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Freshwater Fish Diversity in Protected Areas of Goa

Final Report



**Report submitted to:
Research and Utilization Division
Goa Forest Department
Government of Goa**

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CHAPTER I: INTRODUCTION

Biodiversity from lakes and other freshwater bodies is a valuable natural resource. (Prieur-Richard *et al.*, 2006). They provide habitat for large number of aquatic life, including fish (Silambarasan *et al.*, 2014). In India, river systems, streams, lakes, different wetland and ponds, at different altitudes have favored the development of a species-rich fish fauna with a large variety of adaptations.

Goa is bestowed with rich biodiversity, and the Western Ghats which is one of the mega biodiversity hotspot in the world runs across the state. There are 6 Wildlife Sanctuaries and 1 National Park, most of which forms the part of Western Ghats and also harbors many endemic and globally threatened species. It also has a wide range of many unique species of flora and fauna. Goa, has a rich diversity of freshwater fish species due to its network of rivers, streams, ponds, and lakes. These water bodies provide a diverse habitat for various freshwater fish. There are 11 rivers in Goa, all these rivers need serious attention from the authorities as the siltation rate is increasing every year. Issues relating to water diversion from the river (e.g. Mhadei river diversion) pose great threat to the ichthyofaunal diversity.

The freshwater ecosystems are the most threatened ecosystems globally (Sala *et al.*, 2000) and are facing pressures with regards to stability of the ecosystem and its biodiversity (Cowx, 2002; Suski and Cooke, 2008). Increase in temperature, sea level and precipitation has impacted the freshwater system (Zbigniew *et al.*, 2007).

Fish are the group of aquatic vertebrates and are divided into Agnatha (jawless fishes), Chondrichthyes (shark and rays), Sarcopterygii (lobed-finned fishes) and Actinopterygii (teleost or ray-finned fishes). Actinopterygians constitute more than 32,500 marine and freshwater species. The majority of fish found in freshwater are Actinopterygians (Keat-chaun *et al.*, 2017). Fish are important from socioeconomic point of view and serve as indicators of aquatic ecosystem.

A quarter of global vertebrate diversity constitutes of freshwater fish (Priour-Richard *et al.*, 2006). India is rich in freshwater biodiversity (Mittermeier and Mittermeier, 1997; Chandra *et al.*, 2017). It hosts about 7.7% i.e. 2,546 species of fishes (Wani *et al.*, 2015) of global fish diversity, of which 1,673 are marine and 994 are freshwater (Kar, 2003; Froese and Pauly, 2020). Dahanukar *et al.* (2004) documented 288 fish species belonging to 12 orders, 41 families and 109 genera, of which, 118 were endemic and 22 species were distributed all over the range of Western Ghat.

Western Ghats and are included amongst the top eight most important hotspots in the world (Chaudhuri, 2004). Western Ghats runs from north to south and traverse the states of Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu (Arunkumar *et al.*, 2018). It is rich in diversity of flora and fauna and is listed amongst the 25 global biodiversity hotspots with high level of endemism (Dahanukar *et al.*, 2004). It is also rich in freshwater fish fauna (Arunkumar *et al.*, 2018). More than 300 freshwater fish species are reported from Western Ghats (Kumar and Devi 2013).

Goa is the smallest state of India through which the Western Ghats pass. With the rivers originating from Western Ghats, Goa is drained by two major river systems viz.

Mandovi and Zuari. Goa is the least explored in terms of freshwater fish diversity studies. Tilak, 1972 reported 52 species of freshwater fishes in Goa. The study conducted by ICAR research Complex of Goa in Mandovi and Zuari river system during the period 2013-2014 reported 55 species of fish. A study conducted by Atkore (2017) reported 49 species of freshwater fishes from the Mhadei sub-basin (BMWS & NP). The freshwater diversity in Goa is poorly documented as compared to other faunal diversity and report on checklist specific to the Protected Areas of Goa is lacking. Present study therefore aims at developing baseline data of ichthyofaunal diversity in freshwater bodies of the Protected Areas in Goa.

OBJECTIVES

- To study the diversity and prepare a checklist of freshwater fishes found in the Protected Areas of Goa.
- To study the seasonal changes in diversity of freshwater fishes.

METHODOLOGY

Study area

Goa being the smallest state of the country is located along the central-west coast of India (Figure 1), stretching between 14°51' to 15°48' N and 73°41' to 74° 20' E latitude and longitude respectively. The mountainous region of the Sahyadris in the East, the middle level plateaus in the centre and the low-lying river basins with coastal plains are three main physical divisions (Rao, 1985–86). Goa enjoys an average rainfall of 2750 mm (2500 to 3000 mm) and the mean daily temperature is around 30° C and maximum temperature rises to 36° C.

Study site

The field work was conducted in five Protected Areas of Goa which forms a part of the Western Ghat region namely, Mhadei Wildlife Sanctuary (MWS:208.48km²), Bhagwan Mahaveer Wildlife Sanctuary and National Park (BMWS:241km²), Bondla Wildlife Sanctuary (BWS: 8km²), Netravali Wildlife Sanctuary (NWS: 211.05km²), Cotigao Wildlife Sanctuary (CWS: 86 km²) and adjoining areas of these PAs (Fig. 1).

COLLECTION AND PRESERVATION

Fish collection was done from October 2022 to November 2023 from different sites of all the five Protected Areas. The fish fauna were collected using cast nets, dip nets, drag nets and gill nets of different mesh sizes ranging from 8 to 22 mm with the help of local fishermen (Arunkumar *et. al.*, 2018). Proper care was taken to avoid

damage to the specimens during collection. Fish fauna were photographed before being preserved in formalin so that they could be photographed in their original colour. Further, for smaller samples, specimens were preserved in 10 % formalin, and for larger samples, formalin was injected into the abdominal cavity so that the internal organs could be preserved well for further taxonomic studies (Raghavan *et. al.*, 2008). The specimens were given reference name and numbers for specimen identification, and they were transported to the laboratory for identification.

TAXONOMIC STUDY

Morphometric measurements viz. total length, standard length, body depth, head length, height of the head at occiput, head width, eye diameter, snout length, interorbital width, predorsal length, post dorsal length, pre-pelvic distance, length of pectoral fin, length of dorsal fin, length of pelvic fin, least height of caudal peduncle, length of caudal peduncle, length of longest fin ray, post orbital length, snout-orbital width, width of gape of mouth were taken. Fin rays and scale count was also recorded (Jayaram, 2010). Measurements were taken with the help of digital caliper. The species were identified based on the key given by Day (1967), Talwar and Jhingran (1991), Menon and Devi (1992) and Jayaram (1999,2010).

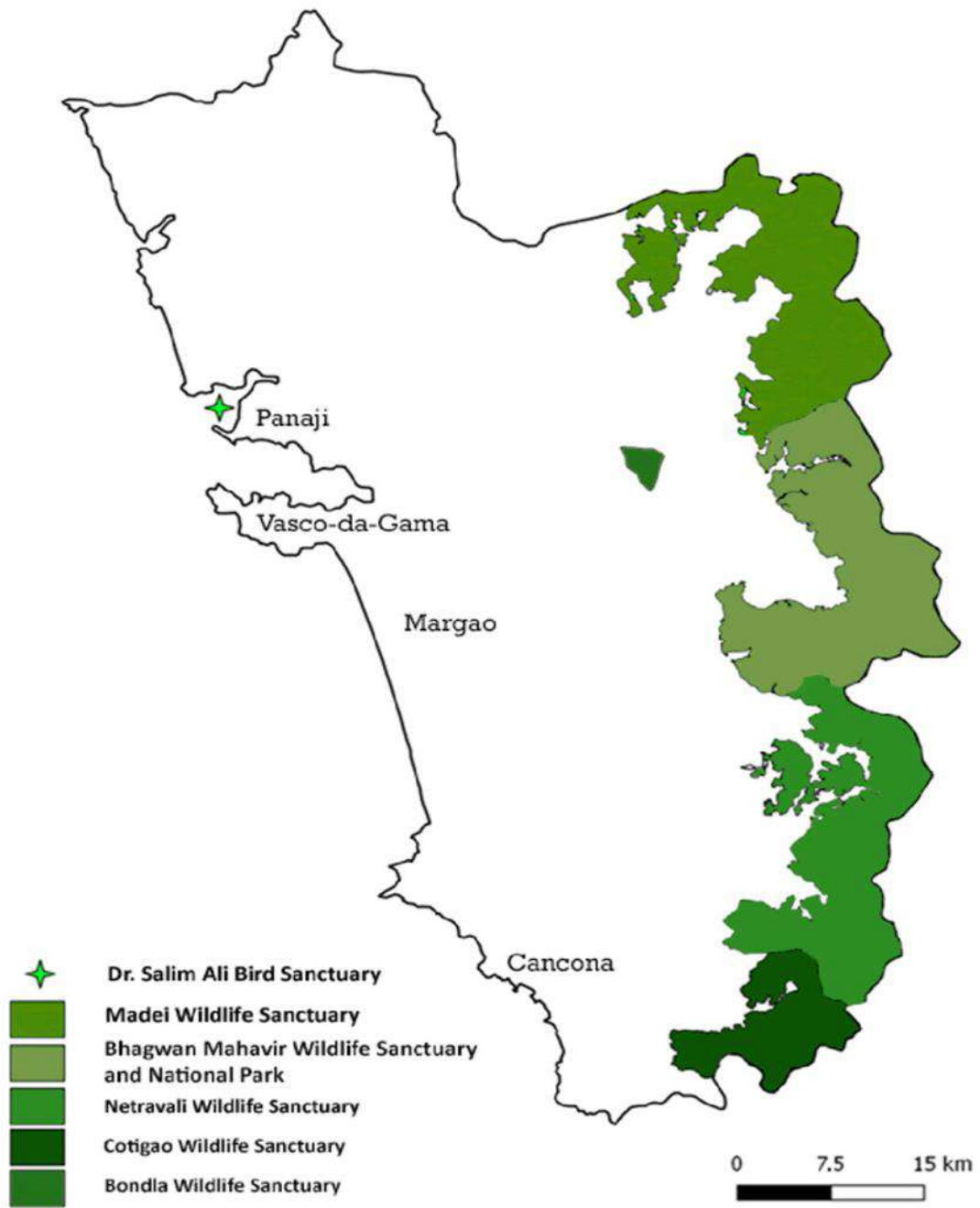
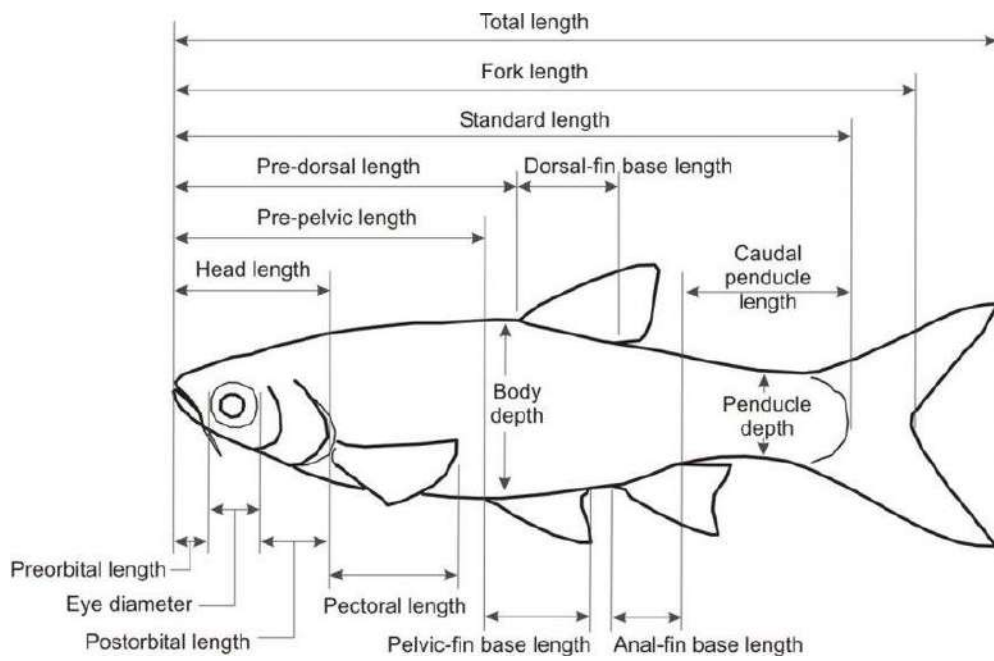
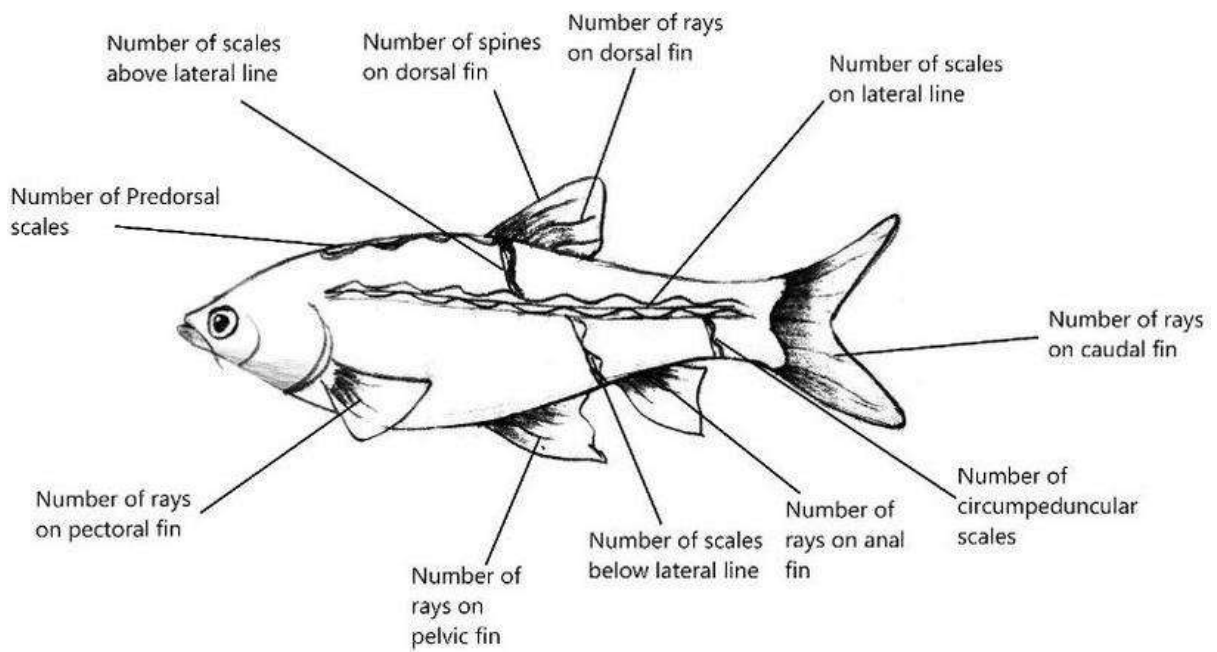


Figure 1: Map Showing the location of Study area.



(a)



(b)

Figure 2: Morphometric (a) and Meristic (b) count of Fish.

OBSERVATION

Fish Diversity

During the present study a total of 31 species of freshwater fishes, belonging to seven orders, 12 families and 21 genera were recorded. The list of fishes recorded along with their order, family and IUCN status is given in table no. 1.

The most commonly observed order was Cypriniformes including two families (Cyprinidae and Nemachilidae) and nine genera (*Puntius*, *Rasbora*, *Devario*, *Garra*, *Pethia*, *Haludaria*, *Paracanthocobitis*, *Tor* and *Schistura*). Followed by Perciformes with three families and five genera and Siluriformes with three families each with one species. Whereas, in order Synbranchiformes, Tetraodontiformes, Cyprinodontiformes and Beloniformes only one family with single species was recorded.

Highest number of species was recorded from Mhadei Wildlife Sanctuary followed by Bhagwan Mahaveer, Netravali and Cotigao. The least number of species was recorded in Bondla Wildlife Sanctuary (Figure 3).

SEASONAL VARIATION

The present study period was divided into four periods *viz.* monsoon (June-August), post-monsoon (September-November), winter (December-February) and Summer

(March- May). Highest number of species was recorded in monsoon and post-monsoon season, whereas least number of species was observed in summer season. Species belonging to Cypriniformes, Perciformes and Cypridontiformes were recorded during the summer season.

Highest number of species was recorded from order Cypriniformes during all the four seasons followed by Perciformes. Cypridontiformes represented by a single species was recorded during all the seasons, whereas, Tetraodontiformes was recorded only during the post-monsoon season (Figure 4).

IUCN STATUS

The threat status of fishes based on IUCN Red List of Threatened species encountered during study period is shown in figure 5. It shows high percentage (68%) of the least concern (LC) species and 6% each in the Vulnerable (VU) and data deficient (DD) categories, 3% of the fish species is under Near Threatened (NT) category and four species were identified upto genus level and hence the IUCN category could not be verified.

TABLE 1: CHECKLIST OF ICHTHYOFAUNA WITH IUCN STATUS RECORDED DURING THE STUDY PERIOD

SR. NO.	ORDER	FAMILY	SCIENTIFIC NAME	COMMON NAME	IUCN TATUS	
1	Cypriniformes	Cyprinidae	<i>Puntius filamentosus</i>	Black spot barb	LC	
2			<i>Puntius amphibious</i>	Scarlet-banded barb	DD	
3			<i>Puntius ticto</i>	Ticto barb	LC	
4			<i>Puntius dorsalis</i>	Long snouted barb	LC	
5			<i>Rasbora daniconius</i>	Slender rasbora	LC	
6			<i>Rasbora labiosa</i>	Slender rasbora	LC	
7			<i>Devario regina</i>	Queen danio	LC	
8			<i>Devario malabaricus</i>	Malabar danio	LC	
9			<i>Garra stenorhynchus</i>	Sucker fish	LC	
10			<i>Garra mullya</i>	Sucker fish	LC	
11			<i>Garra bicornuata</i>	Sucker fish	NT	
12			<i>Pethia setnai</i>	Indigo Barb	LC	
13			<i>Tor khudree</i>	Deccan mahseer	LC	
14			<i>Haludaria melanampyx</i>	Melon Barb	DD	
15			Nemachilidae	<i>Schistura denisoni</i>	Stone Loach	LC
16				<i>Paracanthocobitis sp</i>	Loach	
17	Perciformes	Cichlidae	<i>Etroplus suratensis</i>	Pearl spot	LC	
18			<i>Pseudetroplus maculatus</i>	Orange Chromide	LC	
19		Ambassidae	<i>Parambassis ranga</i>	Glassy perchlet	LC	
20			<i>Chanda nama</i>	glassy perchlet	LC	
21		Channidae	<i>Channa gachua</i>	Dwarf Snakehead	LC	
22			<i>Channa striata</i>	Snakehead	LC	
23	Synbranchiformes	Mastacembeloidae	<i>Macrognathus guentheri</i>	Spiny eel	LC	
24	Beloniformes	Belonidae	<i>Xenentodon cancila</i>	Needlefish	LC	
25	Siluriformes	Siluridae	<i>Ompok pabda</i>	Pabdah catfish	VU	
26		Sisoridae	<i>Gylothorax sp.</i>			
27		Heteropneustidae	<i>Hetropneustes sp</i>			
28		Bagridae	<i>Mystus sp</i>			
29	Cyprinodontiformes	Aplocheilidae	<i>Aplocheilus lineatus</i>	Striped panchax	LC	
30	Tetraodontiformes	Tetraodontidae	<i>Carinotetraodon travancoricus</i>	Dwarf Puffer Fish	VU	

TABLE 2: LIST OF SPECIES RECORDED FROM THE STUDY AREAS.

Sr. No.	Species	Madei WLS	Bondla WLS	Bhagwan Mahavir WLS	Cotigao WLS	Netravali WLS
1	<i>Puntius filamentosus</i>	•		•	•	
2	<i>Puntius amphibious</i>	•		•		•
3	<i>Puntius ticto</i>	•		•	•	•
4	<i>Puntius dorsalis</i>	•		•	•	•
5	<i>Rasbora daniconius</i>	•	•	•	•	•
6	<i>Rasbora labiosa</i>	•	•	•	•	•
7	<i>Devario regina</i>	•		•	•	•
8	<i>Devario malabaricus</i>	•	•	•	•	•
9	<i>Garra stenorhynchus</i>	•	•	•	•	•
10	<i>Garra mullya</i>	•	•	•	•	•
11	<i>Garra bicornuata</i>	•		•	•	
12	<i>Pethia setnai</i>	•		•		•
13	<i>Tor khudree</i>	•		•		
14	<i>Haludaria melanampyx</i>	•		•		•
15	<i>Schistura denisoni</i>	•		•	•	
16	<i>Paracanthocobitis sp</i>	•				
17	<i>Etroplus suratensis</i>	•		•		
18	<i>Pseudetroplus maculatus</i>	•				•
19	<i>Parambassis ranga</i>		•			
20	Chanda nama		•			
21	<i>Channa gachua</i>	•		•	•	•
22	<i>Channa striata</i>	•	•	•	•	•
23	<i>Macrognaathus guentheri</i>	•	•	•	•	
24	<i>Xenentodon cancila</i>	•	•	•		
25	<i>Ompok pabda</i>			•		
26	<i>Gyplothorax sp.</i>	•				
27	<i>Hetropneustes sp</i>	•		•		
28	<i>Mystus sp.</i>	•		•		
29	<i>Aplocheilus lineatus</i>	•	•	•	•	•
30	<i>Carinotetraodon travancoricus</i>	•		•		

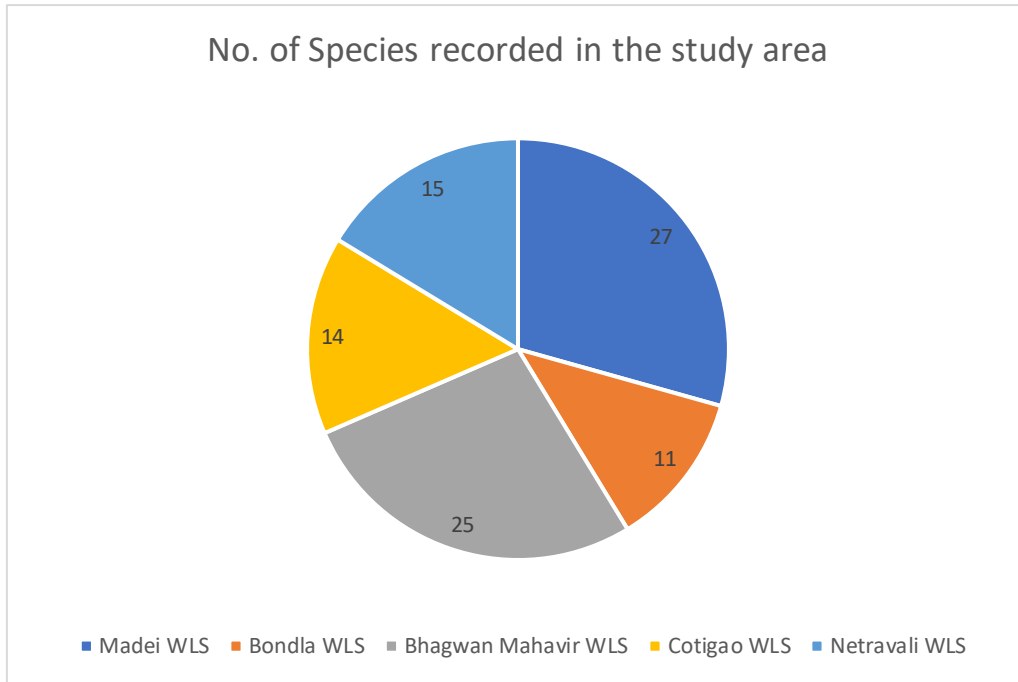


Figure 3: Chart showing the no. of species recorded in each study area.

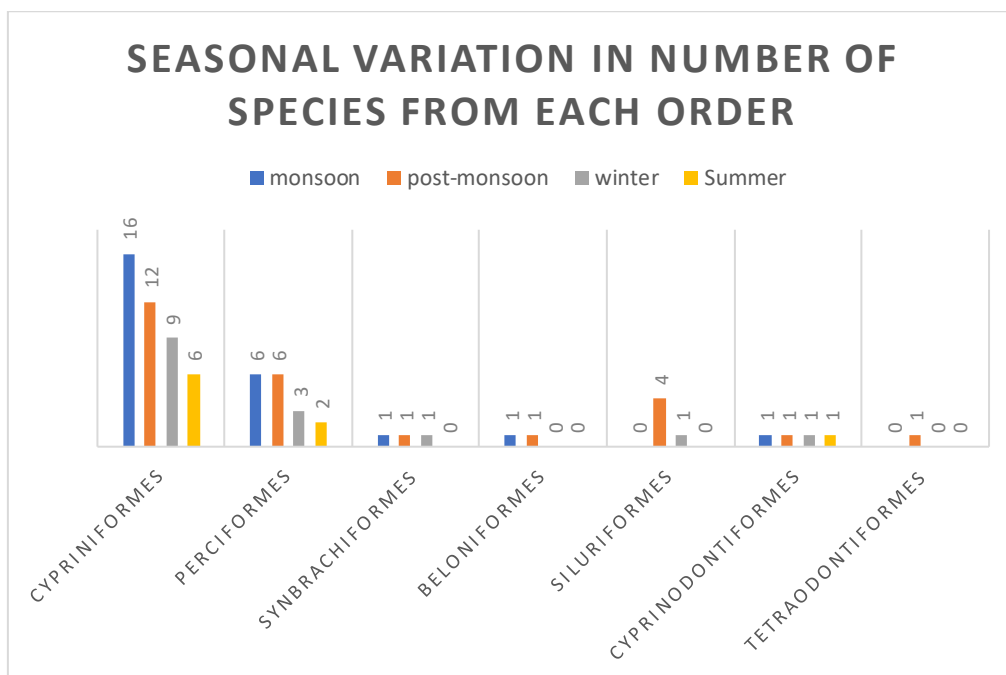


Figure 4: Graph showing seasonal variation in number of species belonging to different Orders.

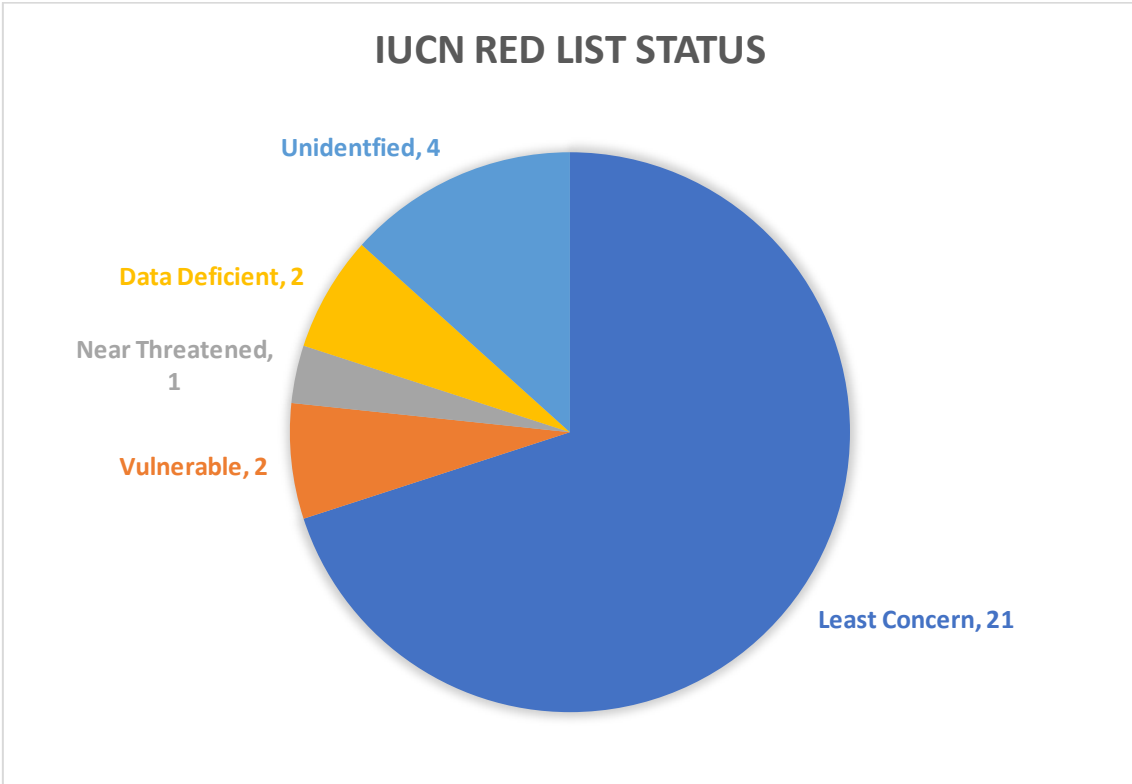


Figure 5: Chart Showing IUCN Status Ichthyofauna.



a) *Puntius filamentous*



b) *Puntius amphibious*

c)



d) *Puntius ticto*



e) *Puntius dorsalis*



f) *Rasbora daniconius*



g) *Rasbora labiosa*



h) Devario regina



i) Devario malabaricus



j) *Garra stenorhynchus*



k) *Garra mullya*



l) *Garra bicornuata*



m) *Pethia setnai*



n) *Tor khudree*



o) *Haludaria melanampyx*



p) *Schistura denisoni*



q) *Paracanthocobitis sp*

PLATE I: a) to p) Fish species belonging to Order Cypriniformes.



a) *Etroplus suratensis*



b) *Pseudetroplus maculatus*



c) *Parambassis ranga*



d) *Chanda nama*



e) *Channa gachua*



f) *Channa striata*

PLATE II: a) to f) fish Species belonging to Order Perciformes.



a) *Macrognathus guentheri*

b)

PLATE III: Fish species belonging to Order Synbranchiformes.



c) *Xenentodon cancila*

d)

PLATE IV: Fish species belonging to Order Beloniformes.



a) *Ompok pabda*



b) *Gylothorax* sp.



c) *Hetropneustes sp*



d) *Mystus sp*

PLATE V: a) to d) Fish species belonging to Order Siluriformes.



a) *Aplocheilus lineatus*

PLATE VI: Fish species belonging to Order Cypinodontiformes.



a) *Carinotetraodon travancoricus*

PLATE VII: Fish species belonging to Order Tetraodontiformes

DISCUSSION

The present study is the first attempt to investigate the diversity of freshwater fishes in the Protected Areas of Goa. The present study recorded the presence of 30 species from the Protected Areas. It was observed that the highest number of species were recorded from Bhagwan Mahaveer Wildlife Sanctuary and Mhadei Wildlife Sanctuary. Whereas the lowest number of species was recorded in Bondla Wildlife Sanctuary. This can be attributed to the type of habitat found in Bondla Wildlife Sanctuary as it is located at foothills of the Western Ghat, and also the study was restricted to the geographic area of the Sanctuary. Lakra *et. al.* 2010 reported that the physical habitat variables play key role in the distribution of fishes. Also, it has been reported that the fish communities are known to follow a pattern of increasing species diversity from upstream to downstream (Granado 2000), Bondla being a small sanctuary and given the topography of the sanctuary its observed that the Sanctuary lacks a perennial source of flowing water. The variation in species diversity in different sampling areas can be attributed to variation in environmental factors and altered habitat which support less biological communities as compared to disturbed sites.

Seasonal Variation in fish diversity was observed in all the study areas. Highest fish diversity was reported during the monsoon and post monsoon season. Whereas, lowest diversity was seen during the summer season. It was observed during the study period that most of the water bodies in the Protected Areas dried up during the summer season, this could be the reason for decrease in the diversity. Hydrological dynamics has a strong effect on environmental and habitat conditions which affects the fish

faunal diversity (Humphries *et al.*, 2014). Further, the variation in environmental factors especially unusual and heavy rainfall during the non-monsoon period has also impacted the study as most of the areas in the Protected Areas were inaccessible due to heavy flow of water in the streams and rivulets.

CONCLUSION

The present study indicates that, the Protected Areas of Goa hosts fairly good diversity of freshwater fishes. However, the diversity of fishes is greatly affected by the environmental and seasonal changes in the habitat. In order to provide more accurate information about the seasonal variations in the composition, it is recommended to carry out ecological studies with respect to fish diversity and habitat characteristics which will help to better understand the cause of variation in diversity across season and regions. It is also recommended to initiate water conservation activities especially in the Bondla and Cotigao Wildlife Sanctuary which lacks perennial water sources in most parts of the Sanctuary during the summer season and as evident from the observation made during the summer season wherein most of the water bodies dried up which was not the scenario in the previous years, water conservation activities is recommended in the other sanctuaries too. The study also reported the presence of species of Ichthyofauna, which are categorized under Vulnerable and Near Threatened criteria of IUCN Red List of threatened species. Fish diversity study needs extensive survey. The present study duration was one year which was hindered by the unusual heavy rains therefore, some areas were not covered during the monsoon, post-monsoon seasons. This might lead to some species left undetected. Thus, further study covering all seasons and ecological aspects will provide good base in framing better conservation strategies.

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