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Analytical Study on Threats and Challenges of the Fish Biodiversity of West Bengal

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ABSTRACT

Investigations and germplasm inventories of fish biodiversity in the amphibian water groups of India are as a rule dynamically refreshed and broke down with a few new revelations in any case; a well-characterized number of existing fish species at territorial/state level stays to be resolved. Of the all out freshwater fish decent variety of the nation, imperilment ranges from 10-13% shows across the board and inescapable corruption of sea-going freshwater fish living spaces. The State of West Bengal is supplied with 7.5% of the water asset of the nation and that is getting progressively rare with the uncontrolled development of populace, extension of water system organize and formative needs. Worry over declining harvests and a conspicuous decrease in biodiversity of fish species has prompted a progressively all encompassing way to deal with fisheries the board and research. The state is blessed with immense sea-going assets as streams, lakes/tanks, store, beel and hog, salty water fishery and furthermore prevailed by a few wetlands. Scrutiny of writing uncovers that few dispersed data on fish biodiversity of West Bengal is accessible. In the present audit, inside and out, 190 local freshwater fish species were recorded from the West Bengal contributing about 23% of the Indian freshwater angles. The displayed survey featured a succinct audit of Indian fish biodiversity, examine the dangers, challenges, protection projects and offer trust later on for the country's endangered freshwater fish supportability of the West Bengal. Saving the biodiversity of these fishes and simultaneously dealing with their misuse in a maintainable manner is a troublesome exercise. The differing collections of freshwater types of the state ought to be focused by all who have a stake in our freshwater legacy. This paper features the example of freshwater fish biodiversity in numerous points of view, usage, dangers and examines the administration systems to be actualized for the preservation of freshwater fish decent variety in the state.

1. Introduction

Fishes are the most various gathering of vertebrates, with 32,447 species [1]. Information on the fish fauna of tropical Asia is still in its exploratory stage especially in India where review work is fragmented [2]. Fish Base has now developed into an enormous on-line reference book with data on 32,447 fish species and fills in as a significant apparatus for researchers [1]. In India, the National Bureau of Fish Genetic Resources (NBFGR) has built up a solid database on fish hereditary assets of the nation. West Bengal is on the eastern bottleneck of India, extending from the Himalayas in the north to the Bay of Bengal in the south. The state has an all out region of 88,752 square kilometers (34,267 sq. m). The Ganga-Padma waterway vein partitions the states in two sections, North and South Bengal. West Bengal's atmosphere changes from tropical savannah in the southern parts to muggy subtropical in the north. West Bengal has had the option to verify the main situation in fish generation for seven progressive years and has been compensated in like manner by the Central Government as best profitability grant. The point of the investigation was: to survey the past and ebb and flow example of freshwater fish biodiversity, audit the dangers to angle decent variety and to make suggestions for fish biodiversity protection and the board. This paper likewise talks about the administration procedures to be actualized for the protection of freshwater fish assorted variety in the state through preservation of natural surroundings and preservation of fish stocks.

2. Review of Literature

In West Bengal the all out generation of inland fish was 15.30 lakh ton and marine fish was 2 lakh ton. Absolute Inland generation of fish is fluctuates time to time with expanding and declining request which is appeared in Figure 1. Examination of fish generation of West Bengal (WB) with regard of Bihar, Utter Pradesh (UP) and India are enrolled in Figure 2. Various creators recorded various quantities of species from various wastes of West Bengal. 46 species having a place with 7 requests, 18 families and 26 genera are recorded from Damodar River, Burdwan region [3]. It is reported that W. B. having 45 species under 29 genera, 18 families and 8 requests during 1990-1995 [4]. It has been additionally recorded 70 indigenous fancy fish species having a place with 45 genera, 30 families and 9 requests [5]. 39 neighborhoodimperiled angles is recorded from the state [6]. 171 species additionally recorded [7]. An aggregate of 155 fish species having a place with 49 families and 15 requests were recorded from the tidal freshwater zone of the Hooghly estuary [8]. 218 types of fish are recorded from entire Himalayas [9]. 65 types of fishes are recorded from the River Teesta [10]. 21 species [11] and 125 species [12] were referenced from Darjeeling Himalayan upland. A sum of 176 indigenous elaborate fishes are

accounted for having a place with 98 genera under 41 families and 10 requests [13]. A sum of 67 types of finfishwere recorded from Sundarbans [14]. A rundown of 250 fishes [15], 172 species [16] and 207 species [17] are recorder from Sundarban. Figure 3 demonstrated fish assorted variety on request and family insightful.

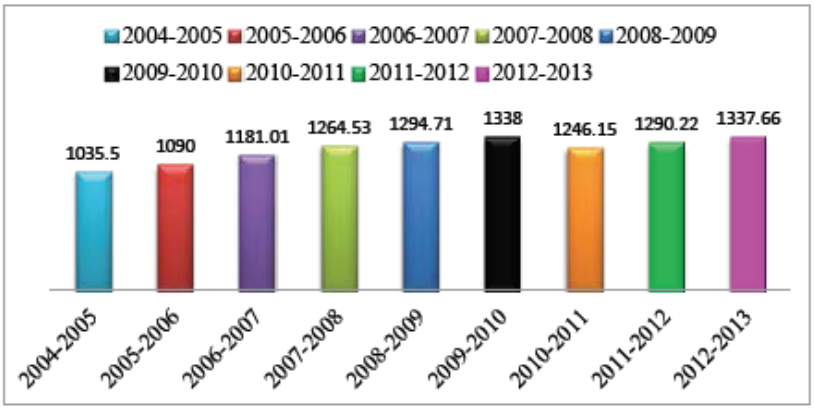

Figure 1: Inland fish production in West Bengal [54].

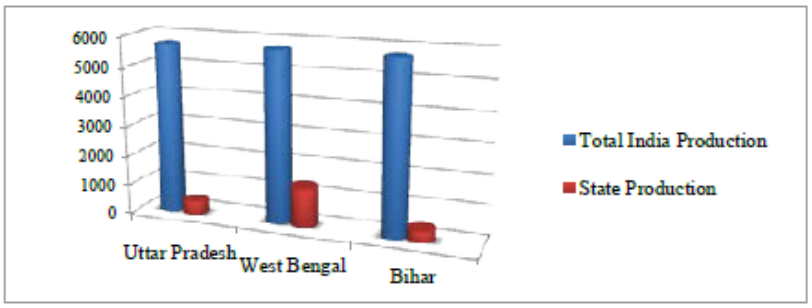

Figure 2: Comparison of fish production of West Bengal with respect of Bihar, UP and India.

3. District-wise Freshwater Area

There is just one region specifically Murshidabad which comprises of in excess of 20,000 ha zone under stream. Rest of the locale has under 20,000 ha zone under waterway. Concerning Beels, there are just two areas to be specific North 24-Pargana (8861.19 ha) and South 24-Pargana (5749.47 ha) which have in excess of 5000 ha of Beels under their influence. In excess of 3000 ha Beels are contained in 7 regions. Out of these seven regions, in particular Malda (4551.55 ha), Nadia (4271.61 ha) and Hooghly (3884.76 ha) have huge territory of Beels under their regulatory control for the advancement of the fisheries.

4. Marine and Brackishwater Area

In the territory of West Bengal, just three areas contain brackishwater region. These are North 24 Pargana (35371.26 ha), South 24 Pargana (17759.00 ha) and PurbaMidnapur (5227.00 ha). All out coast line of West Bengal is 158 km. The inshore and seaward zones of Bay of Bengal in the PurbaMidnapore locale are separately 777 Sq. km. what's more, 1813 Sq. km. The Continental rack territory is 17049 Sq. km. The all out inland water assets are enrolled at Table 1 and 3. The all out fishery asset of West Bengal is enrolled at Table 2.

5. Drainage of River Basin

Ganges enters West Bengal close Rajmahal and afterward streams in a south-eastern course and partitions into two close to north of Dhulian in Murshidabad. One branch enters Bangladesh as the Padma, while different moves through West Bengal as the Bhagirathi River and Hooghly River a southern way and reach to Bay of Bengal (Figures 4 and 5). The Mayurakshi, Ajay, Damodar, Kangsabati, Rupnarayan and their tributaries which ascend in the Western level and high grounds stream eastwards through the various areas of West Bengal and joins the Bhagirathi on the correct bank. The Dwarakeswar and Shilabati streams join to shape Rupnarayan. Kangsabati and Keleghai waterways join to frame the Haldi. The Rupnarayan and Haldi fall into the Bhagirathi. The Subarnarekha River subsequent to streaming for a short separation in West Bengal tenants into Orissa. The distributaries of the Padma River like Bhairab, Jalangi, Mathabhanga River and their tributaries enters West Bengal and joins the Bhagirathi to its left side bank. The Mathabhanga separates into branches in particular; Churni and Ichhamati, while the Churni meets the

Bhagirathi while different streams southwards and joins the Kalindi. The significant waterways of Sundarbans are Hoogly, Matla, Gosaba, Saptamukhi, Haribhanga, Piyali, Thakuran/Jamira, Raimangal, Kalindi and Ichhamati. The Teesta stream slicing profound chasms from north to south in the rugged Darjeeling locale; it enters the fields at Sevoke and

streams in a powerful stream on straight line towards the south east until it empties its waters into the Brahamaputra in Bangladesh. Torsa, Jaldhaka, Kaljani, Raidak, Sankosh and Mahananda streams are in the northern bumpy area which ascend in the Himalayas and stream in a southernly heading through the regions of Darjeeling, Jalpaiguri, Cooch Behar and North and South Dinajpur and enters Bangladesh.

The Mahananda ascends from the Dow Hills woodland, close to the town of Darjeeling and are sustained by comparative little streams like, Mahanadi, Balason, and Machi and runs in a crisscross route through the area of Malda and joins the Padma in Bangladesh. In the focal area, the primary stream is the Mahananda. The Tangon and Punarbhabha, and Atrai emerges in the fields, while the previous two combines and streams into Mahanadi, Atrai streams into the Padma.

6. Major Rivers and Biodiversity

It is accounted for the Gangetic framework alone bookkeeping 143 types of fish contributes about 20% of freshwater fish of the absolute fishes detailed in India [18]. 126 species have been recorded from Brahmaputra pursued by Mahanadi 99, Cauvery 80, Narmada 95 and Tapti 57 [19-21]. The high species lavishness of stream Ganga has written about a few events [22-25]. A portion of the significant tributaries of waterway Ganges bowl in viz. Gomti, Ghaghara, Betwa, Ramganga, Ken and Gerua streams additionally harbors the rich species range of compromised, transient and financially significant fishes with a wide dissemination of animal categories, families and genera [26-30]. Concentrates on the fish fauna of the Ganga and its tributaries have been made by different creators and data was distributed on the deliberate, bio-geological and natural viewpoints [31-36].

Studies uncovered that adjustments in atmosphere and hydrology of the of Ganges bowl is presently become a genuine concern [18,27]. Various fish species which were never detailed in the upper stretch of the waterway and accessible in the lower and center stretches during the 1950s [37] were accounted for conveyed from the upper cold-water locale [18]. As of late, an eel-loach Pangiopangia Hamilton, which was once portrayed in 1822 from East India in the River Ganges have been re-depicted by NBFGR from in the center Ganga in Uttar Pradesh [38]. Stream astute near investigation of accessible species with deference of all out species showed in Figure 6.

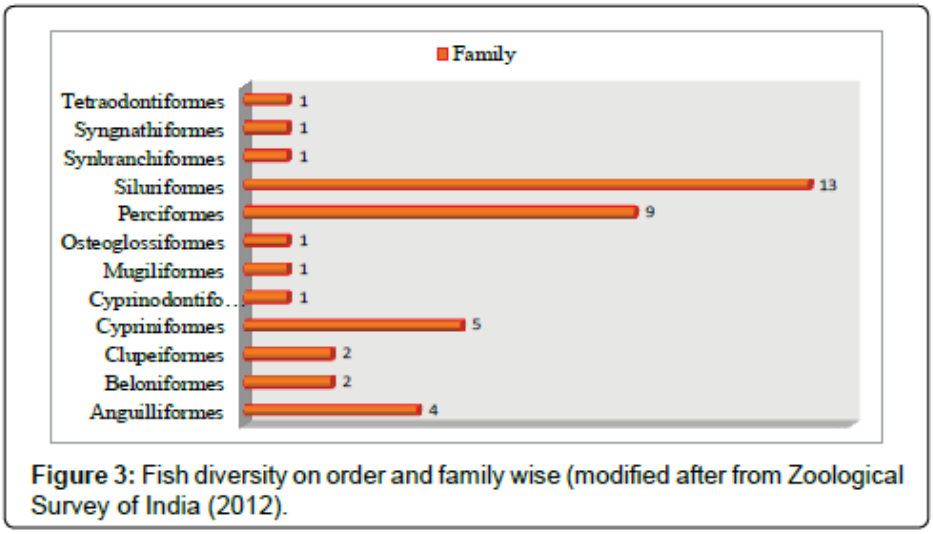

Figure 3: Fish diversity on order and family wise (modified after from Zoological Survey of India (2012).

Table 1: Inland water resources of West Bengal [50].

Resources	Area (lakh Ha)	Under Culture (In Lakh Ha)	% of Resource Area Under Culture
Open water systems:			
Rivers	1.64	-	-
Canals	0.80	-	-
Reservoirs	0.28	0.13	48.15
Estuarine	1.50	-	-
Enclosed water bodies			
Tanks & ponds	2.88	2.61	90.62
Flood plain lakes/ derelict waters	0.42	-	-
Beel & Boar	0.42	0.21	50.00
Sewage fed fishery	0.04	0.04	100.00
Brackish water fishery	0.60	0.59	98.33

Table 2: Total fish diversity of West Bengal (Modified after ZSI, 2012).

Indigenous fresh water fishes	190
Indigenous brackish water fishes	28
Indigenous fresh water ornamental fishes	176

7. Fish diversity in Ganga Basin

The Ganga River Basin covers more than 1,080,000 km2 (416,990 sq. mi) in India and positions among the biggest on the planet in waste bowl region and length. The Ganga and its significant tributaries, the Yamuna, Ram Ganga, and Ghaghara are the main Himalayan Rivers that have noteworthy base and flood streams. The stream is home for in excess of 140 fish species, of which many are monetarily significant, are recorded in Table 4. Figure 7 shows the fish assorted variety of West Bengal with deference of Bihar, Uttar Pradesh and India.

8. Diversity of Special Significant Area

Sundarbans is the biggest jutting delta on earth covering around one million ha in the delta of the waterways Ganga, Brahmaputra and Meghna is shared between Bangladesh (~60%) and India (~40%).

The Indian Sundarbans (Latitude 21° 32'- 22°40'N, Longitude 88° 22'- 89°0'E) in the north east shore of India involve 9630 square kilometer and are limited by River Hooghly in the West, River Raimangal in the East, Bay of Bengal in the South and Dampier Hodges line in the North.

The gathering of islands is blended by multitudinous streams, brooks, and so on which makes the majority of the region unavailable and rest is saved woodland, falling under the Sundarbans Biosphere – a world legacy site. The entire territory of the Sundarbans envelops about 0.6 million hectares

of which 0.4 million hectares are backwoods regions and the rest of the part incorporates water bodies. Around 15-20% of the absolute fish prerequisite of Kolkata advertise is being provided from Sundarbans. A sum of 172 types of fishes, 20 types of prawn and 44 types of crabs including two eatable crabs have detailed [15].

The East Kolkata Wetlands (EKW) (22°27' N and 88°27' E), are a complex of regular and human-made wetlands lying east of the city of Kolkata. The wetlands spread 125 km2, and incorporate salt swamps and hectares of the EKW zone was remembered for the 'Ramsar List' making it a 'wetland of International Importance'. The wetlands are utilized to treat Kolkata's sewage, and the supplements contained in the waste water continue fish ranches and horticulture. It involves 254 sewage bolstered fisheries, little horticultural plots and strong waste ranches. Advancement of vegetation based microenterprise (150 units), elaborate fish culture (300 units) and fish cum duck raising (300 units) for business expansion of EKW people group. The industrially significant sea-going species in the EKW incorporates 50 types of fish, 11 types of prawns, 3 types of crabs and 20 types of molluscs. Among the 50 species 17 are refined and 33 are wild species [39]. 13,000 tons of fish are delivered every year in lakes oversaw for wastewater aquaculture.

9. Endemic species and New Species

During the most recent decade many fish species from the biodiversity hotspot zone like North East and Western Ghat area have risen new species. Britz found another species Channaandrao from Jalpaiguri, West Bengal [40].

10. Endemic species

Noemacheilusdevdevi(Hora, 1935). Mainly found at all stream below Darjeeling. The fish is IUCN listed nearly threatened species.

Figure 4: River drainage in West Bengal.

Table 3: Freshwater Resources of India [18,19,21,27].

Resource Type	Length / Area
Rivers & Tributaries (km.)	45,000
Canals (km.)	126,334
Total	171,334
Reservoirs (ha)	3,153,366
Ponds & Tanks (ha)	2,355,300
Flood Plain Wetlands (ha)	202,000
Derelict Water (ha)	868,000
Total	6,578,666

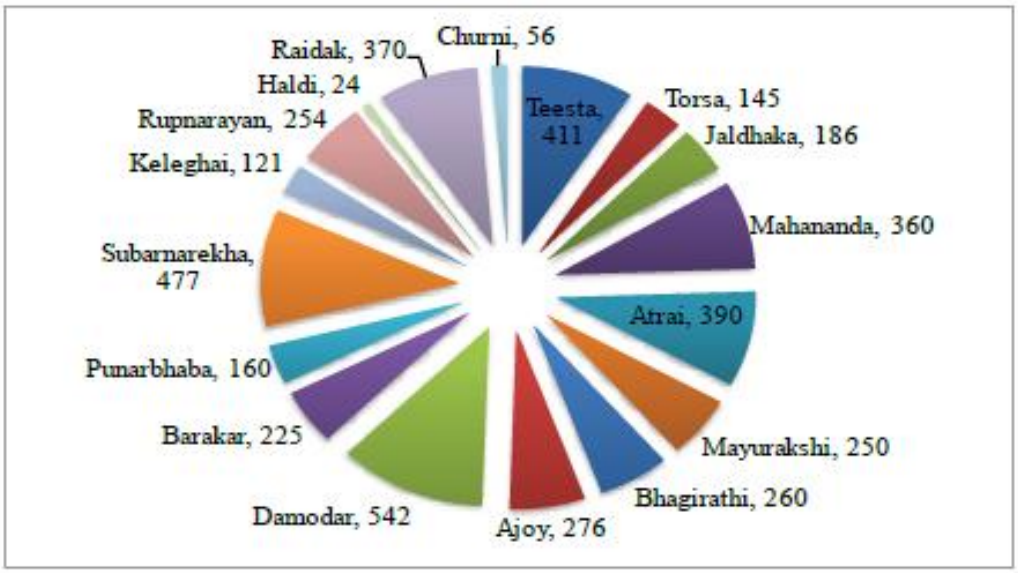

Figure 5: Length (Km) of some important rivers of West Bengal.

Noemacheilusmultifascialus(Day, 1878). Mainly found at Darjeeling. *Balitorabrucei*(Gray, 1830). Commonly known as Gray's Stone Loach. The fish is IUCN listed nearly threatened species.*Puntiusdukai*(Day, 1878). Mainly found in North Bengal.

11. State fish

Tenualosailisha is the state fish of west Bengal. The fish is ordinarily referred to at West Bengal as Ilish in Bengali. The fish is marine; freshwater; saline; pelagic-neritic; anadromous in nature. Inside a tropical range; 34°N-5°N, 42°E-97°E in marine and freshwater. It can grow up to 60 cm long with loads of up to 3 kg. The fish schools in beach front waters and rises up the streams for around 50-100 km to produce during June to September and furthermore in January to March.

Figure 8 demonstrate that the Hilsa creation declining year to year because of the over misuse of adolescents and introverts are the principle dangers of Ilisha. In the event that any populace is influenced by the 'enrollment overfishing', the populace may be genuinely hampered to achieve the practical yield over the long haul, so the angling guideline must be solid for Hilsa to cause this species to continue for quite a while in future. Towards preservation of this high worth fish the Department of Fisheries; West Bengal built up the nation's first since forever committed Hilsa Conservation and Research focus (HCRC) at Diamond Harbor, South 24 Parganas [41].

12. Coldwater Species

Darjeeling Himalaya area has an articulated occasional atmosphere and lies north of the tropical belt (The locale lies somewhere in the range of 27°13'05" and 26°17'10" North scopes and somewhere in the range of 88°53'00" and 87°59'30" East longitudes). Being the basic piece of the eastern Himalaya the locale is viewed as freshwater biodiversity hotspot. The significant patrons on North Bengal new water fish fauna are 21 species [11] and 125 species [12] were referenced from Darjeeling Himalayan upland. Cold water fish species from 39 genera and 10 families with elaborate, nourishment and game estimation of which 11 species were universally found. Fishes of family Cyprinidae were seen as prevailing pursued by Sisoridae and Balitoridae. The vast majority of the fish species were discovered exceptionally uncommon in the waterway, which might be because of different anthropogenic elements. Most extreme number of species (30) recorded were of family Cyprinidae. Comparable most prominent assorted variety in Cypriniformes and Siluriformes in the freshwater natural surroundings were accounted for from different pieces of Himalaya.

13. Introduced and Transplanted Species

Fascinating species have made financial advantages to every nation. The extraordinary species have assumed critical jobs in guaranteeing nourishment security and yield broadening for rustic poor. In culture framework around 19/20 types of nourishment fish has been utilized. A portion of these colorful fish has been lawfully presented and some are un-approved presentation. Silver carp, Common carp, Grass carp, Tilapia are normal and significant colorful nourishment fish which assume a significant job in state fishery. The interest of colorful fancy fishes is expanding surprisingly because of their significant job on the planet exchange for fish and fishery creation. Around 288 extraordinary assortments of elaborate fishes are prominent in West Bengal among these 27 species are liver conveyor and 261 species are egg layerer [42]. Numerous extraordinary elaborate fishes are additionally industrially refined in various ranches. The intriguing decorative fishes are one of the significant fare materials. With the exception of crisp water colorful fishes, numerous marine fancy fishes are additionally assumed significant job in West Bengal fishery. Gambusiaaffinispatruelis and Poecilia reticulate fishes are hatchlings eater and known as Mosquito fish. In this way, it is likewise industrially refined in West Bengal to control the mosquito. The fishes which are presented from various condition of same nation areknown as transplanted species. Osteobramabelangeri is the significant transplanted species from Manipur.

14. Threatened Species

The IUCN Red List of Threatened Species is generally perceived as the most thorough, objective worldwide

methodology for assessing the protection status of plant and creature species. The presentation in 1994 of an experimentally thorough way to deal with decide dangers of annihilation that is appropriate to all species, has gotten a world standard. There are various species in undermined and jeopardized condition. Without legitimate consideration those fishes might be wiped out from nature. The Critically Endangered species are: Erethestismontana, Ompokbimaculatus, pangasius. In West Bengal required information of numerous fishes still inaccessible for IUCN Red rundown assessment. So there is a need of appropriate investigation on those fishes. The IUCN Red recorded jeopardized species are enrolled in Table 3. Examination of compromised, powerless and jeopardized angles are depicted in Figure 6.

15. Potential Marine Species

West Bengal has a short coastline - just around 64 km, spread along the southern edge of its two oceanic areas, South 24 Parganas and Midnapore. This speaks to around one percent of India's coastline. The marine asset base contains 780 km2 of inshore zone (upto 20 m profundity), 1815 km2 (between 20 m and 80 m profundity) and a mainland rack of 17,049 km2 (up 200 m profundity). Bitter water territories in the deltaic district an incorporate an area of 200,000 ha. The Rv Dr Fridtj of Nansen overview (1979-1980) in the upper Bay of Bengal (the territory contiguous Swatch of No Ground, Bangladesh) and exploratory angling by the Fishery Survey of India off northern Orissa found critical amounts of demersals, for example, croaker, catfish, threadfin

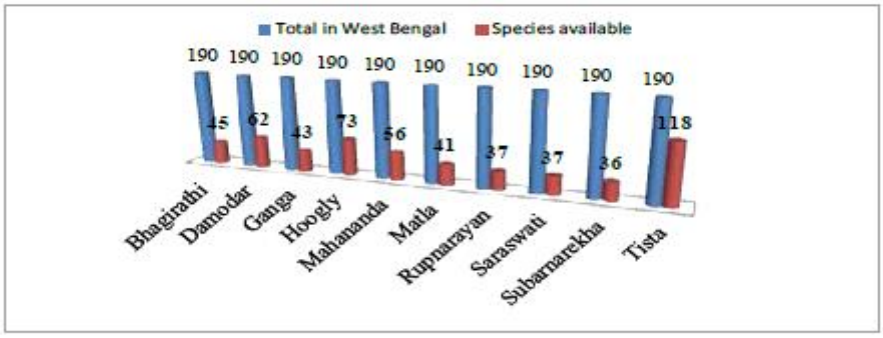

Figure 6: River wise comparative study of available species with respect of total species (Source: ZSI with own compilation).

16. Conclusion

Despite the fact that the state and focal government have just taken a few measures to preserve the fish biodiversity in the River Ganga bowl, we feel more protection is required so as to hold whatever number of the normal biological procedures and elements of the streams and related waterbodies as would be prudent. Since the River bowl is experiencing extreme weakening as a result of anthropogenic changes, the protection systems must be imaginative and coordinated. Achievement will rely upon the degree to which progressives, water commissions, partnerships, and districts work agreeably in these spots to keep up or reestablish characteristic water living spaces of the state. Additionally, there is have to improve information on biodiversity by fortifying the ordered limit utilizing PC, picture investigation, and atomic apparatuses and so on. There is additionally a pressing need to keep up the uprightness of these amphibian environments by reestablishing biological procedures of the common waters.

References

1. www.fishbase.org
2. Lévêque C, Oberdorff T, Paugy D, Stiassny MLJ, Tedesco PA (2008) Global diversity of fish (Pisces) in freshwater. Hydrobiologia 595: 545-567.
3. Patra BC, Saha MK (2013) Present Status of Ichthyofaunal diversity at Damodor River at Burdwan district, West Bengal, India. International Journal of Scientific and Research Publications 3: 6.
4. Bhakta JN, Bandyopadhyay PK (2008) Fish Diversity in Freshwater Perennial Water Bodies in East Midnapore District of West Bengal, India. Int. J. Environ. Res. 2: 255-260.
5. Basu A, Dutta D, Banerjee S (2012) Indigenous ornamental fishes of west Bengal. Recent Research in Science and Technology 4: 12-21.
6. Mukherjee M, Praharaj A, Das S (2002) Conservation of endangered fish stocks through artificial propagation and larval rearing technique in West Bengal, India. Aquaculture Asia 7: 8-11.
7. Sen TK (1992) Freshwater Fish. In: State Fauna Series 3: Fauna of West Bengal. Zoological Survey of India, Calcutta 2: 101-242.
8. Roshith CM, Sharma AP, Manna RK, Satpathy BB, Bhaumik U (2012) Ichthyofaunal diversity, assemblage structure and seasonal dynamics in the freshwater tidal stretch of Hooghly estuary along the Gangetic delta. Publisher:Taylor& Francis 16: 445-453.
9. Menon AGK (1962) A distributional list of fishes of the Himalayas. Journal ofZoological Society, India 14: 23-32.
10. Acharjee ML, Barat S (2012) Ichthyofaunal Diversity of Teesta River in Darjeeling Himalaya of West Bengal, India. Asian J. Exp. Biol. Sci. 4: 112-122.
11. Barat S, Jha P, Lepcha RF (2005) Bionomics and Cultural prospects of Katli, *Neolissocheilushexagonolepis*(McClelland) in Darjeeling district of West Bengal. Coldwater Fisheries Research and Development in North East Region of India. NRCCWF, Bhimtal. Vikrant Computers, Haldwani: 66-69.
12. Mukherjee M, Sarkar G (2005) Endangered Fishes of West Bengal, with a special reference to North Bengal on Research, restoration, and Future plan of action. Published by Department of Fisheries, Aquaculture, Aquatic Resources and Fishing Harbour.

13. Mahapatra BK, Ghosh SD, Lakra WS (2012) Peri-urban Aquaculture in East Kolkata Wetland- Its present status and future potential. In the books of Abstracts - Global Symposium on Aquatic Resources for Eradicating Hunger and Malnutrition - Opportunities and Challenges, organized by Indian branch of Asian Fisheries Society, PFGF and KFDC at Mangalore, Karnataka, India.
14. Mandal B, Mukherjee A, Sarkar S, Banerjee S (2012) Study on the Ornamental Fin Fish of Indian Sundarbans with Special Reference to Few Floral Sources for Carotenoid Pigmentation. World Journal of Fish and Marine Sciences. Mangrove Ecosystem 4: 566-576.
15. Gopal B, Chauhan M (2006) Biodiversity and its conservation in the Sundarban. Aquatic Science 68: 338-354.
16. Mahapatra BK, Sarkar UK, Lakra WS (2014) Pattern of fish biodiversity in Indian Sunderban. International Day for Biological Diversity Island Biodiversity. U. P. State Biodiversity Board.
17. Sanyal AK, Alfred JRB, Venkataraman K, Tiwari SK, Mitra S (2012) Status of Biodiversity of West Bengal. ZSI.
18. Sarkar UK, Pathak AK, Sinha RK, Sivakumar K, Pandian AK, et al. (2012) Freshwater fish biodiversity in the River Ganga (India): changing pattern, threats and conservation perspectives. Rev. Fish. Biol. Fish. 22: 251-272.
19. Lakra WS, Das P, Sarkar UK (2011) Fish genetic resources and their conservation. ICAR Handbook of Fisheries and Aquaculture. Indian Council of Agricultural Research, New Delhi: 32-65.
20. Sinha M (1994) Fish Genetic Resources of the Northeastern Region of India. J. Inland Fish. Soc. India 26: 1-19.
21. Nguyen TTT, De Silva SS (2006) Freshwater finfish biodiversity and conservation: an Asian perspective. Biod. Cons. 15: 3543-3568.
22. Payne AI, Sinha RK, Singh HR, Haq MS (2004) A review of the Ganges Basin: its fish and fisheries. Proceedings of the second international symposium on the management of large rivers for Fisheries, FAO Regional Office for Asia and the Pacific, Bangkok, Thailand 1: 229-251.
23. Shrestha J (1999) Coldwater fish and fisheries in Nepal. Fish and fisheries at higher altitude-Asia. FAO Fisheries Technical Paper. No. 385: Rome, FAO:13-40.
24. Pathak V, Tyagi RK (2010) Riverine ecology and fisheries visa-vis hydrodynamic alterations: impacts and remedial measures. CIFRI, bulletin no: 161.
25. Venkateswarlu T, Menon AGK (1979) A list of fishes of the river Ganges and its branches. ActaIchthyol. Piscat 9: 45-70.
26. Sarkar UK, Gupta BK, Lakra WS (2010) Biodiversity, eco-hydrology, threat status and conservation priority of the freshwater fishes of river Gomti, a tributary of river Ganga (India). Environmentalist 30: 3-17.
27. Lakra WS, Sarkar UK, Kumar RS, Pandey A, Dubey, VK et al. (2010) Fish diversity, habitat ecology and their conservation and management issues of a tropical River in Ganga basin, India. Environmentalist 30: 306- 319.
28. Joshi KD, Biswas BK, Lal Shyam, Vass KK (2009) Piscine diversity in the river Betwa. J. Inland Fish. Soc.India 41: 61-64.
29. Sarkar UK, Pathak AK, Lakra WS (2008) Conservation of freshwater fish resources of India: new approaches, assessment and challenges. Biodivers. Conserv 17: 2495-2511.
30. Atkore VM, Shivakumar K, Johnsingh AJT (2011) Patterns of diversity and conservation status of freshwater fishes in the tributaries of river Ramganga in the shivaliks of Western Himalaya. Current science 100: 731-735.

