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ECOLOGY AND PARTIAL RESTORATION OF MONE WETLAND FOR FISH PRODUCTIVITY

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ABSTRACT

Shatiya wetland, a threatened water body of eutrophicated nature in the Gopalganj district of Bihar was studied for its degradation and possible restoration practices. There high rate of sedimentation and agricultural activities causing significant changes in water quality and local biotic populations. Agricultural activities have led to high input of N and P fertilizers along with pesticides being used by the farmers. The positives response of restoration practices was observed with partial improvement in fish-productivity due to hindrance factors acting upon severe fish species.

Keywords: water quality, sediment analysis, restoration practices.

INTRODUCTION

Small rivers and several floodplains are common in north Bihar. In recent years, rapid population growth resulted in pollution of water bodies by domestic, industrial sewage and agricultural effluents containing fertilizers and pesticides. The fact that wetland values are overlooked has resulted in threat to the ‘Kidneys of the landscape’ (Mitsch and Gosselinls 1986). Hydrologic conditions and man induced preturbances can modify physical and chemical quality of water resources. These changes have direct impact on the biotic component of the water body. The study of ecological parameters in such resources may provide clue for appreciating the key relations which are relevant for restoration strategies.

The Shatiya wetland is a floodplain wetland connected with Gandak River. The anthropogenic activities in last two decades polluted this wetland so exclusively that several places hold water only in flood time during winter.

Restoration requires reconstruction of antecedent physical conditions, chemical adjustment of soil and water; and biological manipulation (Zedler, 1996). A survey of is essential for restoration of any open system like rivers. This means that a functional ecosystem can be constituted from an arbitrary set of species from the species pool that could occupy a given site. Restoration practice typically begins with a different goal, which is to accomplish specific objectives. The restoration project needs re-establish a species in a place, reduce rates of within its natural range, re-establish a natural environment, eliminate an invading species, or create vegetation that will provide nesting habitat for a species of interest. Besides other restoration tools bused on ecological theory, public co-operation is important for fast recovery of degraded ecosystems.

The main objective of this research was to determine the ecological status of Shatiya wetland prior and after restoration in terms of fish productivity.

MATERIALS AND METHODS

The water samples were collected repeatedly during 2019 at three sites in washed bottles of 2 litre capacity to cover spatial variation for physic-chemical analysis of water. The temperature, PH electrical conductivity and do were analyzed immediately after sampling. Various physic-chemical parameters Viz. DO, Total hardness, alkalinity, COD, TDS, nitrate and phosphate were determined as per the standard methods described in APHA (1998).

This research was conducted to restore functional ecology with adopted measures as enhanced water storage through excavation, debris jam removal and macrophyte enrichments. Restoration of spawning site of fishes accomplished with plant-species growth, stone-bolder dipping and side-channel preferences to Gandak river. The vegetative methods for bank stabilization were applied. The fish assemblage was also determined on the basis of ecological (Schiemer and Weidbacher, 1992) and balance of fish assemblage according to Balon (1975).

RESULTS AND OBSERVATIONS

In general, data on water quality is indicative of pollution prior to restoration with extreme temperature variation is due to differential amount of light incidence over the water surface, in different seasons prior and after restoration (Table 1).

Table 1. Physicochemical Characteristics of Shatiya wetland at selected Sites.

Sl. No.	Parameters	Site- I		Site- II		Site – III	
		Min	Max	Min	Max	Min	Max
1.	Water Temp. (ºC)	12.6	28.3	11.7	27.6	13.6	29.6
2.	pH	7.4	8.2	7.6	8.4	8.2	8.9
3.	TDS (mg/L)	1230.60	1410.0	1310.0	1520.0	1460.0	1580.0
4.	Total hardness (mg/L)	620.30	770.10	660.20	810.10	710.30	840.10
5.	Chloride (mg/L)	470.40	560.10	520.30	610.0	620.10	680.60
6.	Alkalinity (mg/L)	380.10	732.60	410.30	840.20	530.0	910.60
7.	DO (mg/L)	3.10	4.20	3.70	4.80	4.30	6.10
8.	COD (mg/L)	110	170	140	210	170	240
9.	Nitrate (mg/L)	1.30	1.70	1.60	2.30	1.80	2.50
10.	Phosphate (mg/L)	0.60	0.90	0.70	0.90	1.10	1.40

The mean value of total alkalinity gradually decreased from March to July and increased in August. The values are comparatively high in cold months may be possible due to dissolution of calcium carbonates at lower temperature (Table 1). Hardness of wetland water decreased from August to November due to the abundance of floodwater, while higher values in dry months due to the discharge of water through outlets and evaporation (Table 1). TDS value was maximum at station in June and minimum at station in July due to large inflow of rainwater (Table 1). Variation in salinity was notable with maximum and minimum value in May and August related with amount of organic deposition at different sites (Table 1). The pattern of variation in dissolved oxygen followed closely with changes in temperature and biomass of planktons and macrophytes (Table 1). Total nitrogen and phosphorus value showed higher concentration prior to restoration, while adjusted after restoration (Table 1 and 2). Less COD value were observed after restoration, perhaps due to low amount of organic compounds in this river (Table 1). Also same trend were visible in the case of total chloride in this wetland. There is considerable changes in all physical parameters after restoration might be adaptive for growth and survival of fishes (Table 2).

showed hindrance. The plantation was suitable with soil moisture, available sunlight for competing species and potential for food traffic.

The colonization of the adult fish occurred with restoration in 2018. The fishes were always present in side-channel occasionally connected to the river. Species occurrence varied only as predatory fishes were dominated during summer and followed months. The herbivore species was also occurred during rainy season. The relative abundance increased mainly due to high occurrence of 1^+ and 2^+ fish in assemblage after restoration at different studied sites rather than polluted state of Shatiya wetland (Figure 1).

Table 2: Physicochemical characteristics of Shatiya wetland after restoration.

Sl. No.	Parameters	Site- I		Site- II		Site – III	
		Min	Max	Min	Max	Min	Max
1.	Water Temp (ºC)	13.1	29.4	12.9	28.8	13.3	29.6
2.	pH	6.1	6.3	6.4	6.7	6.5	6.8
3.	TDS (mg/L)	478.10	530.20	524.20	560.10	540.10	570.60
4.	Hardness (mg/L)	180.20	210.10	200.0	230.0	220.0	240.0
5.	Chloride (mg/L)	470.40	560.10	520.30	610.0	620.10	680.60
6.	Alkalinity (mg/L)	90.60	130.0	110.0	160.10	120.10	168.20
7.	DO (mg/L)	6.10	6.70	5.80	6.40	5.60	6.20
8.	COD (mg/L)	25.20	32.10	26.10	32.60	28.0	34.10
9.	Nitrate (mg/L)	0.60	0.90	0.70	1.0	0.80	1.10
10.	Phosphate (mg/L)	0.20	0.35	0.25	0.40	0.32	0.48

The assessment of migration barriers was best performed after restoration scheme in studied wetland. Barriers to fish migration have evaluated at various flow conditions, and observed that barrier only prevent fish movement during low flow regime of water. The majority of migration barrier was associated with vertical drops in life-stage of target species. In addition, the ability to jump a vertical drop is also related to water depth from which a fish could leap. A pool depth of at least 1.25 times the length of the barrier provides ideal leaping of largest fishes.

The construction of spawning site was primarily a reflection of prevailing hydrological conditions with review of conditions during typical spawning season and peak flow of water to assess habitat stability. Introduced vegetation was cost effective and self-sustainable appliance for improvement of bank stability. However, selected species at studied sites with specific requirements

In January 2013, the abundance and biomass were 3-4 times higher than prior to restoration suggested possible adaptive changes of environmental condition after restoration in Shatiya wetland and there is great difference in species abundance (Figure 2).

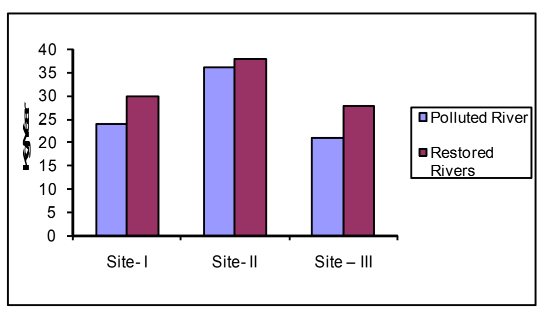

Figure 1: Fish assemblage Analysis at different sites of study.

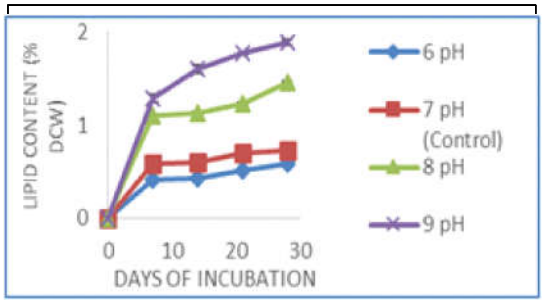

Figure 2: Fish guilt abundance Analysis.

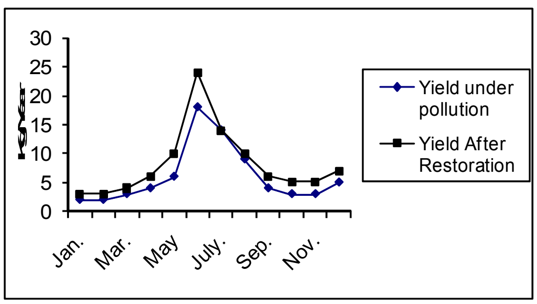

Figure 3: Seasonal Fish Catchment Analysis.

The contribution of herbivore fishes were linked only in flood time. The fish abundance showed seasonal variation in fishes similarly in both cases of pollution and restoration (Figure 3). However, predatory fish remains dominated in river. Applied vegetative method improved the aesthetic qualities of the riparian zone. The plantation of graminaceous grass and road creeper reduced surface erosion and structural integrity of wetland sides has enhanced with root spreading in soil. The road creeper was also observed as fish access and spawning site of fishes. The herbaceous ground grasses provide control of erosion during flood time.

DISCUSSIONS

This study is in agreement with Nazneen (1980) reported the influence of hydrological factors on the seasonal temporal changes of fish assemblage. The elevated temperature through fast biochemical reactions affects upon growth and survival of fishes in this study showed consistency with Harshley et al (1982) who reported close relation between water temperature and fish productivity.

The variation in pH was related with free carbon dioxide and carbonate, and, less value observed after restoration due to limited phytoplanktons. This type of observation has also reported by Das and Srivastava (1956). Also gradual decrease of alkalinity from March to July and after restoration is attributed to low rate of nutrient cycling in the wetland. High concentration of total hardness during summer in polluted state of wetland and gradual decrease in hardness after restoration is probably related with organic deposition in water as also reported by Singhal et al (1986). The variation in salinity and TDS as pH was observed and consistent with study of Kumar et al (2002). Kulshreshtha et al (1992) also reported high COD in polluted river as findings of this study. Natural water generally contains low chloride level as resulted after restoration practice. Amount of chloride prior to restoration as a consequence of macrophyte decomposition is also reported by Sauver (1987). The present study support findings of Elser et al (1990) as high level of nitrogen resulted with growth of planktons and agricultural effluents. The phosphate amount showed similar trend as nitrogen through fertilizer effluents in wetlands.

This research hold relation between water quality and fish productivity was consistent with study of Downing et al (1990). The fish yield was variable for existing species and showed Gaussian curve for productivity. There is effect of unconventional diets on growth and survival of fishes as reported in the case of *Clarias batrachus* as reported by Tiwary et al (2013). The higher bed loads are beneficial in terms of their role in the creation of spawning, rearing and over-wintering habitat.

The entrapment of spawning gravel was necessary during restoration due to lack of riparian vegetation. The study showed that restoration supported fish assemblage increment as reported in similar case by Penaz and Jurajda (1993). The fish habitat has been achieved with improvement in water quality. A lower ratio of predatory fishes after project was partly caused by increased occurrence of herbivore than previous years. During the study, initial land limiting fish migration was observed. This study confirms that restoration provide new chances and enriched habitat scale of the freshwater systems for local populations as reported by Schiemer and Weidbecher (1992) in the similar conditions.

CONCLUSION

There is direct relationship between fish yield and water quality. However, restoration of Shatiya wetland with limited approach and economy resulted in partial backwater and there are several hindrance factors encountered due to specific need of all fish species. Thus, further researches may be needful during restoration for particular fish species for local population.

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