Relationship of Ecological Factors and Commercial Bronze Featherback Fish, *Notopterus notopterus* (Pallas, 1769); Irrawaddy River, Myitkyina Segment, Kachin state, Myanmar

Mie Mie Kyaw [1], Myat Mon Kyaw[2], M. Roi Lum[3,] Soe Soe Su Naing[4]

Abstract

Nowadays, there are gradually decreasing the quality of water bodies of Rivers, among them, Irrawaddy River is also little impacts asunder the impact of ecological stress that is leading to be declining fisheries resources including *Notopterus notopterus* (Pallas, 1769) (here after target species, one of commercially importance fishes in Myanmar), therefore, this research work is conducted on the basis of assessing water quality, availability of target fish, its productivity rate, local indigenous groups participation for conservation, and to control illegal fishing methods and gears in order to sustain natural resource of fisheries as well as water bodies. It was observed some constraints such as poor stakeholder mapping, unclear understanding on ecological engagement, and weak environmental awareness. In doing so, it is focused on intervention with observation of actual target fish species population that is about 30 % of all fishes in the study area, Irrawaddy River, Myitkyina segment (Kachin state, Myanmar) according to survey versus aquatic ecosystem with respect to water quality monitoring assessment in which physico chemical indicator by comparing desirable as well as imperative of world health organization (W.H.O) standard, in doing so, all are chemically potable except color (units), turbidity (N.T U) concerning physical examination for pH (scale) = 6.8, color (units) = > 50, turbidity (N.T.U) = 52.1, conductivity (micromhos/cm) = 56; as well as chemical analysis for calcium as Ca = 8, total hardness ($CaCO_3$) = 36, magnesium as Mg = 3, chloride as Cl = 5, total alkalinity = 36, total iron (Fe) = > 0.2, manganese (Mn) = 0.03, sulphate (SO_4) = < 200. And the result of B.O.D (Biochemical Oxygen Demand) = 3.80, D.O (Dissolved Oxygen) = 5.60, C.O.D (Chemical Oxygen Demand) = -, pH value = 6.8, Salinity = 0.1, T.D.S (Total Dissolved Solids) = 29.6 (mg/l). Therefore, it leads to clear comprehensive understanding on ecological integrity, importance of fisheries resources with stakeholder mapping, compact information on conservation and monitoring fisheries as well as water resource with capacity building engagement of stakeholders regarding community development and better livelihood of local indigenous group.

Key words: ecological stress, *Notopterus notopterus*, monitoring assessment, physico chemical indicator, stakeholder mapping

Introduction

Notopterus notopterus (Pallas, 1769), the "Asian knife fish" or "Bronze featherback" and the large growing species of the genus Chitala are fish from tropical South-East Asia. The Asian knife fish is mainly found in floodplains, in stagnant backwaters and ponds and even enters brackish waters of the river mouths. Its natural habitats are located in India, Pakistan, Burma, Thailand, the Malay, Archipelago, the Philippines, Cambodia, Vietnam, Laos, Bangladesh, and Myanmar (Day 1889, Roberts 1992). *N. notopterus* is predominantly a carnivorous and a free water column feeder (Mustafa and Ahmed 1979, Azadi et al. 1994).

The osteoglossiform family Notopteridae comprises four genera, eight better known and ten nominal species with mostly long and notably slender bodies occurring in tropical Africa and South and South-East Asia (Roberts 1992, Nelson 2006, Eschmeyer and Fong 2017). *Notopterus notopterus* (Pallas, 1769) is a member of the family Notopteridae,

[1] Lecturer, Dr., Department of Zoology, University of Mandalay
[2] Lecturer, Faculty of Information Science, University of Computer Studies (Maubin), Myanmar
[3] Lecturer, Department of Zoology, University of Myitkyina, Myanmar
[4]Associate Professor, Department of Zoology, Magway University, Myanmar

commonly known as grey featherback and bronze featherback but locally known as Foli and Pholoi in Bangladesh. This species is locally important for its taste and abundance in the Kaptai reservoir. Kaptai Lake, located at Kaptai Upazila in Rangamati district of Bangladesh, is the spawning, nursing and feeding ground of many important fishes (M. Golam Mustafa., et,al (2014). During the last couple of decades availability of this fish in the Reservoir environment has been drastically declined due to several factors, such as siltation caused by deforestation, over fishing, indiscriminate killing of supplemental fingerlings and use of various types of destructive fishing methods (Ahmed and Hambrey, 1999). In this study, the availability of *Notopterus notopterus* (here after target species), the present population of target species is decreasing by comparing with the precious time in the study area, Irrawaddy River, Myitkyina segment (Kachin state, Myanmar, there are due to overfishing, IUU (Illegal, Unreported and Unregulated (IUU) fishing including battery-shock typed fishing, illegal fishing in the breeding and spawning season, using sand mines enterprises along the route of River, wrong mesh size as well as chemicals as side products of small scale gold mines in Irrawaddy river with poor ecological awareness on aquatic ecosystem in the study area, Myitkyina, Kachin state, Myanmar, therefore, all of the reasons are leading to challenges to be stress of aquatic ecosystem in the study area in Myanmar.

The oviparous bronze featherback (knife-fish), *Notopterus notopterus* (Family Notopteridae), a popular food fish with ornamental valued, thrives well in freshwater rivers, ponds and lakes. It is a very hardy fish and can be easily reared in aquarium, stagnant water and aquaculture system on a variety of feeds. The bronze featherback is distributed in south and south-east Asian countries including Bangladesh, Malaysia, Thailand, Myanmar, Java, Sumatra and Borneo (Rahman, 1989). In this study, target fish is also very popular food fish by using in various meals, many kinds of salads, lot of soups in whole Myanmar especially the meat of this target fish is very tasty with highest nutrient value as well as high price but it is very uncommon to rare for ornamental purpose. It is very common in the rivers as well as in lakes especially for favorable conditions in nature. The study area is origin of Irrawaddy River, therefore, the impact of river flowing is almost none but poor ecological awareness of people that makes some impacts on flowing of Irrawaddy River.

Mekong Fish catch and culture stated in 1999 about the bronze featherback is caught in traps or with hook and line in rice fields and other small water bodies. Although these fish, like other featherbacks, have more spines in their flesh than any other Mekong fish species, they are popular food fish. Women in markets can be seen skillfully separating the soft meat from skin and bones. Most often the meat is used to make very tasty fish cakes. Soup made from these fish is said to cure measles in children. In this study, there are many fish selling women in the local markets who can peel off the meat of target fish from their bone within very short time as experts. This meat without bone of the target fish is very good for healthy life and capable for recover life from unhealthy; therefore, it is very popular in the cooking meals with various styles in Myanmar.

Notopterus notopterus is oblong, compressed and deep, with long and tapering caudal region that was stated by V. UMA GNANA KIRAN AND SARALA WAGHRAY (1998). The recruitment of the species was found throughout the year with two peaks - one from March-April; and another from May- June. In this research work, target fish is available in the study area commonly but not very much common as in the previous time. The body is laterally compressed and the color is mostly silver but there are slightly changes in color according to various habitats of fish. There are common throughout the year in the study area, Myitkyina area, Kachin state, Myanmar, but fewer in number by comparing the previous timeline.

Gut content analysis of *N. notopterus* of length ranging from 11.2-32.2 cm showed that the fish is a carni-omnivorous, euryphagic, bottom feeder which feeds on aquatic insects, small fishes, prawns, nematodes, aquatic weeds, sand and mud, in the order of preference. Feeding intensity which is maximum in summer and minimum in winter is related to maturity. The fish is capable of adjusting and widening its food spectrum, when preferred items become scarce that was mentioned by V. UMA GNANA KIRAN AND SARALA WAGHRAY (1998). In this present study, this target fish is also carni-omnivorous, and is can adapt foods according to its surrounding area.

They are able to swim backwards almost equally well as forwards by undulation of the anal fin. If present at all, the dorsal fin is small and featherlike, so these fish are commonly referred to as "Feather backs" or "Knife fish". Knife fish have a long anal fin, which conjoins with the caudal fin posteriorly and with the leading edge closely behind the rudimentary ventral fins anteriorly. The mouth has many small teeth and the body is covered with numerous tiny scales. The swim bladder remains connected to the gut and is also used for breathing air. This swim bladder may have four functions: keeping buoyancy, as a means for aerial respiration, as an accessory auditory organ, and as an organ for sound production that was mentioned by (Bridge 1900, Greenwood 1963, Alexander1966).

Mekong Fish catch and culture also described in 1999 about the featherback family, Notopteridae, is one of the most conspicuous groups of fish in the Mekong. The peculiar knife-shaped body with a long anal fin, which is continuous with the caudal fin, readily identifies a featherback. The fish in this family are dusk- and night-active predators, with well-developed teeth on their jaws and tongues. Featherbacks do not have barbels, but they possess a small appendage on each nostril. Other characteristics include a small tuft-like dorsal fin, and very small body scales. Unlike most other fish a featherback does not flex its body when swimming. It swims by means of waving its anal fin, by which it can move both backwards and forwards. The featherbacks are capable of breathing atmospheric air by inflating the swim bladder, and they come to the surface from time to time. In this study, target fish can stand some environmental conditions and can eat minute zooplanktons by using their fine teeth. Swimming is fast along water current in the study area and it is obvious weaving fin is peculiar character of it.

Overall aim is to clear understand about the target fish species *Notopterus notopterus*, its population, the ecological impacts on water bodies versus target fish species. Three objectives are to observe the target fish species population, and diversity with respect to the quality of water resource, to evaluate the main reasons of impacts on water bodies, and to inform local communities as well as stakeholders

Materials and Methods

Study area

Myitkyina segment, Irrawaddy River, Kachin state, northern part of Myanmar, Latitude 25.709647°, Longitude 97.502596°, (Google Earth location).(Hereafter, study area)

Study period

January to December 2019, time duration is one year.

Target fish species

*Notopterus notopterus (*Pallas, 1769), Asiatic knifefish, bronze featherback

Systematic position

Kingdom: Animalia

Phylum: Chordata

Subphylum: Vertebrata

Class: Actinopterygii

Order: Osteoglossiformes

Family: Notopteridae

Genus: *Notopterus* (Lacépède, 1800)

Species: *Notopterus notopterus (*Pallas, 1769), Asiatic knifefish, bronze featherback

According to Day (1889), Mishra (1962), Jayaram (1981, 1999, 2006), Fischer and Bianchi (1984), Talwar and Jhingran (1991), and Jhingran (1997), the fish is followed order and family;

Order: **Osteoglossiformes**

1. Dorsal fin small
2. Anal fin very long and tapering, more than 100 rays, confluent with small caudal fin
3. Pelvic fin rudimentary
4. Bony tongue with curved teeth

Family: Notopteridae

1. Body deep and strongly compressed
2. Abdomen serrated before pelvic fins
3. Barbels absent
4. Dorsal fin small and slender, with eight to ten rays
5. Anal fin long based (100 to 135 rays)
6. Scales very small
7. Lateral line complete, with about 180 scales

Species: *Notopterus notopterus*

D 7-9; A+C 100-110; V 5-6

1. Maxilla extends to midorbit
2. Pre-orbital serrated
3. Larger scales on opercles than those on the body
4. No transverse bars on back
5. No rounded spots near caudal origin
6. Pectoral fin moderate, extends beyond anal fin origin
7. Lateral line straight and complete

8. Body silvery-white with numerous fine grey spots
9. Maximum size: 61 cm

Range Description:

Ng, H.H. stated in 2010 about the species is recorded in Pakistan, India, Nepal, Bangladesh, Myanmar, Laos, Cambodia, Thailand, Viet Nam, Malaysia and Indonesia.

Country Occurrence:

Ng, H.H. described in 2010 about native: Bangladesh; Cambodia; India; Indonesia; Malaysia; Myanmar; Nepal; Pakistan; Thailand.

Methods

1. Identification of target fish, *Notopterus notopterus (*Pallas, 1769), Asiatic knifefish, bronze featherback); FishBase software with special emphasis on the finfishes Myanmar (http://localhost:20010/) regarding IUCN list. Target fish was also identified in accordance with Talwar and Jhingran (1991) and Jarayam (2013)

2. Ecological assessment on physico-chemical indicator of Irrawaddy River; B.O.D (Biochemical Oxygen Demand), D.O (Dissolved Oxygen), C.O.D (Chemical Oxygen Demand), pH value, Salinity, T.D.S (Total Dissolved Solids); physical examination for pH (scale), color (units), turbidity (N.T.U), conductivity (micromhos/cm); as well as chemical analysis for calcium as Ca, total hardness ($CaCO_3$), magnesium as Mg, chloride as Cl, total alkalinity, total iron (Fe), manganese (Mn), sulphate (SO_4) by comparing desirable as well as imperative of world health organization (W.H.O) standard.
3. Field survey with ground truth of Google earth with synthesis of key stakeholder interviews, meetings with researchers, decision makers, and policy makers, as well as fishermen and local indigenous groups.

Research Design

1. Water quality analysis regarding physico- chemical indicators
2. Identification of target fish according to key character of Talwar and Jhingran (1991) and Jarayam (2013) , Fish base software (2013) and also confirmation with fisheries expert Dr Chaiwut GRUDPAN (Thailand)
3. Making research data for clear information to local communities and stakeholders

Laboratory Procedures

1. Collections of target fish species and preservation in ethyl alcohol
2. Morphological analysis were identified based on taxonomic characters such as body and fins color, the types of scales, number of spine and soft rays belong to dorsal, anal, ventral, pectoral and caudal fin according to key character of Talwar and Jhingran (1991) and Jarayam (2013)
3. Physical - chemical analysis of water bodies of riverine ecosystem,

Research framework

Problem statement	Research question	Constraint	Intervention	Research tasks	(1) Output and (2) Outcome
Changing population of target fish species due to ecological Stress	What are the main reasons to be impacts on decreasing target fish species?	Poor stakeholder mapping, unclear understanding on ecological engagement, and weak environmental awareness	Observation of actual target fish species versus aquatic ecosystem with respect to water quality monitoring assessment	Actual role of target fish species in aquatic ecosystem and finding reasons of ecological impacts on target fish and water bodies	(1) Clear comprehensive understanding on ecological integrity and importance of fisheries resources with stakeholder mapping (2) Compact information on conservation and monitoring fisheries as well as water resource with capacity building engagement of stakeholders regarding community development and better livelihood of local indigenous group

Analysis on key factors

1. Selected target fish species,
2. Physico-chemical indicators of water resources
3. Local communities' understanding on ecological stress

Fish Consumption by the Local Population

Almost 65 % of the local people are consuming fish and most are preferred to have target fish's meat according to survey of this research work.

Results and Discussion

Talwar & Jhingran, stated in 1991; Rainboth mentioned in 1996 about the bronze featherback *Notopterus notopterus* (Pallas, 1769), which is distributed throughout the Indian subcontinent and into Southeast Asia, is unique species in the genus (Nelson, 2006). The fish is a common commercial species, and it is popular in the daily diet of people inhabiting the Indochina Peninsula. It occurs mainly in clear streams, but also enters brackish waters, still and sluggish lakes, floodplains, canals and ponds. In the present study, the target fish can be getting all Rivers and lakes but especially in Irrawaddy River from the origin to end as Irrawaddy delta, brackish water as well, where more favorite target fish in the market zones, the target fish from Irrawaddy River, is very popular for its taste and specified quality.

Findik and Cicek, stated in 2011 about good quality foods which are very important for the wellbeing of humanity, and animal health has long been used as an environmental indicator of food source quality. This research work is agreed with this statement because the superior

quality of meat of target fish is vital for healthy life and human kind. The meat of the target fish is very fame and tasty in Myanmar, therefore, it is adjusting for supply and demand in the market areas not only in this study area but also in whole Myanmar; therefore, it is necessary as important task to maintain this target fish to be sustainable state in Irrawaddy River.

Heng K, Chevalier M, Lek S, Laffaille P, mentioned in 2018 about in flood-pulse systems, water level oscillations directly influence the connectivity to floodplain habitats for fish. Here, we aimed to investigate whether seasonal changes in the water level of a flood-pulse system(the Tonle Sap Lake, Cambodia) differentially affect diet breadth and dietary overlap of three common and commercially important fish species (*Anabas testudineus*, *Boesemania microplepis and Notopterus notopterus*) presenting important differences in their life-cycle (e.g. seasonal migration). Sokheng et al., described in 1999; in Cambodia, fish migrate from the Mekong River to floodplains during the wet season and swim back to the mainstream or other permanent water bodies during the dry season. In this study, the target can migrate from the primary habitats to secondary habitats of Irrawaddy River for breeding purposes.

Ng, H.H. stated in 2010 that *Notopterus notopterus* is most likely a species complex (R. Britz, pers. comm.), despite the very wide range as currently accepted. Until the taxonomic issue is resolved, the species is assessed as Least Concern. Further work is required to understand the species taxonomy when a reevaluation is also necessary to assess the status of the species. In the present study, it is classified species taxonomy according to the target fish's morphological characters with relevant literatures that have already mentioned in Martials and Methods section.

Mohammad Noor Azmai Amal., et.al, stated in 2018 for water temperature, pH, dissolved oxygen (DO), total dissolved substance (TDS), electrical conductivity (EC) and salinity were measured at each sampling site using a YSI 556 MPS probe (YSI Incorporation, NY, USA). A total of 500 mL of water sample was collected in sterilized polyethylene sampling bottle in replicates from 15 cm below the water surface at each sampling station and transferred into an ice box. The samples were immediately transported to the laboratory for further analysis. The chlorine (Cl2), nitrite (NO3-N), phosphate (PO4), sulphate (SO4) and ammonia-nitrogen (NH3-N) concentration were measured using a DR900 Multiparameter Handheld Calorimeter (Hach Company, Loveland, Colorado, USA). Analyses and sample collection were done between 8.00 AM and 12.00 AM during the sampling period. In this work, water sample is taken in the early morning before sun shine, water was collected in clean plastic bottles and tight it, then covered by black plastic in the clean bag and sent to the laboratory within 24 hours.

Banothu Raveendar, et.,al mentioned in 2018 for their work; the present study indicates that the water quality of the selected reservoir is within normal condition but the fish production level is not so satisfactory due to imbalanced trophic structure. The fish production was low due to several problems such as over population of weed fishes occupying 56.9% of the total catch and preponderance of Cat fishes/ Carnivorous fishes (9.92%), decrease in water depth due to excessive sedimentation, excessive macrophytic vegetation, poor stocking of commercially important fishes, illegal fishing during breeding period, poaching etc. The present study provides information on the current status of water quality and biodiversity of Nanaksagar reservoir. The present fish production from the reservoir could be increased through adoption of culture based fisheries. Physiochemical parameters like temperature, transparency, conductivity, TDS, pH, dissolved oxygen, free CO2, alkalinity, nitrate, phosphate are known to affect ecosystem characteristics. In this study of Myitkyina area, Kachin state (Myanmar), there are many small scales gold mine enterprises along Irrawaddy River, their side effects including mercury are easily throwing in the river that makes one of

ecological stress, sand mines enterprises along the route of River that is leading the destructions of fishery habitats and niches, using wrong mesh size is also challenges of fisheries populations that have caught all sizes of fish from the smallest to various size, all of these main reasons are challenging for survival of fish population especially target fish community.

Water quality is a broad term used to referring to the physical, chemical, biological, and radiological characteristics of water. It is often employed as a measure of water condition relative to the life requirements of biotic species and human need. Several studies detailing the influence of water quality on fish aggregation has been employed, mostly in the form of a combined physico-chemical parameters (Beamish et al. 2006, 2003; Dubey et al. 2012; Fischer & Paukert 2008) and rarely biological parameters (Ismail et al. 2016). In this study, it was analyzed for physical examination as pH (scale) = 6.8, color (units) = > 50, turbidity (N.T.U) = 52.1, conductivity (micromhos/cm) = 56; as well as chemical analysis for calcium as Ca = 8, total hardness ($CaCO_3$) = 36, magnesium as Mg = 3, chloride as Cl = 5, total alkalinity = 36, total iron (Fe) = > 0.2, manganese (Mn) = 0.03, sulphate (SO_4) = < 200. And the result of B.O.D (Biochemical Oxygen Demand) = 3.80, D.O (Dissolved Oxygen) = 5.60, C.O.D (Chemical Oxygen Demand) = -, pH value = 6.8, Salinity = 0.1, T.D.S (Total Dissolved Solids) = 29.6 (mg/l) by comparing desirable as well as imperative of world health organization (W.H.O) standard; , all are chemically potable except color (units), turbidity (N.T U) by resulting at the laboratory of Water and Sanitation Department, Mandalay City Development Committee (MCDC) within 24 hours. The result of water resources, the color and turbidity is not very much impact on aquatic life but may be little that the level was unknown.

Generally, different parameters of water quality had been shown to predictably influence fish communities in a wide range of aquatic habitats (Beamish et al. 2006, 2003; Dubey et al. 2012; Fischer & Paukert 2008; Ikhwanuddin et al. 2016; Rashid et al. 2018). This study totally agrees with this statement, water parameters influence fish population and entire communities regarding fisheries habitats in the study area.

Tawatchai Tanee., et.al, (2013) stated that about heavy metals are the most significant pollutants in the problem of environmental pollution worldwide. Metals tend to accumulate in water and then move up through the food chain, therefore accumulating in the fish, the main protein source for locals. In the present study, there are small scale gold mines that are using chemical such as mercury in order to collect minute gold particles but the local people are throwing their side effects of chemicals in the water bodies that is leading to the challenges of river and its tributaries where various habitats of target fish. If the toxic chemical is very small, there are almost no impacts as well as no ecological stress. If not, the opposite condition of the riverine ecosystem in the study area. Therefore, it is vital to inform local communities as well as all stakeholders about the clear information of the importance of aquatic ecosystem and possible main challenges on fisheries resource including target fish in order to be sustainable state in riverine ecosystem by monitoring it.

Conclusion

Heng K, Chevalier M, Lek S, Laffaille P, described in 2018 about *Notopterus notopterus* is a species found in a wide range of habitats including fresh waters, standing and sluggish waters, floodplains, canals, and ponds. Grayfish generally execute short migrations between the floodplain, where they reside during the wet season for breeding and feeding, to the main river channel, where they shelter in marginal vegetation or in the deeper pools of the channel over the dry season. These species are intolerant to hypoxia but present elaborate reproductive behaviors, which enable them to go into the floodplain for breeding during the dry season. In particular, we hypothesized that *N. notopterus* would display low seasonal variations

in its diet breadth because of its ability to migrate back and forth between different habitats, making it possible for individuals to forage on different resources and to maintain a broad diet during the whole year. In the preset study, the target fish can go wide area for breeding as regular purposes and feeding as sometimes from the main river to its tributaries where they can survive and adapt according to seasons by searching their breeding grounds and survival routes. Therefore, it is important to sustain habitat areas, feeding, breeding, and spawning as well in the aquatic ecosystem, in doing so, it is necessary to understand and inform possible reasons to be ecological stress in the study area to all local communities with stakeholder mapping.

Mohammad Noor Azmai Amal., et.al, described in 2018 about their work; this study presents new data on the influences of water quality on fish occurrence in peat swamp and its converted areas in North Selangor peat swamp forest (*NSPSF*), Selangor, Malaysia. The findings showed a progressive decrease in fish diversity recorded in the NSPSF over the years due to peat land clearing and conversion for residential and agricultural purpose. Therefore, this study agrees with this because water quality is highest regards to be monitoring that will surely effect on fisheries resources including target species.

Maharashtra Pollution Control Board stated in 2011 about actions are to be initiated to maintain the minimum water flow, otherwise known as environmental flow, to sustain the ecological functions at a healthy status. The lack of this flow adversely affects the loading of nutrients as also the distribution and recruitment of fish species. The lack of a continuous stream of water adversely affects the migration and breeding of the fishes. Urgent action is needed for the treatment domestic sewage and industrial effluents, especially at Tapovan and Kopergaon. This would help in the restoration of these two stretches, which are the most polluted sections of the river. This has to be curbed by vigorous monitoring and control of the fish farming activities in the watershed area of the river. In this study, it is focused on possible ecological stress to aquatic ecosystem, in doing so; it is vital importance to control the possible reasons of ecological stress that is leading to changing target fish population by observing target species versus aquatic ecosystem with respect to water quality as well as it is also equally important to reduce possible constraints including poor stakeholder mapping, unclear understanding on ecological engagement, and weak environmental awareness.

Heng K, Chevalier M, Lek S, Laffaille P, explained in 2018 about seasonal change in hydrology is a prominent feature of freshwater ecosystems influencing populations, communities and ultimately ecosystem processes by modifying the connectivity to floodplain habitats. Therefore, in conclusion of the present study, it is intended to have clear comprehensive understanding on ecological integrity and importance of fisheries resources with stakeholder mapping as well as compact information on conservation by monitoring fisheries as well as water resource with capacity building engagement of stakeholders regarding for the sake of communities including better livelihood of local indigenous group in the study area.

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Appendix

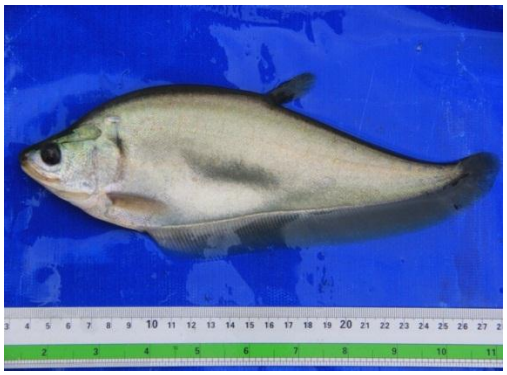

Figure 1. Target fish species, *Notopterus notopterus* (Pallas, 1769)

Figure 2. Google map of study area

Figure 3. Target fish, *Notopterus notopterus*

Figure 4. Target fish's meat

Figure 5. Discussion with local fisherman

Figure 6. Discussion with local people

Figure 7. Taking water sample in study area

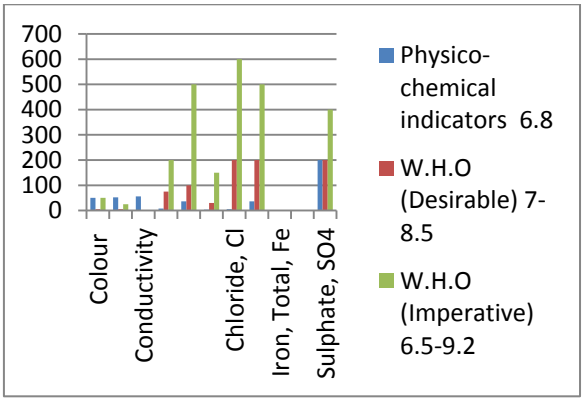

Figure 8. Result of physicochemical indicator

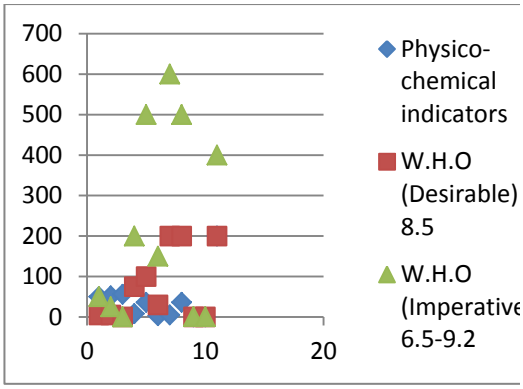

Figure 9. Result of physicocheminal indicator

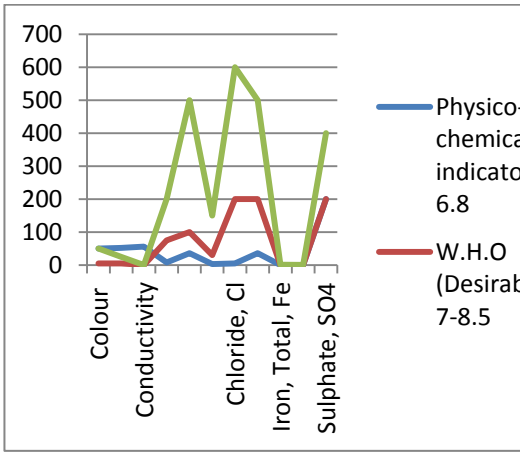

Figure 10. Result of physicochemical indicator

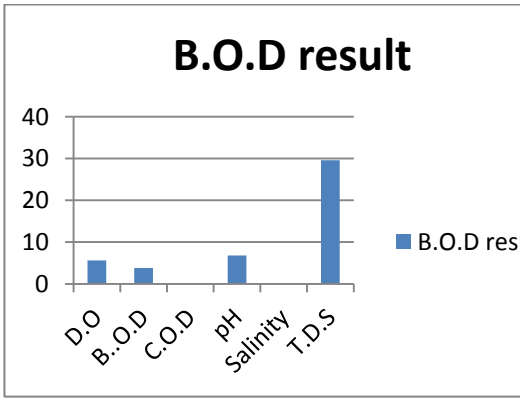

Figure 11. Result of B.O.D

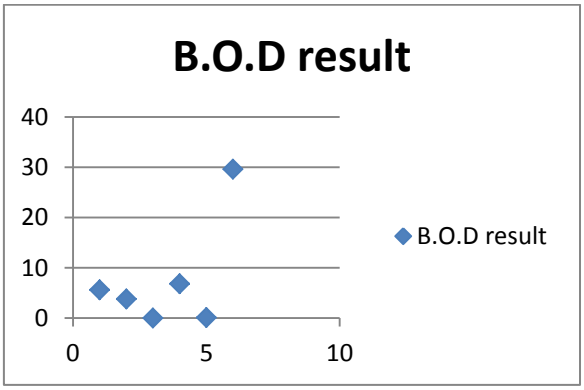

Figure 12. Result of B.O.D

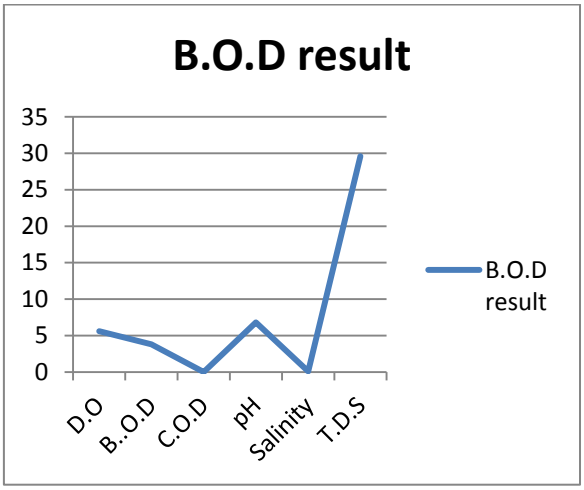

Figure 13. Result of B.O.D

Figure 14. Source: *The IUCN Red List of Threatened Species: Notopterus notopterus – published in 2010.*http://dx.doi.org/10.2305/IUCN.UK.2010-4.RLTS.T166433A6208173.en