SUMMARY
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The importance of fresh water habitats is far greater than marine and other terrestrial ecosystems though they occupy very meager area on the earth’s surface. Among fresh water ecosystems, wetlands represent one of the most productive water bodies as they play a significant role in the ecological sustainability of the region. It serves a range of functions such as providing suitable habitat for a variety of flora and fauna, purification of water, recycling of nutrients and provides cultural and aesthetic values also. Unfortunately, these habitats have not been given their due importance as either they are facing severe problems of pollution or are not explored sufficiently from ecological point of view. Continuous inputs of domestic waste, sewage, industrial and agricultural effluents into the water bodies is the leading cause for their deterioration, which may further lead to collapsing of these ecosystems. If this trend continues then it may become all the more impossible to restore these in near future thus culminating into extinction of some species or permanent damage to them. So proper steps must be taken to restore these habitats before the situation becomes worse and uncontrollable. For this regular monitoring of these ecosystems should be done in terms of physico-chemical and biotic components which will be helpful in designing appropriate conservation strategies and restoration methods towards conservation, management and sustainable use of natural resources.

Nangal wetland is a man-made lacustrine wetland which is located at foothills of Shiwaliks and made on river Sutlej in Nangal. This wetland has varied range of flora and fauna so it has been declared as National wetland and protected area in the recent past by Ministry of Environment and Forest, Government of India. The present investigation has been designed so as to analyze the various physico-chemical parameters and other aspects of fishery.

FISH FAUNA

The most important characteristic for maintenance of stability and a vital agent for stress buster against any type of environmental change in an aquatic ecosystem is aquatic biodiversity.
Summary

For assessment of fish biodiversity in the wetland, regular collection trips were organized and random sampling was done with the help of gill net and hired help of fisherman. Fish biodiversity, species richness and abundance of fauna were done.

- A total of 15 fish species belonging to 6 families and 5 orders have been recorded.
- Order Cypriniformes with 10 genera dominated amongst all followed by order Siluriformes (2), Perciformes, Synbranchiformes and Beloniformes (1). All orders have been represented by 1 family except for Siluriformes which has been represented two families i.e. Bagridae and Sisoridae.
- *Cyprinus carpio* L., *Tor putitora* (Ham.) and *Labeo dero* (Ham.) have been collected in significant numbers whereas other fish specimen were collected in insignificant numbers.
- A key has been prepared for identification of the fish specimens.

LENGTH-WEIGHT RELATIONSHIP

LW analysis on 80, 23 and 12 specimens of *Cyprinus carpio communis* L., *Tor putitora* (Ham.) and *Labeo dero* (Ham.) respectively have been investigated.

- Highly significant positive correlation \( r \) has been observed between length and weight for all the fish species \( r = 0.953^{**}, 0.965^{**} \) and \( 0.965^{**} \) for *Cyprinus carpio communis* L., *Tor putitora* (Ham.) and *Labeo dero* (Ham.) respectively. There is direct linear relationship between both these parameters as is evident from correlation values.
- Negative allometric growth has been observed for *Cyprinus carpio communis* L., *Tor putitora* (Ham.) and *Labeo dero* (Ham.) but growth is very nearer to isometric in case of *Labeo dero* (Ham.) as evident from ‘b’ values in the regression equations given below:
  - *Cyprinus carpio communis* L. \( \log \text{TW} = -1.508 + 2.781 \log \text{TL} \)
  - *Tor putitora* (Hamilton) \( \log \text{TW} = -1.593 + 2.726 \log \text{TL} \)
  - *Labeo dero* (Hamilton) \( \log \text{TW} = -1.895 + 2.980 \log \text{TL} \)

MORPHOMETRIC ANALYSIS

Morphometric analysis is a very efficient tool in fisheries management and also helpful in depicting the impact of ecological conditions of a water body on the fish. In present work, total 24 morphometric characters were undertaken. All the calculations were done in percentage of Total Length (TL) and Head Length (HL) as they are considered as independent variables and others as dependent variables.
Cyprinus carpio communis L.

- All the morphometric parameters showed positive correlation which was significant at 0.01 level. When all parameters were computed in percentage of TL, correlation has been found to vary between a range of 0.504**-0.990**, minimum being observed between Total Length (TL) and Maximum Body Width (MBW) and maximum between Total Length (TL) and Standard Length.

- Similarly, when all head parameters have been calculated in percentage of HL, it has been observed that all parameters showed moderate positive correlation (range of correlation: 0.738**-0.899**) except for inter-orbital distance (r= 0.475**) which showed poor correlation.

- Based on range differences, it has been concluded that maximum characters fall in genetically controlled category i.e. 18 out of 24, and remaining 5 are intermediate and just 1 character is environmentally controlled with respect to total length. It has been inferred this fish has little or no tendency to form subspecies if introduced into different ecological environment.

Tor putitora (Hamilton)

- Range of coefficient of correlation has been observed to be between 0.494**-0.988**, significant at 0.01 level indicating direct collinear relation between TL and all parameters. All head characters in HL also showed significant positive correlation.

- 21 characters showed least and just 3 showed medium and no character showed wide range difference i.e. >15.00. The morphometric characters of medium and wide range help in indicating population of a species inhabiting different geographical locations. On the basis of this, it has been inferred that fish under study has restricted geographical distribution, thus suggesting that this fish has no tendency to form subspecies.

Labeo dero (Hamilton)

- A linear relationship for all the more all characters both in percentage of TL and HL was observed as evident from coefficient of correlation for the various morphometric characters, which ranged between 0.590** for eye-diameter to 0.957** for post-dorsal distance for parameters computed in TL and range of correlation for head characters have been observed to be between 0.604**- 0.939** with pre-orbital distance being least correlated and eye-diameter the most correlated.
Summary

• Out of all the twenty-two characters, twenty-one have been found to be genetically controlled with range difference ranging between 0.22 – 5.87 much less than 10 indicating the most restricted distribution of this fish.

TRENDS OF FISHERY

• The trends of fishery at Nangal wetland remains almost same as during the period 2002-2009, *Cyprinus carpio* L. dominated the wetland except year 2002-2003 when *Labeo dero* (Ham.) was collected more in number. But irregular trends in number of individuals of *Cyprinus carpio* L. were observed during different months of the different years.

• Other key species observed were *Labeo dero* (Ham.), *Tor putitora* (Ham.) and *Schizothorax richardsonii* (Gray).

• Although *C. carpio* dominated among the fish catch but in the initial years i.e. during 2002-2005 percentage abundance of *C. carpio* was less than 50%, but afterwards its percentage composition kept on increasing being maximum 92% during 2008.

• Maximum catch in terms of numbers and weight (kg) were recorded during 2008 while minimum being recorded during the succeeding year i.e. 2009. The major reason for low figures during 2009 was mainly due single most limiting factor which is overexploitation of fishery resources in 2008.

• Maximum biodiversity in terms of number of fish species was reported during 2007 wherein a total of 8 species were observed.

PHYSICO-CHEMICAL ANALYSIS

Limnology is an area of interdisciplinary science wherein a great deal of detailed field as well as laboratory studies are required so as to make an understanding of various structural and functional aspects and problems associated with the freshwater environment, from a holistic point of view.

• All the physico-chemical parameters were found to be well within the range as per USEPA (1986) for healthy fish production, except carbon-dioxide, which has been found to be only marginally high and silicates which were recorded to be quite high as compared to the reference values.

• Very low values of nitrates and phosphates are indicative of low nutrient levels in the lake, the major reason may be because of diurnal flow of water from the lake.

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Summary

- Major parameters for supporting fish fauna i.e. pH and DO have been found to be within range except during extreme summers when values of DO decreases slightly.
- Lower values of chlorides have been observed indicating minimal amount of organic waste of animal origin.

BIOTIC COMPONENTS

- A total of 77 taxa have been identified from Nangal wetland which included 54 species of phytoplanktons, 16 species of zooplanktons, 4 benthos, 1 neuston, 2 nektons.
- Phytoplankton communities have been observed to be constituted by the members of Chlorophyceae (27), Bacillariophyceae (16), Cyanophyceae (6), Euglenophyceae (3) and Dinophyceae (2). Amongst these, Chlorophyceae was the dominant group with 50% followed by Bacillariophyceae (30%), Cyanophyceae (11%) of total number of phytoplankton.
- Zooplankton community is constituted by rotifera (8), Crustacea (5), Protozoa (3). Amongst all, rotifera was found to be dominant group.

THREATS TO THE WETLAND

- Increased human intervention over the past few years are imposing a greater stress and threat to aquatic ecosystems, which is the leading cause of progressive deterioration of water quality making it unfit and unhealthy for the survival of aquatic organisms.
- The major anthropogenic threat Nangal wetland faced in recent past is over exploitation of fishery resources which lead to decline in their numbers and illegal fishing still practiced there, but no proper laws are framed, although it has been declared as protected area.
- Siltation and pollution are two other problems being faced by Nangal wetland although these are not major threats as reflected from limnological analysis.