An Assessment Of Fresh Water Fish Diversity Of Nuapada District, Odisha

Nikita Kand[1], Ajay Kumar Harit[1]*, Manoj Singh[1], Sohini Bhhattacharyya[1]

[1]*Department of Zoology, Kalinga University, Naya Raipur, Chhattisgarh, India-492101

***Corresponding Author:** Ajay Kumar Harit
*Department of Zoology, Kalinga University, Naya Raipur, Chhattisgarh, India-492101,
Email: ajay.harit@kalingauniversity.ac.in, om.harit@gmail.com

Abstract
Fish diversity plays a significant role in aquatic ecosystems to ensure the long-term sustainability and resilience of aquatic ecosystems, as well as the well-being of human populations that depend on them for their day-to-day life activities, need and economy. Odisha, located on the eastern coast of India, and Nuapada district of Odisha, India, is well known for its diverse freshwater ecosystems, including rivers, lakes, and ponds. While don't have specific data on the fish diversity of Nuapada district. To fill this gap present study was conducted. This study found 21 species of fish, which belonging to 21 genera, 12 families and 10 orders. Most of the species belong to family Cyprinidae (*Labeo rohita, Catla catla, Hypotthalmichtys nobilis, Cyprinus carpio, Ctenopharyngodon Idella, Cirrhinus cirrhosis, Systomus sarana, Tor putitora, Osteobrama vigorsii*). Most of the identified species belong to bottom feeder (57%) followed by Colum feeder (24%) and surface feeder (19%). All the identified fishes found in fresh water ecosystem of Nuapada district of Odisha. As it is the preliminary study on fish diversity of Nuapada district. However, further study needs to conduct for comprehensive and more appropriate information on the specific fish diversity of this district.

Keywords: Fish diversity, fresh water, Nuapada district, *Labeo rohita, Catla catla*

1. Introduction

Fish diversity refers to the variety and abundance of fish species found in a particular geographic region or ecosystem. Fish belong to diverse group of aquatic vertebrates and their inhabit included different type of habitats (Cardinale et al., 2012) such as freshwater bodies, marine, lakes, rivers, brackish water, estuaries, and reservoirs (Press and Delong, 2002). They come in various sizes, shapes, colors, and adaptations, allowing them to occupy different ecological niches and fulfill various ecological roles. Fishes contributes more than one half of the total vertebrate's population that is 34300 species (Froese and Pauly, 2020). Coad and Murray (2006) reported more than 32000 fishes found on earth belong to 536 families and 85 orders. Also reported 43% of fishes are fresh water.

India is one of the Mega biodiversity hotspots (Venkataraman and Sivaperuman, 2018) and a home to a vast array of freshwater ecosystems (rivers, ponds, lakes, wetlands, and reservoirs. Consequently, the country boasts a rich diversity of freshwater fish species and contributes about 7.4% of global fish diversity (Gopi and Mishra, 2015, Soni et al 2023a).

The freshwater fish fauna of India is extremely diversified, with 1027 species (Gopi et al., 2017). Approximately 13.92% of India's freshwater fish fauna in Odisha (Dutta et al., 1993). Odisha is the India's fourth-highest fish production state, approximately 8.16 lakh MT in 2019-20. Freshwater resources comprises 6.85 lakh Ha in the state (FARD, 2021) and contribute totally 6% of fish production On India. Odisha is the blessed with the diverse of fish fauna and found 186 species, belonging to 11 order, 33 families and 96 genera from various freshwater (Mogalekar, 2018).

The trophic level of fishes of Odisha ranged from 2.0 to 4.5 containing 62.41% of carnivorous species. Fishery status about 120 species worth for capture fishery, 101 species worth for ornamental fishery, 37 species worth for culture fishery and 57 species worth for sport fishes (Mogalekar, 2018).

The fish faunal composition of freshwater fishes is strongly dependent not only on their habitat but also on a variety of factor and such as fishing pressure, Population and habitat degradation affecting the habitat and aquatic diversity (chaki et al. 2014; Galib et al. 2016; parvez etal. 2017). It is presently critical to determine the primary drivers of aquatic biodiversity loss and to design a long-term management strategy for both the biota and their habitat (Mohsin et al. 2013; Galib 2015). Day (1878), their classic book 'fishes of India', Day (1878) was the first describe 89 species of fish from Odisha state. Following those freshwater fishes from India were studied. The first comprehensive research of Odisha's marine and freshwater fishes was conducted. Odisha's freshwater fish has since been extensively studied and described via various researchers (Chauhan, 1947; Jayram and Majumdar, 1976; 2006; Datta et al., 1993; Baliarsingh et al.,2000;Pathak et al., 2007; Ramakrishna et al., 2006; Das, 2008; Karmakar et al 2008; Baliarsingh et al., 2013; Singh et al., 2013); Behera and Nayak 2014, Satpathy, 2014, Baliarsingh et al., 2014; Mishra, 2014; Singh, 2014; Baliarsingh et al., 2015; Sarkar et al., 2015; Mohanty et al., 2015; Dandapat, 2015; Samal et al., 2016; Das et al. ,2016; Mogalekar, 2018

and FARD, 2021) from various part of Orisha like Bargarh, Sambalpur and Jharsuguda, - Kalahandi, Nawrangapur, Koraput, Sambalpur, Sonepur, Anugul, Deogarh, Kendujhar, Mayurbhanj, and Similipal Biosphere Reserve. Where to best of our knowledge no study has been reported from the Nuapada district of Odisha. So the main objective of the present study to study the fresh water fish diversity of this study area and fill the knowledge gap.

2. Materials and Methods

To study the fresh water fish diversity of Nuapada district of the state of Orisha. There are 21 wildlife sanctuary in Odisha, one of them.

2.1 Study area

Nuapada is situated between 20.65° N latitude and 82.833° E longitude (figure 1) and it is the southern district of Odisha. Geographical region of Nuapada district is located in 3852sq.km area and located in the western part of Odisha. The Sunabeda wildlife sanctuary (and a proposed tiger reserve located in the Nuapada district of Odisha, adjoining Chhattisgarh). Boundaries of Nuapada extends in the north, west and south to Raipur district of Chhattisgarh and in the east to Bargarh, Balangir and Kalahandi district of Odisha, The state of Odisha is distributed in two distinct agro climate region i.e., Eastern Plateaus and Hills and East Coastal plain and Hills.

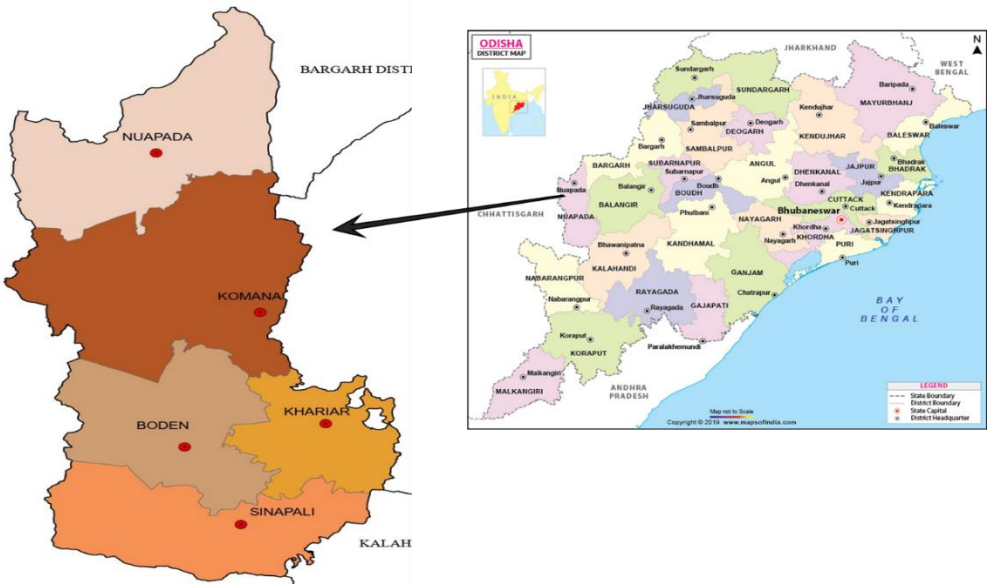

Figure 1: Map of Study area: Nuapada district of Odisha

Waterbodies, Vegetation, Soil and Climatic condition

Nuapada district is blessed with some rivers namely Tel, Udanti, Hatti, Sagada, Jonk etc. The drainage of the district is controlled by the tributaries of the Mahanadi River like Tel and Ong River. Which are in charge of the district's drainage. Indra, Udanti, Hatti, Sagada, Jonk and other major tributaries of the Tel are perennial and outflow in character and sustain sluggish flow (GWIB, 2013).

The Nuapada district extensive plateaus, which are part of the main line of the Eastern Ghats and include rich tropical grass, are surrounded on all sides by rocky hill ranges. These plateaus are approximately 4000 ft (1200m) above the sea level. They have bauxite, graphite, and laterite mineral resources. The dense Sal trees cover the hill sides that rise abruptly from the plains (ND, 2023).

Nuapada district contain three different types of soil (Alfisols, Ultisols and Vertisols) while used for agriculture, domestic purpose and the inland in the fish culture ponds (GWIB, 2013).

Global climate change is affecting freshwater ecosystems and populations of fish. The Nuapada area has a diversified agro-climate. Although the district receives moderate rainfall, its irrigation system is insufficient. The annual rainfall in the Nuapada district is 1378.2mm. The rainy season (June-September) contribute to almost 75% of total rainfall (GWIB, 2013).

2.2 Sample Collection

To study the fresh water fish diversity, a systematic survey was conducted in different location of Nuapada district. The details of survey and fish samples collection are given in table 1. The survey was conducted from January 2023 – March 2023 and sample were collected with the help of local fisherman and local peoples. Indeed, some samples also collected from local market. Photographs of collected fishes were also taken for identification purpose.

S. No	Location	Latitude	Longitude
1	Gudel pond-1 , Khariar	20.281464	82.768155
2	Gudel pond-2, Khariar	20.28145	82.768063
3	Boden chowk market-1, Khariar	20.299229	82.754105
4	Boden chowk market-2, Khariar	20.299207	82.754082
5	Boden chowk market-3, Khariar	20.299195	82.754065
6	Boden Chowk market-4, Khariar	20.29924	82.754012
7	Boden chowk market-5, Khariar	20.299227	82.754025
8	Boden chowk market-6, Khariar	20.299224	82.754044
9	Kalimati, Block- Komna	20.4391	82.671951
10	Daily market, Khariar	20.292326	82.760061
11	Block chowk market, Khariar	20.29861	82.754747
12	San maheswar	20.374844	82.698228
13	Road side-1, penraban Block- Komna	20.398897	82.677159
14	Road side-2 penraban,Block-Komna	20.408433	82.675217
15	Kalimati Bridge side, Block- Komna	20.443634	82.67318
16	Pendraban Bridge, Block-Komna	20.437946	82.671711
17	Tir bandh, Khariar	20.278571	82.670481
18	Tukla	20.265982	82.847772
19	Duajhar market	20.234483	82.751916
20	Duajhar pond	20.226962	82.743216
21	Putupada, Khariar	20.274839	82.762738
22	Chindaguda, Khariar	20.302587	82.721391

Fish Identification

Fish specimens were identified on their morphological characters, shape, size, colour etc. The samples also identified based on taxonomic keys for India subcontinent fishes by Jayaram, (1999), Talwar and Jingran (1991) and Berra (2001). Indeed, conservation status of the collected fish samples were also study as per International Union for Conservation of Nature, 2018 (IUCN, 2018)

3. Results and Discussion

3.1 Abundance and distribution

The total freshwater fishes of Odisha have been presented, along of their habitat, maximum size, fisheries information, and IUCN conservation status. A list of the fish fauna of Nuapada district of Odisha consist of about 21 species of fish belonging to 21 genera, 12 families and 10 orders were identified (Table-2) and pictures of all the 21 identified fishes is given below in figure 2.

Table 1. Showing the fish species and IUCN status of Nuapada district, Odisha.

S.No.	Common name	Scientific name	Family	Order	Genus	IUCN status
1	Rohu	*Labeo rohita*	Cyprinidae	Cypriniformes	*Labeo*	LC
2	Climbing perch	*Anabas testudineus*	Anabantidae	Perciformes	*Anabas*	DD
3	Bighead carp	*Hypotthalmichtys nobilis*	Cyprinidae	Cypriniformes	*Hypotthalmichtys*	DD
4	Pangas fish	*Pangasius pangasius*	Pangasiidae	Siluriformes	*Pangasius*	CE
5	Catla	*Catla catla*	Cyprinidae	Cypriniformes	*Catla*	LC
6	Silver pomfret	*Pampus pampus*	Stromateidae	Scrombriformes	*Pampus*	VU
7	Hilsa shad	*Tenualosa ilisha*	Clupeidae	Clupeiformes	*Tenualosa*	NT
8	White mullet	*Mugil curema*	Mugilidae	Mugiliformes	*Mugil*	LC
9	Snake head murrel	*Channa striata*	Channidae	Anabantiformes	*Channa*	LC
10	Grass carp	*Ctenopharyngodon idella*	Cyprinidae	Cypriniformes	*Ctenopharyngodon*	LC
11	Common carp	*Cyprinus carpio*	Cyprinidae	Cypriniformes	*Cyprinus*	LC
12	Indian mottled fresh water Eel	*Anguilla bengalenesis*	Anguilidae	Anguiliformes	*Anguilla*	NT
13	Mrigal carp	*Cirrhinus cirrhosus*	Cyprinidae	Cypriniformes	*Cirrhinus*	VU
14	Indian Mackeral	*Rastrelliger kanagurta*	Scombrini	Scombroidei	*Rastrelliger*	DD
15	Chitala	*Notopterus notopterus*	Notopterinae	Osteoglossiformes	*Notopterus*	LC
16	Pabda	*Ompok pabda*	Siluridae	Siluriformes	*Ompok*	LC
17	Olive barb	*Systomus sarana*	Cyprinidae	Cypriniformes	*Systomus*	LC
18	Mahseer	*Tor putitora*	Cyprinidae	Cypriniformes	*Tor*	EN
19	Godavari osteobrama	*Osteobrama vigorsii*	Cyprinidae	Cypriniformes	*Osteobrama*	LC
20	Malayan leaffish	*Pristolepis fasciata*	Pristolepididae	Anabantiformes	*Pristolepis*	LC
21	Mola carplet	*Amblypharyngodon mola*	Cyprinidae	Cypriniformes	*Amblypharyngodon*	LC

(LC= Least concern, NT=Near threatened, VU=Vulnerable, EN=Endangered, DD=Data Deficient, CE=Critical Endangered; IUCN = International Union for Conservation of Nature)

Figure 1.a- ***Labeo rohita***

Figure 1.b- ***Anabas testidineus***

Figure 1.c- ***Hypotthalamichtys nobilis***

Figure 1.d- ***Pngasius pangasius***

Figure 1.e- ***Catla catla***

Figure 1.f- ***Pampus pampus***

Figure 1.h- ***Mugil curema***

Figure 1.g- ***Tenualosa ilisha***

Figure 1.i- ***Channa striata***

Figure 1.j- ***Ctenopharyngodon idella***

Figure 1.k- ***Cyprinius carpio***

Figure 1.l- Anguilla bengalenesis

Figure 1.m- ***Cirrhinus cirrhosus***

Figure 1.n- ***Rastrelliger kanagurta***

Figure 1.o- ***Notopterus notopterus***

Figure 1.p- ***Ompok pabda***

Figure 1.q- ***Systomus sarana***

Figure 1.r- ***Tor putitora***

Figure 1.s- ***Osteobrama vigorsii***

Figure 1.t- ***Pristolepis fasciata***

Figure 1.u- ***Amblypharyngodon mola***

Figure 2: Showing the 21 species of fresh water fish found in Nuapada district of the Odisha (a-u).

3.2 Distribution of Fishes on the basis of families

Most of the identified fishes belong to family Cypriniformes (10 numbers) followed by Anabantiformes and Siluriformes (2 in each), Perciformes, Scrombriformes, Clupeiformes, Mugiliformes, Anguiliformes, Scrombroidei and Osteoglossiformes (1 in each). Based on family, the graphical representation of distribution of fishes is given in figure 3.

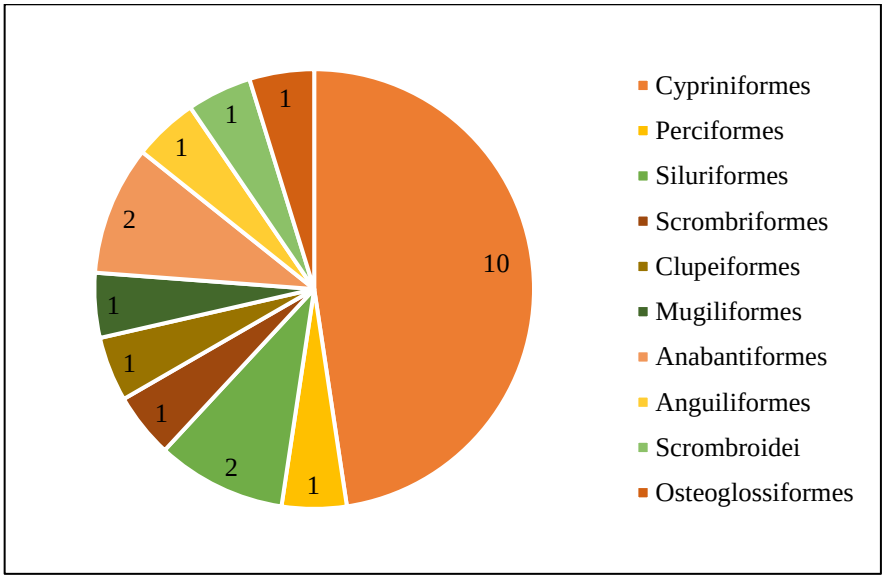

Figure 3: Distribution of Fishes on the basis of families

3.3 Distribution of Fishes on the bases of living and feeding

Based on fish living and feeding, the distribution of Fishes was also studied in waterbodies. The study found that most of the fishes are bottom feeder (57%) followed by colum feeder (24%) and surface feeder (19%) (figure 4).

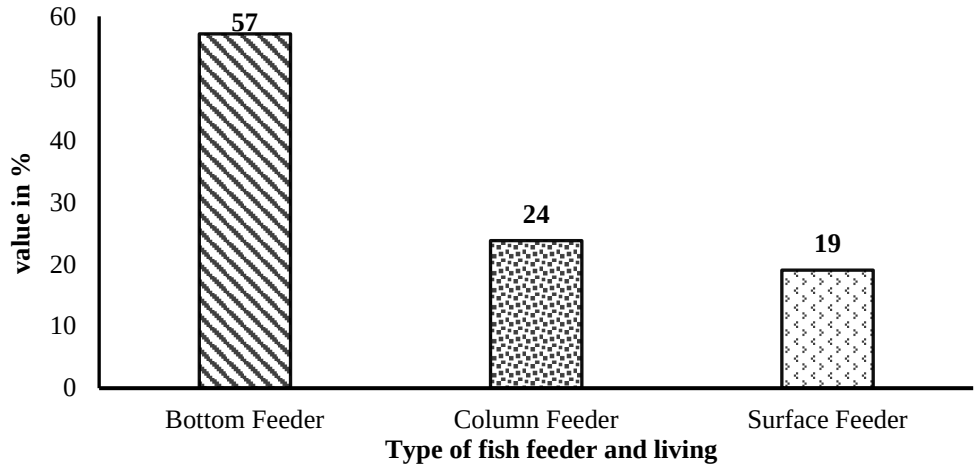

Figure 4: Distribution of fishes based on their feeding and living behaviour

3.3 International Union for Conservation of Nature (IUCN) Conservation Status

The present study also provides the IUCN conservation status of identified fresh water species of Nuapada district of Odisha (Table 1). According to IUCN (2018) conservation status 57.1% species are least concern (LC), 14.2 % data deficient (DD), 9.5 % near threatened (NT) and vulnerable (VU), and 4-7% of each endangered (EN) critical endangered (CN) categories (figure 5)

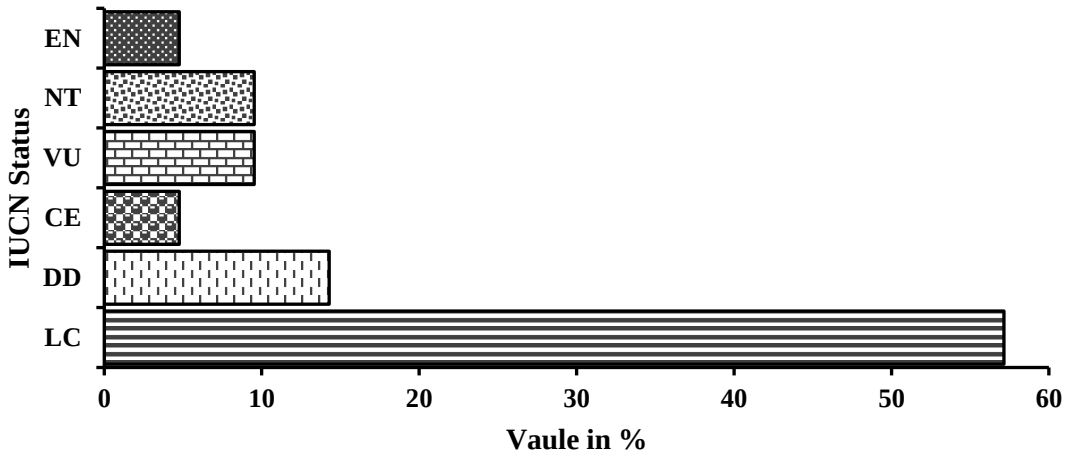

Figure 5: International Union for Conservation of Nature (IUCN) Conservation Status of fresh water fish of Nuapada district of Odisha

Discussion

The biodiversity of fish mainly represents the dangers of fish faunal diversity and abundance to fishermen and other stakeholders. Freshwater prevents species extinction and the necessity for a diverse range of fish species that contribute to conservation. This will help to safeguard commercial fisheries significantly (Ekaratne, 2000). The extinction of fish species in an aquatic conservation system, as well as broad range of species that contribute to conservation.

The present study of fish fauna along the Nuapada district revealed that the majority of the species reported were extensively spread throughout Odisha's freshwater. The fish like *Labeo rohita, Hypoptthalamichtys nobilis, Catla catla, Ctenopharyngodon Idella, Cyprinus carpio, Cirrhinus cirrhosus, Systomus sarana, Tor putitora, Osteobrama vigorsii, Amblypharyngodon mola* groups more dominant. As a result of the current analysis, Cyprinidae fishes were discovered to be the more dominant group than others. The conservation strategies for the species highlighted the necessity for scientists to raise awareness about the protection of fish species (Pethiyagoda, 1991). This study emphasised the importance of stakeholders being aware of autogenic and anthropogenic threats, activities, and harmful practises that may lead to the extinction of fish species in the freshwater system of Odisha's Nuapada district, as well as the consequence of this extinction and how it can be avoided. A holistic approach to the eventually create instability in the socio-economic sector

conservation of fish species in the freshwater would be the study area in terms of increased poverty of local integrate its conservation management strategies into its fishermen. It demonstrates an enormous decrease in the quality of fish water and production management programmes. According to the economic importance and scope of fish, and this research will be utilised as a tool for research will be utilised as a tool or regulating fisheries, particularly in Nuapada. The growing reliance on aquatic fisheries resources, particularly water, and the continued introduction of exotic species into natural water bodies, the loss of aquatic fish variety is expected to worsen unless effective conservation measures are implemented.

Indigenous fishes should also be included into societal value systems (sports, biological management, aesthetic, and so on). Mosquitoes can be controlled by fish such as Gambusia ap. Similarly, there are a number of brightly coloured native decorative fishes (Panda et al., 2014). India must collect baseline data on the indigenous species natural population potential. Extreme risk location must be identified in order for effective monitoring and conservation programmes to be implemented.

According to the results of the survey, the different ponds of Nuapada district is abundant in many types of Ichthyofauna, i.e., 12 families, 21 genera, 10 orders and 21 species of fishes. These are *Labeo rohita, Anabas testudinus, Hypotthalmichtys nobilis, Pangasius pangasius, Catla catla, Pampus pampus, Tenualosa ilisha, Mugil curema, Channa striata, Ctenopharyngodon Idella, Cyprinus carpio, Anguilla bengalenesis, Cirrhinus cirrhosus, Rastrelliger kanagurta, Notopterus notopterus, Ompak pabda, Systomus sarana, Tor putitora, Osteobrama vigorsii, Pristolepis fasciata, Amblypharyngodon mola.*

Freshwater fish fauna were 15 families and 45 species of fishes reported from Baripada. A total of 7 species of freshwater fishes namely *Labeo rohita, Catla catla, Amblypharyngodon mola, Chana striata, Cirrhinus cirrhosus, Notopterus notopterus, Anabas testudineus* are reported in Nuapada district, Odisha. Total of 38 species of freshwater fishes namely *Labeo bata, Salmophasia bacaila, Garra mullya, Punitus ticto, Punitus conchonius, Crossochelius latius, Punitus amphibius, Punitus pulchellus, Barilius vagra, Rasbora daniconius, Chela bacaila, Punitus stigma, Acanthocobitis botia, Rita rita, Mystus vittatus, Mystus tengara, Sperata aor, Sperata seenghala, Mystius bleekeri, Mystus cavasius, Mystus seenghala, Glossobius giuris, Chanda nema, Mastacembelus pancalus, Channa marulius, Clarias batrachus* were not recorded during present study (Samal et al., 2016).

The distribution of fish species varies greatly according to environmental factors. It is because deep water bodies allow for niche segregation, allowing fish to survive without predators.

As per (IUCN, 2018) the fish fauna of study area includes 12 least concern, 3 data deficient, 2 vulnerable, 2 near threatened, 1 critical endangered and 1 endangered. In Nuapada district the highest number of species classified as Least concern throughout the research period. Dandapat, 2015; Mohanty et al., 2015; Sarkar et al., 2015; Das et al., 2016; reported the dominance of cyprinid fishes in south Asia. The species comes under in data deficiency are often neglected in conservation program.

The surface water temperature ranged from 20.4° to 34.0°C, with an average of 28.28°C. The pH is varied. The water sample analysis through the help of the Aquaread water monitoring instruments (Aquaprobe AP-2000-D, S/N:228200720). Shannon-Weiner index for Budhabalamg river fish diversity, Baripada. Its values range from 3.35 to 3.359 (Samal et al., 2016).

The freshwater fish fauna of India is extremely diversified, with 1027 species (Gopi et al. 2017, Soni et al. 2023b). Earlier published reported on Odisha's freshwater fish fauna include Hora (1938, 1940), Misra (1938), Chauhan (1947), Jayaram and Majumdar (1976), Dutta et al. (1993), Ramakrishna et al. (2006), Pathak et al. (2007), Karmakar et al. (2013), Mishra et al. (2013). Cyprinid species predominate in natural water bodies throughout the South Asia, according to findings in various studies (e.g., Galib et al. 2009a; Mohsin et al. 2009; Flower et al. 2009). Appropriate management measures for vulnerable fishes should be developed; brood stock development, captive breeding, seed production, and seed rearing in natural water bodies may be considered in this regard. The use of dangerous and affecting fishing equipment and methods, which is widespread throughout the world, including South Asia (e.g. Galib et al. 2009b; Sultan and Islam 2016; Parvez et al. 2017), should be closely monitored and restricted.

4. Conclusion

This current study on the fish diversity of the Nuapada district of Odisha is blessed with fish diverse. The majority are regarded edible fishes. The study clearly demonstrated the number of species mostly from the family cypriniformes. As a results, the vast majority of fishes are members of this family, the economic potential of these fish might be utilised for domestic reasons. A study of their habitats and environment is necessary to estimate their export potential in light of international market demands. In district the diversity of freshwater fish fauna is extremely beneficial to the drainage system to the community's survival. The current study is findings may be used as a baseline for the planning conservational management of Odisha's fish and fisheries resources.

Acknowledgement
The authors are express their sincere gratitude to the higher authorities of Kalinga University, Naya Raipur, for their support and enragement to write this manuscript. NK, also acknowledge to all the fisherman of Nuapada district for their support and help during the filed survey. Also extent, her thank to all the local market merchant to providing local information related to fishes of collected from Nuapada.

Reference

1. Baliarsingh, B. K., S. K. Swain, L. Kosygin, and L. Nayak (2015): "Fish diversity and Physico-Chemical Characteristics of Rivers of Bhadrak district." *Odisha. e-planet* 13, no. 1: 71-76.
2. Baliarsingh, B., Swain, S., Kosygin, L. and Nayak, L. (2021): Fish diversity and physico-chemical characteristics of rivers of Bhadrak district, Odisha. *e-planet*, p.71.
3. Baliarsingh, B.K., Kosygin, L. and Rout, S.D. (2014): January. Fish Diversity and Physico-chemical Characteristics of Rivers of Ganjam district, Odisha. In Biological Forum (Vol. 6, No. 1, pp. 13-18). Satya Prakashan.
4. Baliarsingh, B.K., Kosygin, L., Swain, S.K. and Nayak, A.K. (2013): Species diversity and habitat characteristics of freshwater fishes in the Similipal Biosphere Reserve, Odisha with Some New Records. In Biological Forum–An International Journal (Vol. 5, No. 2, pp. 64-70).
5. Baliarsingh, B. K.; Kosygin, L.; Swain, S. K. and Nayak, A. K. (2013). Species diversity and habitat characteristics of freshwater fishes in the Similipal Biosphere
6. Behera, Durga Prasad, Lakshman Nayak, and Satyabrata Das Sharma (2013): "A check list on ichthyofaunal diversity of Bahuda Estuary, Odisha, East Coast of India." *International Journal of Zoological Research* 9, no. 2: 39.
7. Bera, S. (2022): Current status of fish diversity of Subarnarekha River in Paschim Medinipur district, West Bengal.
8. Bhakta, J. N., and P. K. Bandyopadhyay (2008): "Fish diversity in freshwater perennial water bodies in east Midnapore district of West Bengal, India." 255-260.
9. Cardinale, B. J.; Duffy, J. E.; Gonzalez, A.; Hooper, D. U.; Perrings, C.; Venail, P.; Narwani, A.; MacE, G. M.; Tilman, D.; Wardle, D. A.; Kinzig, A. P.; Daily, G. C.; Loreau, M.; Grace, J. B.; Larigauderie, A.; Srivastava, D. S. and Naeem, S. (2012). Biodiversity loss and its impact on humanity. Nature., 486(7401): 59–67. https://doi.org/10.1038/nature11148
10. Chanda, A. and Jana, A. (2021): A comparative review on freshwater fish fauna between West Bengal and Odisha, two middle east Indian states. *Journal of Fisheries*, *9*(3), pp.93302-93302.
11. CGWB (2013). Central Ground Water Board. Ministry of Water Resources Central Ground Water Board,SER Bhubaneswar May, 2013. https://cgwb.gov.in/District_Profile/Orissa/Nawapada.pdf
12. Das, M. K., S. Samanta, Deepa Sudheesan, M.Naskar, Mk Bandopadhyay, Sk Paul, S. Bhowmick, and P. K. Srivastava (2021): "Fish diversity, community structure and ecological integrity of river Brahmani ".
13. Dash, S. and Roy, S. (2017): A Preliminar a preliminary study of Faunal diversity of Rushikul unal diversity of Rushikulya estuary, Ganjam, Odisha.
14. Dash, S., Payra, A., Payra, P., Palei, H. and Mishra, R.M.A. (2019): Ichthyofaunal diversity in Ansupa lake, Cuttack, Odisha, India
15. Ekaratne, S.U.K. and Yadava, Y.S. (2000): A review of the status and trends of exported ornamental fish resources and their habitats in Sri Lanka.
16. FARD, (2021). Annual Activity Report: Fisheries Sector. 2020-21. Fisheries & Animal Resources Development Department, Government of Odisha, Odisha https://odishafisheries.nic.in:8443/upload/files/04_26_24pm91876187b881c3a81cd48f9085420fe5.pdf).
17. Froese, R. and Pauly, D. (2020). FishBase. 2020. World Wide Web Electronic Publication. Available at: Http://Www. Fishbase. Org (Accessed on 8 January 2018).
18. Folke, C.; Carpenter, S.; Elmqvist, T.; Gunderson, L.; Holling, C. S. and Walker, B. (2002). Resilience and sustainable development: Building adaptive capacity in a world of transformations. Ambio., 31(5): 437–440. https://doi.org/10.1579/0044- 7447-31.5.437
19. Fullonton, S., Roy, S., Mohanty, S.R., Rout, S., Mishra, R.K. and Mohapatra, A. (2020): Ichthyofaunal diversity of Panchupada estuary, Odisha, India.
20. Gopi, K. C., and S. S. Mishra (2015): "Diversity of marine fish of India." In *Marine faunal diversity in India*, pp. 171-193. Academic Press.
21. Islam, M. R., B. Das, D. Baruah, S. P. Biswas, and A. Gupta (2013): "Fish diversity and fishing gears used in the Kulsi River of Assam, India." *Annals of Biological Research* 4, no. 1: 289-293.
22. Johnson, J.A., Parmar, R., Ramesh, K., Sen, S. and Murthy, R.S. (2012): Fish diversity and assemblage structure in Ken River of Panna landscape, central India. *Journal of Threatened Taxa*, pp.3161-3172.
23. Khuntia, A., Swain, T. and Pattnaik, G., (2018): Ichthyofaunal Assessment of Birupa River, Odisha, India. *Int J Biol Med Res*, *9*(2), pp.6313-6316.
24. Krishna, P.V., Panchakshari, V., Suresh, P., Prabhavathi, K. and Kumar, K.A. (2016): Ichthyofaunal diversity of Siluriformes from Kolleru Lake, Andhra Pradesh, India. *International Journal of Fisheries and Aquatic Studies*, *4*(6), pp.420-424.
25. Kumar, S.T. (2014): Fish diversity in selected stretch of the River Mahanadi in Odisha and the livelihood of inhabiting fisher community. International Research Journal of Biological Sciences, 3(8), pp.98-104.

26. Kumar, S.T., Kumar, S.S. and Charan, G.B. (2020): Fish diversity of Mahanadi River (Odisha Part), threats and conservation measures, International Journal of Life Sciences, 8(2), pp.355-371.
27. Lianthuamluaia, L., Mishal, P., Panda, D., Sarkar, U.K., Kumar, V., Sandhya, K.M., Karnatak, G., Kumari, S., Bera, A.K., Das, S. and Ali, Y. (2019): Understanding spatial and temporal patterns of fish diversity and assemblage structure vis-a-vis environmental parameters in a tropical Indian reservoir. *Environmental Science and Pollution Research*, *26*, pp.9089-9098.
28. Marndi, R.K., Satapathy, D., Misra, S.K. and Kund, G.C. (2015): Fish diversity of Tampara Lake, Ganjam, Odisha. *Journal of Applied Zoological Researches*, *26*(2), pp.203-208.
29. Mishra, S., Jha, B.C. and Das, A.K. (2013): Ichthyfaunal diversity of Chilika lake-the southern sector.
30. Mogalekar, H.S., Canciyal, J., Ansar, C.P., Bhakta, D., Biswas, I. and Kumar, D. (2017): Freshwater fish diversity of West Bengal, India. *Journal of Entomology and Zoology Studies*, *5*(2), pp.37-45.
31. Mogalekar, H.S., Canciyal, J., Jawahar, P., Patadiya, D.S., Sudhan, C., Pavinkumar, P., Santhoshkumar, S. and Subburaj, A. (2017): Estuarine fish diversity of Tamil Nadu, India.
32. Mogalekar, Havagiappa Sharnappa, and Johnson Canciyal (2018): "Freshwater fishes of Orissa, India." *Journal of Fisheries* 6, no. 1: 587-598.
33. Mohapatra, S.B. (2022): A Case Study on ichthyofaunal diversity in fresh water Ansupa Lake, Banki, Odisha.
34. Nair, Rekha J., and S. Dinesh Kumar (2018): "Overview of the fish diversity of Indian waters." :35-66.
35. Panda, J. and Sahoo, S. (2020): Fish diversity and water quality of wetlands in attabira block of Bargarh District, Odisha, India. International Journal of Ecology and Environmental Sciences, 2(2), pp.67-71.
36. Pawara Ravindra, H., Patel Nisar, G. and Patel Yusuf, E. (2014): Review on freshwater fish diversity of Maharashtra (India). *Journal of Entomology and Zoology Studies*, *2*(5), pp.358-364.
37. Pethiyagoda, R., (1991): Freshwater fishes of Sri Lanka: Wildlife Heritage Trust of Sri Lanka. *Colombo. 362pp*.
38. Prakash, Sadguru (2021): "Present status of fish diversity of Davipatan Division of Uttar Pradesh, India." *International Journal of Zoological Investigations* 7, no. 2.
39. Press, A. and Delong, D. C. (2002). Chapter 1. Defining biodiversity. Tetrahedron Org. Chem. Ser., 21(C): 3–4. https://doi.org/10.1016/S1460-1567(02)80010-1
40. Rayal Rajesh, Akshita Bhatt, Pankaj Bahuguna, and H. K. Joshi (2021): "Fish diversity of Mal Gad stream Near Purola town from Uttarkashi-District, Uttarakhand, India." *Uttar Pradesh Journal of Zoology* 42, no. 14: 54-59.
41. Rout, Sushree Swati, and Bhaskar Behera (2022): "Ichthyofaunal Diversity in coastal zone of Balasore District, Odisha, India."
42. Samal, D., Sethy, J. and Sahu, H.K. (2016): Ichthyofauna diversity in relation to physico-chemical characteristics of Budhabalanga River, Baripada, Mayurbhanj, Odisha. International Journal of Fisheries and Aquatic Studies, 4(1), pp.405-413.
43. Sandhya, K.M., Lianthuamluaia, L., Karnatak, G. et al., (2019): Fish assemblage structure and spatial gradients of diversity in a large tropical reservoir, Panchet in the Ganges basin, India. Environ Sci Pollut Res 26, 18804–18813. https://doi.org/10.1007/s11356-019-05314-8
44. Satapathy, D. and Misra, S.K. (2014): Fish diversity and conservation of fishery resources of the river Pilasalunki, Phulbani district. Asian Journal of Animal Science, 9(2), pp.124-128.
45. Soni, S., Singh, M., Baghel, R. S., & Harit, A. K. (2023a). Diversity of the Ichthyofauna at the Ghunghutta Dam in the Surguja District of Chhattisgarh. Journal of Survey in Fisheries Sciences, 10(4S), 2805-2809.
46. Soni, S., Singh, M., Baghel, R. S., & Harit, A. K. (2023b). An analysis of Ichthyofaunal diversity in an aquatic reservoir of Surguja District, CG, India. Journal of Survey in Fisheries Sciences, 10(4S), 2810-2814.
47. Surachita, Supriya, and Sharat Kumar Palita (2022): "Freshwater fish diversity in hill streams of Saberi River in Eastern Ghats of Odisha, India." Journal of Threatened Taxa 14, no. 4: 20828-20839.
48. Trivesh, Rejani Chandran Sangeeta Mandal, Suresh Mayekar Amit Singh Bisht Sanjay, and Kumar Singh Lalit Kumar Tyagi (2022): "Fish diversity and habitat ecology of Tel River, a tributary of Mahanadi River." J. Inland Fish. Soc. India 54, no. 1: 03-15.
49. Valentina, Teronpi, H. Singh, A. Tamuli, and R. Teron (2015): "Assessment of Physico-Chemical Characteristics and Fish Diversity of Hill streams in Karbi Anglong district, Assam, India." Int. Res. J. Environ. Sci 4, no. 5: 6-11.
50. Venkataraman, K., & Sivaperuman, C. (2018). Biodiversity hotspots in India. Indian Hotspots: Vertebrate Faunal Diversity, Conservation and Management Volume 1, 1-27.
51. Verma, Narendra Kumar, RR Chavan, and Tausif Ahmad (2016): "Icthyofaunal diversity of three rivers of Raigarh district, Chhattisgarh".
52. Wootton, R.J. (1991): Fish ecology. Springer Science & Business Media.