321):334. PMID: 20882010.

41. Ochumba PBO, Manyala JO. Distribution of fishes along the Sondu-Miriu River of Lake Victoria, Kenya with special reference to upstream migration, biology and yield. Aquaculture Research. 1992; 23(6):701-19.

42. Chemoiwa EJ, Abila R, Macdonald A, Lamb J, Njenga E, Barasa JE. Genetic diversity and population structure of the endangered ripon barbel, B arbus altianalis (B oulenger, 1900) in L ake Victoria catchment, Kenya based on mitochondrial DNA sequences. Journal of Applied Ichthyology. 2013;29(6): 1225-33.

43. Chemoiwa Ej. Morphometric, Genetic Structure And Phylogenetic Studies of Barbus altianalis (Boulenger 1900) Populations in Lake Victoria Watershed (Doctoral dissertation, University of Eldoret).

Citation: Chemoiwa EJ (2022) The current status of *Barbus* species in Lake Victoria Basin, Kenya: A review. Int J Aquac Fish Sci 8(3): 092-097.
DOI: https://dx.doi.org/10.17352/2455-8400.000083