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Fish diversity and habitat ecology of Dihing river - A tributary of Brahmaputra river

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Abstract
Extensive survey of fish diversity of the Dihing River (a tributary of Brahmaputra River) was conducted from February' 2013 to January' 2014. Seasonally sampling was carried out at three sites. During the survey, a total of 50 fish species belonging to 18 families and 34 genera have been recorded from this river and it was found to be dominated with Cyprinidae family followed by Bagridae and Siluridae. Habitat ecology reveals that the minimum (18.5 °C) water temperature was recorded in winter and the maximum (25.76 °C) in monsoon; lowest (20.73 °C) air temperature in winter and highest (26.66 °C) in monsoon; highest (141.33 µS cm^{-1}) conductivity in winter and its lowest (89 µS cm^{-1}) in monsoon; minimum (13.56 cm) transparency in monsoon and its maximum (72.16 cm) in winter; minimum (0.40 m/s) current flow in winter and the maximum (0.98 m/s) in monsoon; the lowest (7.16) pH in monsoon and highest (7.76) in winter; the lowest (6.33 mg/l) DO in post monsoon and its highest (7.51 mg/l) in pre monsoon; minimum (6.13mg/l) FCO_2 in pre-monsoon and its maximum (7.97 mg/l) in post monsoon; the lowest (32.44 mg/l) alkalinity in monsoon and its highest (42.89 mg/l) in winter; the highest (82.23 mg/l) hardness in pre-monsoon while its lowest (36.36 mg/l) in post monsoon; minimum (161.66mg/l) TSS in winter and maximum (393.33 mg/l) in smonsoon; the minimum (108.33 mg/l) and maximum (296.66) TDS was found in winter and monsoon season respectively.

Keywords*:* Dihing, Diversity, Brahmaputra River

1. Introduction
Fish are invariably one of the most important biotic components of an aquatic ecosystem which apart from forming protein rich food source for human beings, also act as a good bio indicators of a water body. The Northeastern region of India is one of the hot spots of freshwater fish biodiversity in the world [1]. However, the rich biodiversity of the freshwater fish of the India has been rapidly declining over the years due to excessive human activities and as well as other environmental factors. In future, the loss of biodiversity and its effects are predicted to be greater for aquatic ecosystems than for terrestrial ecosystems Sala *et al.*, 2000 [2]. Physico-chemical parameters of the waterbody are one of the essential factors required for the sustenance of life in any kind of the aquatic ecosystem. The Dihing River is one of the largest tributary of the mighty Brahmaputra River in Upper Assam. The river originates is in the Eastern Himalayas (Patkai Mountain Range) in Arunachal Pradesh and flows through the district of Tinsukia and Dibrugarh of upper Assam to its confluence with the Brahmaputra at Dihingmukh. Among the several kinds of inland freshwater bodies, the riverine system holds a unique position in terms of ecosystem, which generally covers different types of climatic zones, landscapes and bio-geographic regions. However, the cleanliness of rivers is one of the primary factors required for sustenance of aquatic life. So far, there are no specific records and systematic study on the hydrobiology and fish inventory. However, some works on ornamental fish diversity on different rivers of Assam has been done by the several workers [3, 4]; Sarma, *et al.*, 2012[5]. Moreover, Dihing River is one of the vital resources for earning livelihood of fisher folk and other villager inhabiting in and around the river since long time and also providing recreation and other agricultural activities for human beings as well as habitat for many diverged species of aquatic plants and animals. The river is surrounded by tea garden on one side and on the other side by human habitation.

Keeping the above views of its importance, therefore, an attempt has been made to assess the fish diversity and water quality of the Dihing river of Dibrugarh district, Assam.

2. Materials and Methods

The present study was carried out from Dihing River, a tributary of Brahmaputra River on monthly as well as a seasonal basis during February 2013 to January 2014. For which, the three sampling site were selected (Fig.1) and marked as site I ($27^0$18'42.54'' N and $94^0$52'55.55'' E), II ($27^0$18'57.26'' N and $94^0$53'16.97'' E) and III ($27^0$18'17.63'' N and $94^0$52'48.89'' E). From the sampling station, the river after flowing a distance of about 22 km joins the River Brahmaputra. The water sample was collected between 6:30 and 9:30 am in a glass stopper bottle and immediately fixed at the site and analyzed the certain physico-chemical parameters as per standard procedures [6, 7]. The fish specimens were caught using a cast net randomly from the stretch of the river, including sampling sites and they were photographed in fresh condition, later the specimens were preserved in 5% formalin and identified with the help of standard keys [8, 9]. The conservation status of the recorded fish species were evaluated [10].

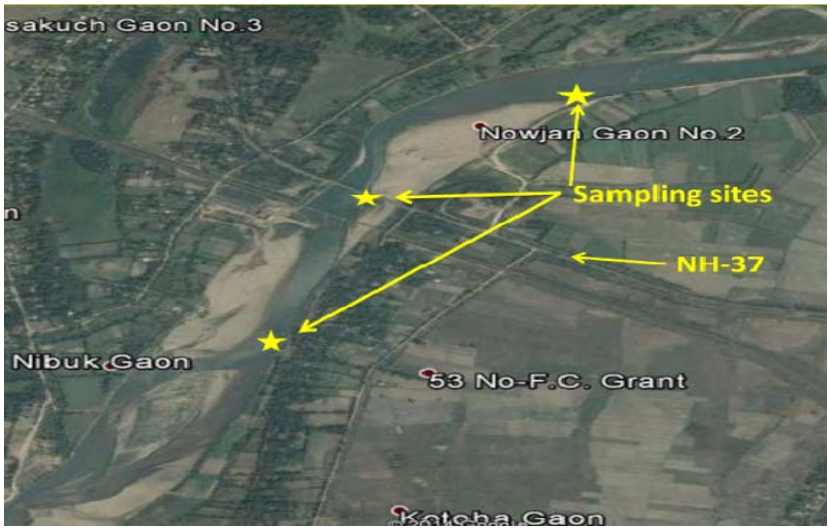


Fig 1: Satellite imaginary showing study site

3. Results and Discussion

The physico-chemical parameters of the Dihing River (Table 1) are summarized as below:

3.1. Temperature

The average minimum (18.5 °C) water temperature was recorded in winter and that of maximum (25.7 °C) was in monsoon whereas the lowest (20.7 °C) air temperature was found in winter and highest (26.6 °C) in monsoon season. A slight variation in water temperature might affect the physiological condition of the aquatic organism, thereby causing threats for their survival in their habitat. There is a very close similarity between the temperature of the atmosphere and water. Usually water temperature largely depends on the intensity of solar radiation, evaporation, insulation and freshwater influx.

3.2. Conductivity

The average conductivity of water was found to be highest (141.33 µS cm^{-1}) in winter and its lowest (89 µS cm^{-1}) was recorded during monsoon season. Conductivity is a measure of water's ability to conduct electrical current which provides a general indication of water quality. Thus, as the concentration of dissolved salt increases, electrical conductivity also increases.

3.3. Transparency

The average minimum (13.56 cm) transparency was recorded during the monsoon while the maximum (72.16 cm) was in winter. Transparency of water is affected by a number of factors. Both dissolved and suspended materials can influence water transparency.

3.4. Current Flow

The average minimum (0.40 m/s) mean current flow was recorded in winter and its maximum (0.98 m/s) current flow was in monsoon. Water current is among the most important factors affecting the distribution of the pelagic larvae of fish.

3.5. PH

The average lowest (7.2) pH was recorded in monsoon and that of the highest (7.8) in winter. The pH value of natural water body was changes due to the biological activity, influx of municipal waste and industrial contamination. Any alteration in water pH is accompanied by the change in other physicochemical parameters. Higher pH includes the formation of trihalomethanes which are toxic [11]. This alkaline pH value was also witnessed due to presence of alkaline earth metals (Na, K) that interact with soluble CO forming carbonates and bicarbonate which results in shifting the pH up over 7 [12].

3.6. Dissolved Oxygen

DO is a very important parameter of water quality and an index of physical and biological process going on in water. In the present study, the average lowest (6.33 mg/l) DO was recorded during the post-monsoon and its highest (7.51 mg/l) was observed during pre-monsoon. The variations in the dissolved oxygen level depend on the primary production and respiration of aquatic organism present in the water. The dissolved oxygen was above the tolerance limit of 5mg/l [13]. Presence of DO in water may be due to direct diffusion from air and photosynthetic activity of autotrophs [14].

3.7. Free CO_2

The average free carbon dioxide value was ranged from 6.13mg/l to 7.97 mg/l. The lowest which was recorded during pre monsoon and its highest was during post-monsoon. The variation of FCO_2 was due to the absorption by the primary producer (plant) for photosynthesis and due to the activity of other living organisms.

3.8. Total Alkalinity

Alkalinity is a total measure of substance in water that has acid-neutralizing capacity. The average alkalinity value was found to be lowest (32.44 mg/l) during the monsoon and the highest (42.89 mg/l) was in winter. Surface alkalinity may result from waste discharge from nearby surface area. The main sources of natural alkalinity are rocks which contain carbonate, silicates and phosphate may also contribute to alkalinity. As the alkalinity value with less than 100 mg/l is considered to be desirable for domestic uses.

3.9. Hardness

As the hardness of water is concerned, the average highest (82.23 mg/l) value was observed in the pre-monsoon period and that of the lowest (36.36 mg/l) was in post monsoon. Hardness in water is due to the natural accumulation of salts from contact with soil and geological formation or it may enter from direct pollution from industrial effluents [15]. Hardness is a measure of the ability of water to cause precipitation of insoluble calcium and magnesium salts of higher fatty acids from soap solutions. Hardness is the property of water, which prevents the lather formation with soap and increases the boiling points of water [12].

3.10. Total Suspended Solids (Tss)

The total suspended solid showed the average minimum (161.66 mg/l) during the winter and its maximum (393.33 mg/l) was in the monsoon. Average maximum values reported in the present study during monsoon months at all study sites were due to increased surface runoff from nearby catchments. The total suspended solids are the materials in water that affect the transparency or light scattering of water. TSS is typically composed of fine clay or silt particles, plankton, organic compounds, inorganic compounds or other microorganism. It can be influence by changes in pH [12].

Table 1: Seasonal variation of physical-chemical parameters of Dhing River (At 3 sites)

Seasons & parameters	Winter			Pre-monsoon			Monsoon			Post-monsoon		
	I	II	III	I	II	III	I	II	III	I	II	III
Water temp. (^{0}C)	19.0 ± 1.0	18.0 ± 1.0	18.5 ± 1.0	21 ± 1.2	20.5 ± 1.0	22 ± 1.3	25.6 ± 0.5	25 ± 0.7	26.7 ± 0.6	23 ± 1.0	23 ± 1.0	22 ± 1.0
Air temp. (^{0}C)	20.5 ± 0.5	21 ± 0.7	20.7 ± 0.6	22.5 ± 1.6	23 ± 1.5	22.6 ± 1.7	26.7 ± 0.6	26.5 ± 0.5	26.8 ± 1.0	24.7 ± 1.2	25 ± 1.0	24.5 ± 0.6
pH	7.8 ± 0.02	7.7 ±0.01	7.8 ±0.01	7.5 ±0.01	7.5 ±0.01	7.4 ±0.01	7.1 ±0.02	7.2 ±0.02	7.2 ±0.02	7.4 ±0.01	7.4 ±0.01	7.5 ±0.01
Transparency (cm)	72.2 ± 12.3	73.5 ±10.4	70.8 ± 9.5	40.3 ±13.2	39.5 ±10.5	40.0 ±12.4	13.5 ± 3.2	14 ± 4.5	13.2 ± 3.0	25.2 ±10.4	24.8 ±12.5	25.0 ±12.0
Conductivity (µS cm^{-1})	140 ± 2.5	142 ± 1.5	142 ± 1.5	120 ± 2.5	123 ± 5.5	120 ± 5.2	90 ± 5.2	89 ± 5.0	88 ± 4.5	110 ± 1.5	108 ± 2.0	110 ± 1.5
Current Flow (m/s)	0.41 ± 0.03	0.4 ±0.02	0.4± 0.02	0.50 ±0.05	0.53 ±0.08	0.55 ±0.07	1.01 ±0.05	0.95 ±0.07	1.0 ±0.06	0.71 ±0.08	0.7 ±0.07	0.71 ±0.07
DO (mg/l)	7.0 ± 1.02	7.12 ±1.07	7.12 ±1.06	7.52 ±0.91	7.53 ±0.95	7.49 ±0.10	7.0 ±0.62	6.8 ±0.56	6.9 ±0.45	6.3 ±1.01	6.4 ±0.71	6.3 ±0.75
FCO_2 (mg/l)	6.52 ± 0.92	6.65 ±1.02	6.55 ±1.05	6.22 ±1.01	6.14 ± 1.0	6.05 ±0.95	7.74 ±1.02	7.50 ±1.14	7.85 ±1.02	8.01 ±1.08	8.0 ± 2.0	7.92 ±1.06
Alkalinity (mg/l)	42.12 ± 2.02	44.55 ±1.05	42.00 ±2.00	40.02 ± 3.0	38.0 ±2.55	37.5 ±2.58	33.25 ±1.22	32.00 ±1.88	32.07 ±1.66	36.05 ± 2.0	37.55 ±1.05	36.02 ±1.44
Hardness (mg/l)	76.5 ± 4.12	70.6 ± 3.8	74.2 ± 2.7	86 ±3.84	82.5 ±2.16	78.2 ± 3.2	45.6 ±1.17	43.3 ± 2.2	44.5 ± 2.7	35.6 ±1.35	37.3 ±2.87	36.2 ±3.25
TDS (mg/l)	110 ± 2.55	110 ±2.55	105 ± 2.0	140 ±5.33	145 ± 5.0	145 ±4.55	300 ±10.33	300 ±12.33	290 ±9.55	200 ±15.33	180 ±10.33	190 ±10.55
TSS (mg/l)	160 ± 15.22	165 ±12.33	160 ±10.33	240 ±15.0	245 ±14.33	245 ±15.33	400 ±16.22	390 ±18.33	390 ±15.55	330 ±16.33	340 ±15.44	340 ±15.33

3.11. Total Dissolved Solids (Tds)

The average minimum (108.33 mg/l) and maximum (296.66) total dissolve solid was recorded during winter and monsoon season respectively. The values are within permissible limits of 1500mg/l [13]. As the TDS value was obtained in almost all the sampling site, thereby indicating the mixing of pollutants in river by several anthropogenic activities carried out adjacent to the river. Higher TDS in water system increases the COD and BOD and ultimately depletes the dissolve oxygen level in water [16].

3.12. Fish Diversity

Altogether a total of 50 fish species has been recorded from the sampled stretch of the River Dihing and belonging to 34 genera and 18 families (Table 2). It has been observed that among the families Cyprinidae family was the most dominant, which includes 16 species, accounting a percentage of 32% (Fig. 2). Next followed by the Bagridae family with 6 species holding 12% share which is followed by Siluridae and Osphronemidae with 8 % each, these are further followed by Channidae and Mastacembelidae comprising each with 6%,

whereas families like Cobitidae and Schilbeidae accounted 4% each and the rest of the families like clariidae, Nandidae, Gobiidae etc. were observed to be the least dominating with 2% each. The present finding was contradictory with the findings of Sarma *et al*. 2012 [5, 17-21] Shahnawaz *et al.* 2009[22]. In the earlier, 54 and 47 fish species were recorded from River Kopili and Jamuna River of Karbi Anglong district of Assam [4]. Both the river was also dominated by Cyprinidae family. Recently, Baro *et al*. 2014[23] listed 49 ornamental fish species from Sankosh River a tributary of the Brahmaputra River in Kokrajhar district.

Table 2: List of fish species recorded from Dihing River and their conservation status

Scientific name	**Abundance**	**Conservation status (IUCN, 2014)**
Family: Notopteridae		
1. *Notopterus notopterus* (Pallas,1769)	++	LC
Family: Cyprinidae		
2. *Amblypharyngodon mola* (Hamilton, 1822)	+++	LC
3. Aspidoparia morar (Hamilton, 1822)	++	LC
4. *Barilius barila* (Hamilton,1822)	++	LC
5. *Gibeliond catla* (Hamilton, 1822)	+++	LC
6. *Cirrhinus reba* (Hamilton,1822)	+++	LC
7. *Danio rerio* (Hamilton, 1822)	++	LC
8. *Devario devario* (Hamilton,1822)	++	LC
9. *Esomus danrica* (Hamilton,1822)	+++	LC
10. *Labeo bata* (Hamilton,1822)	+++	LC
11. *L. gonius* (Hamilton,1822)	++	LC
12. *L. rohita* (Hamilton,1822)	+++	LC
13. *Osteobrama cotio cotio* (Hamilton,1822)	++	NE
14. *Puntius sophore* (Hamilton,1822)	+++	LC
15. *P. ticto* (Hamilton,1822)	+++	LC
16. *P. sarana* (Hamilton,1822)	++	LC
17. *Parluciosoma daniconius* (Hamilton,1822)	++	LC
Family: Cobitidae		
18. *Botia dario* (Hamilton,1822)	+	LC
19. *Canthophrys gongota* (Hamilton,1822)	++	LC
Family: Bagridae		
20. *Rita rita* (Hamilton,1822)	++	LC
21. *Mystus tengara* (Hamilton,1822)	+++	LC
22. *M. dibrugarensis* (Chaudhuri,1913)	++	LC
23. *M. vittatus* (Bloch,1794)	++	LC
24. *Sperata aor* (Hamilton,1822)	++	LC
25. *S. seenghala* (Sykes,1839)	++	LC
Family: Siluridae		
26. *Ompok bimaculatus* (Bloch,1794)	+	NT
27. *O. pabda** (Hamilton,1822)	++	NT
28. *O. pabo* (Hamilton,1822)	++	NT
29. *Wallago attu* (Bloch & Schneider,1801)	+	NT
Family: Schilbeidae		
30. *Ailia coila* (Hamilton,1822)	++	NT
31. *Eutropiichthys vacha* (Hamilton,1822)	+	LC
Family: Clariidae		
32. *Clarias batrachus* (Linn, 1758)	+	LC
Family: Heteropneustidae		
33. *Heteropneustes fossilis* (Bloch,1794)	+	LC
Family: Synbranchidae		
34. *Monopterus cuchia* (Hamilton,1822)	+	LC
Family: Ambassidae		
35. Chanda nama (Hamilton,1822)	+++	LC
Family: Nandidae		
36. *Nandus nandus* (Hamilton,1822)	+	LC
Family: Gobiidae		
37. *Glossogobius giuris* (Hamilton,1822)	++	LC
Family: Anabantidae		
38. *Anabas testudineus* (Bloch,1792)	+	DD
Family: Osphronemidae		
39.*Trichogaster fasciata* (Bloch 1801)	++	LC
40. *T. labiosa* (Day,1877)	+	NE
41. *T. lalius* (Hamilton,1822)	+	LC
42. *T. sota* (Hamilton,1822)	+	NE
Family: Belonidae		
43. *Xenentodon cancila* (Hamilton,1822)	++	LC
Family: Channidae		
44. *Channa gachua* (Hamilton,1822)	+	LC
45. *C. punctata* (Bloch,1793)	+	LC
46. *C. striata* (Bloch,1793)	+	LC
Family: Mastacembelidae		
47. *Macrognathus aral* (Bloch 1801)	++	LC
48. *M. pancalus (*Hamilton,1822)	++	LC
49. *Mastacembelus armatus* (Lacepede,1800)	++	LC
Family: Tetraodontidae		
50. *Tetraodon cutcutia* (Hamilton,1822)	+	LC

Legend: + = Least abundance; ++ = Abundance; +++ = Most abundance, EN - Endangered, NT - Near Threatened, LC - Least Concern, NE - Not Evaluated, DD - Data Deficient.

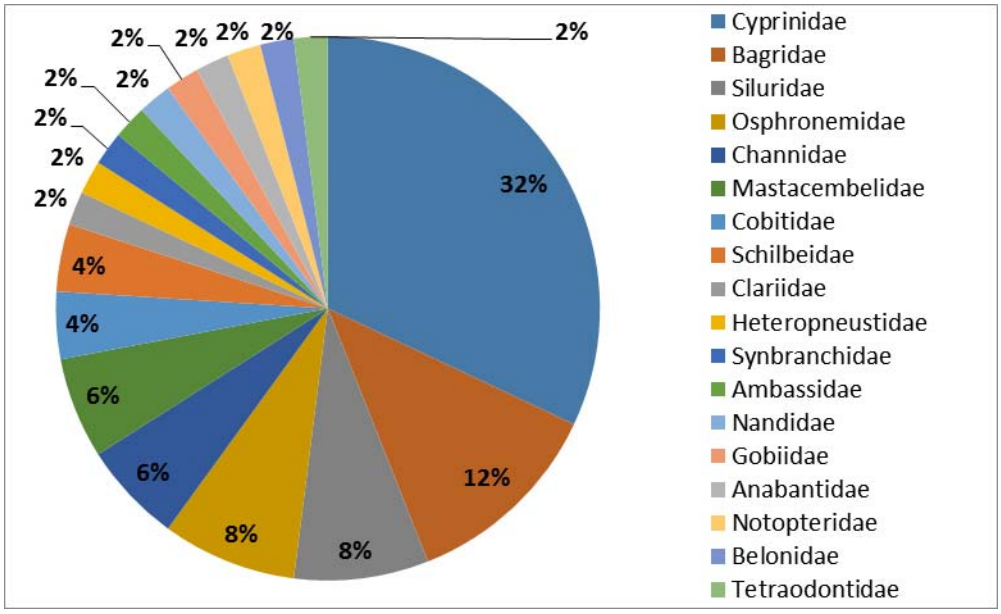


Fig 2: Percentage distribution of species composition

As far as abundance of the recorded fish is concerned, they were categorized into 3 groups such as most abundance, abundance and least abundance. It was observed that the species like *Amblypharyngodon mola*, *Cirrhinus reba*, *Esomus danrica*, *Puntius sophore*, *P. ticto*, *Chanda nama* and *Mystus tengara* were most abundantly found while, species like *Labeo gonius*, *Ompok pabda*, *O. pabo*, *Osteobrama cotio cotio*, *Puntius sarana*, *M. dibrugarensis*, *Rita rita*, *Ailia coila*, *Glossogobius giuris*, *Trichogaster fasciata*, *Xenentodon cancila Macrognathus aral*, *M. pancalus*, *Mastacembelus armatus* were abundant (Plate I & II). On the other hand, the species such as *Wallago attu*, *Botia dario*, *Heteropneustes fossilis*, *Trichogaster labiosa*, *T. sota*, *T. lalius*, *Eutropiichthys vacha*, *Tetraodon cutcutia* were recorded as least abundance. Further, the local fishermen revealed that the occurrence of *H. fossilis*, *O. bimaculatus* and *Channa species* has been gradually declining. Riverine fish communities show seasonal changes in the composition and relative abundance of species, which may be influenced by constant fluctuations in environmental factors Thiel *et al*., 1995[24]. Regarding the conservation status of the recorded fishes, they have been classified into five category viz., EN - Endangered, NT - Near Threatened, LC - Least Concern, NE - Not Evaluated and DD - Data Deficient [10]. Of which, 41 species were found under the least concern (LC) category, 5 species under as near threatened (NT), this is followed by 3 species under not evaluated category (NE) and 1 species was observed in data deficient category (Fig. 3).

Plate I

Chanda nama

Puntius sophore

Puntius ticto

Anabas testudineus

Aspidoparia morar

Amblypharyngodon mola

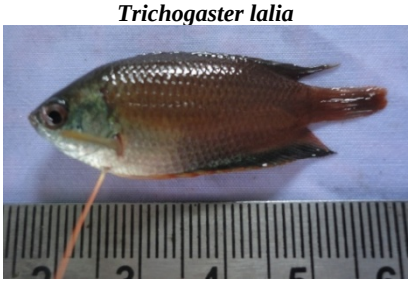
Trichogaster fasciata

Notopterus notopterus

Wallago attu

Trichogaster labiosa

Trichogaster lalia



Trichogaster sota

Esomus danrica

Devario devario

Monopterus cuchia

Puntius sarana

Parluciosoma daniconius

Tetraodon cutcutia

Some Edible & Ornamental Fishes of Dihing River

Plate II

Channa punctata

Rita rita

Mystus tengara

Mystus dibrugarensis

Labeo gonius

Nandus nandus

Mastacembulus armatus

Xenentodon cancila

Glossogobius giuris

Heteropneustes fossilis

Some edible & Ornamental fishes of Dihing River

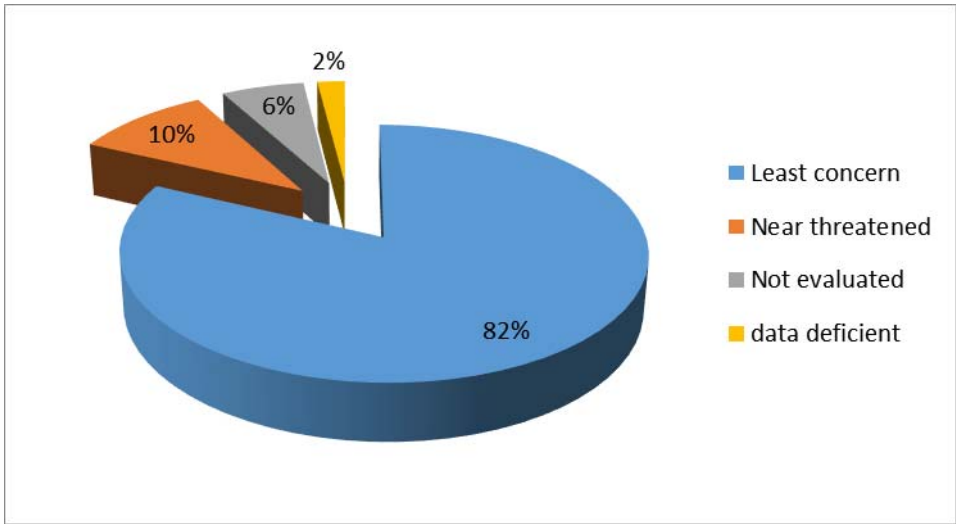


Fig 3: Percentage distribution of conservation status of recorded fish species.

4. Conclusion

From the above investigation, it is clear that a feasible or slight variation was observed in certain physico-chemical parameters of River Dihing. However, all the studied physico-chemical parameters of water are found to be within permissible range [13]. As far as the pollution of the study area is concerned, it was observed that till yet the pollution level was not found in an alarming condition but likely to be rising in the future. The river exhibit a good number of ornamental and edible fish species. Further, the assessment of water quality needs for to avoid further contamination and pollution for the better development and survivality of aquatic flora and fauna.

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