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A Review on Fisheries Management and Development in Bhadra Reservoir, Karnataka

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Abstract: *The development and management of Bhadra reservoir in Karnataka is reviewed based on published literature. In addition to fisheries the reservoir water is used for hydroelectric power generation and irrigation. The fish diversity, water quality, fish catch composition, craft and gear, vegetation, regulations, exotic species and habitat improvement factors are discussed. The fish diversity was low in pre-monsoon probably due to the shrinkage of the water spread of the reservoir. The high value of dissolved oxygen coupled with low biochemical oxygen demand and other nutrient levels indicate that the water body is moderately oligotrophic in nature. Water quality is highly congenial for fish life. Fish seed stocking is a major input in the management of reservoir fisheries. To save fishes and to develop a sustainable fishery practices and proper documentation leading to diversity information system is an urgent need.*

Key Words: *Bhadra reservoir, Development, Fisheries, Management,*

I. INTRODUCTION

The Bhadra reservoir project was the irrigation scheme to be undertaken by the National Water Management Project (NWMP), with the aim of increasing agricultural prosperity, particularly for rice production (Thiruvengadachari and Sakthivel,1997). The dam was built to a height of 59.13 metres (194.0 ft) (above the river bed level) between 1947 (start of construction) and 1965 (year of commissioning). It has a gross storage capacity of 2.025 km³, (Modernization strategies for irrigation management: Bhadra Project,2011) live storage of 63.00 BCF at full reservoir level and a dead storage of 8.50 BCF at RL (reservoir level) of 631.54 metres (2,072.0 ft) ("Bhadra Reservoir Project". Water Resources Karnataka: National Informatics Center, 2011; Modernization strategies for irrigation management: Bhadra Project,2011) . The storage created by the reservoir is according to the allocation of 61.70 BCF (1.747 km³ including direct evaporation of 0.14 km³) of water made under the Krishna Water Disputes Tribunal Award. ,(Modernization strategies for irrigation management: Bhadra Project,2011) The dam is built on a shattered rock based with a central masonry spillway. It has an earthen embankment on the left side and a rock hillock on the opposite side (Rao,2006). The Ogee type spillway in the middle section of the river has been provided with four numbers of vertical lift gates over a width of 18.28 metres (60.0 ft) and designed for a discharge of 3,020 cubic metres (107,000 cu ft)/s. In addition, two number river sluices are also provided to pass a discharge of 13,300 cubic metres (470,000 cu ft)/s.

The annual siltation load considered in the design is 10.78 million cubic feet per square kilometer of catchment area. The canal outlets provided in the dam, initially for Hydropower generation followed by irrigation, consists of the left Bank canal outlet to discharge 10.76 cubic metres (380 cu ft)/s and two right bank canal outlets to pass a discharge of 75.03 cubic metres (2,650 cu ft)/s ("Bhadra Reservoir Project". Water Resources Karnataka: National Informatics Center, 2011; Modernization strategies for irrigation management: Bhadra Project,2011; Thiruvengadachari and Sakthivel,2011) . There are several islands in the reservoir area which have been developed for tourism (Water falls and Dams,2011).

A. Fish and Fisheries

Thirumala et al (2011) identified 33 fish fauna belongs to Cyprinidae 18 species, Channidae 2 species, Bagridae and Siluridae with 3 species and a species each of Mastacembelidae, Ambassidae, Cichlidae, Claridae, Notopteridae, Cobitidae and Heteropneustidae. The species diversity is peak in post monsoon, coinciding with favorable conditions such as sufficient water and ample food resources. The diversity was low in pre-monsoon probably due to the shrinkage of the water spread of the reservoir (Thirumala et al.,2011).

The species of *Clarias*, *Channa*, *Mastacembelus*, *Heteropneustes*, etc, have air breathing organs and fetch good market value as live fish. *Puntius*, *Ambassis* and *Nemacheilus* species have ornamental value due to small size and bright colors and can be used as aquarium fishes. *Gambusia* sp is used as larvivorous fish. However, *Labio calbasu* found to be rare species in the present study. With the onset of Southwest monsoon, heavy influx of freshwater occurs in the reservoir in early July developing a freshwater isostatic habitat. Consequently, the high floods during monsoon changes the entire system. The human anthropogenic activities and over exploitation leads to rapid decline in the fish diversity. Though commercially important species are available they are not abundant to make fishery commercial and economical. Conservation measures require afforestation in catchment and awareness on illegal fishing and killing of brood fishes and juveniles. The present study of fish fauna in Bhadra reservoir showed that most of the fish species recorded were widely distributed in the streams and rivers of Western Ghats. The fish species like *Cirrhinus fulungee*, *Salmostoma*, *Rasbora* and *Puntius* groups were more dominant. Therefore, the present investigation reveals that Cyprinid fishes are found to be the more dominant group than others which is supported by other studies also (Singh et al., 2006). The fish species recorded from Bhadra reservoir, the following are considered as economically important and cultivable fishes including *Notopterus notopterus*, *Cyprinus carpio*, *Oreochromis mossambica*, *Labeo rohita*, *Cirrhinus mrigala*, *Catla catla*, *Sperata seenghala*, *Sperata oar*, *Channa striatus* and *Channa marulius*. The reservoir inhabit the ornamental fishes like *Puntius sophore*, *Puntius deucanensis* and *Puntius filamentosus* (Thirumala et al., 2011).

B. Water Quality

Thirumala et al (2011) studied the physico-chemical parameters of Bhadra reservoir in Karnataka. They reported that water temperature ranged from 26°C to 28.9°C. Highest water temperature was recorded during summer season (28.9°C) whereas least was observed in winter season (26.10°C). High turbidity was observed on an average of 7.33 NTU during winter season and least was noticed in summer season (6.00 NTU). The pH was observed in the range of 7.3 to 7.65 which indicates that water was slightly alkaline in nature. The total alkalinity ranged from 32 to 40 mg/l and it was highest during rainy season. Electrical conductivity (EC) ranged between 59 to 71.60 μ mhos/cm. High electrical conductivity was recorded during rainy season. This may be due to greater ionic concentration of the inlet flow (Prithwiraj Jha and Sudip Barat 2003). Total dissolved solids (TDS) ranged from 36 to 43.67 mg/l. Seasonal analysis reveal that TDS values were low during winter and high during monsoon. DO values ranged from 6.2 to 7.18 mg/l. Minimum values of DO were recorded during summer season and maximum during winter months. Minimum DO in months may be due to high metabolic rate of organisms. Maximum DO may be due to low atmospheric temperature.

Biochemical oxygen demand values ranged from 0.5 to 2.75 mg/l. Total hardness is a measure of the capacity to precipitate soap. It is the sum of the polyvalent cations present in water. The total hardness ranged from 25 to 33.83 mg/l. Maximum hardness was recorded during rainy season due to surface runoff. The total hardness values were within the permissible limits prescribed by WHO. Chlorides are important in detecting the concentration of ground water by waste water. In the present study, the chloride value ranged between 9.0 and 14.03 mg/l. Chemical oxygen demand was maximum during summer season and minimum in rainy season indicate lower microbiological activities and presence of oxidisable matter in the water body. Nutrients like phosphate, nitrate, calcium, magnesium, and ammonia were in low level, indicates the moderately oligotrophic status of the water body. Apart from agriculture, all other human activities are negligible considering pollution factor in the catchment area agriculture is the main activity with significant usage of fertilizers and pesticides. These pollutants ultimately reach the reservoir due to run off. Even though there is no possibility of a high pesticide level in the reservoir water, in the higher order organism like fishes it becomes significant due to bio magnification (Thirumala et al., 2011).

C. Stocking

Fishes are introduced into the reservoir even prior to the sealing of the reservoir. The purpose of stocking is (1) to fill the new niches created in the reservoir (2) to replace the species that may disappear (3) to replenish the stock that is getting exhausted (4) to provide fish of good consumer acceptance, etc. Stocking is the major input in the management of reservoir and is a key factor in sustaining a good fishery (Sreenivasan, 1989-90).

D. Fishing Catch and Composition

Peak fishing is mainly constrained to pre-monsoon months till the onset of monsoon. Fishing activity is generally low during monsoon season and post-monsoon months. The catch mainly consists of native species. Indian major carps like *Catla catla*, *Cirrhinus mrigala* and *Labeo rohita* are reported to occur during first flood and Juveniles of *Mystus seenghala* were recorded during post-monsoon month.

The dried fish (Figure 3) of *Salmostoma untrahi* is used in poultry in addition to human consumption. The cost of raw *Salmostoma untrahi* is very much cheaper than the other fresh water fishes.

E. Craft and Gear

Coracle with oar is the most commonly used fishing craft (Figure 1). Gill nets, cast nets, hook and line are the commonly used fishing gear. The gill nets are used throughout the year and fish catch includes large fishes to medium carps, depending on the mesh size. Small-sized gill nets (Figure 2) are used to catch *Salmostoma untrahi* fishes which are normally processed by sun drying.

F. Vegetation

The back water of the reservoir extends into the forest reserve which has "moist deciduous forest of the *Tectona-Dillenia-Lagerstroemia* series with patches of dry deciduous forest of the *Anogeissus-Tectona-Terminalia* type forests occurring in the northern fringes". A key ecological feature of the forest is the presence of five species of bamboos, three are profusely found in the reserve forests (en.wikipedia.org). However, plants obstruct fishing gear, cause damage to nets and thereby result in lower catches. They also provide resting place for fish eating birds.

G. Fish Farm at Reservoir Site

Bhadra Fish seed farm at B.R Project area to facilitate the production of fry and fingerlings and supply to the fish farmers. This farm has also hormone spawning centre where India major carps are bred. This policy has enabled the Department to stock the reservoirs with well grown seed in adequate numbers.

H. Bhadra River Tern Lodge

Nestled in the Western Ghats the River tern lodge gets its name from the nearby island that attracts hundreds of river terns during the breeding season. It is located on a hillock on the edge of the Bhadra reservoir, near Lakkavali: a stone's throw away from the northern boundary of the Bhadra Tiger Reserve, in the Chikmagalur district. Chikmagalur was once a princess' dowry – and still holds the charms of a place that a king's favourite daughter once took as her dowry. Amongst all this, is a perfect place to form a whole new bond with nature (<http://www.junglelodges.com/river-tern-lodge/>).

I. Regulations

Conservation measures are enforced in all reservoirs and connected rivers through legislation. Mesh regulations are in operation. Fishing is prohibited at the sites of congregation and in the breeding grounds. Certain areas are declared as fish sanctuaries. Temporary prohibition of fishing (ad hoc "closed season") is enforced during low water levels to conserve the brood stock. Size restrictions are implemented through mesh regulation. The mesh size is so fixed that major carps are not caught before they spawn at least once (Sreenivasan,1989-90).

A close co-ordination is desirable in multiple use reservoirs between the fisheries managers and other major users like irrigation department or electricity department. Closure or opening of sluice gates is intimated to fisheries officials to enable them to carry out "rescue operation" of relocating stranded fish. "Minimum conservation pool" is maintained in the reservoirs to conserve the brood stock. Discharge of upstream reservoir water during breeding season facilitates the spawning of major carps (Sreenivasan,1989-90).

J. Pollution Abatement

Though industries should be sited downstream of a reservoir, Mysore paper mills Limited and Visveswaraya Iron and Steel limited industries are located at the downstream stretch of the reservoir limits. In these cases, the effluents are monitored and the industries are required to treat their wastes to conform to ISI standards. Sometimes, pollution still occurs, causing a depletion of fishery as in downstream stretch of Bhadra river.

K. Exotic Species

In order to fill up vacant niches, multispecies stocking is done. In addition to indigenous species, exotics like *Oreochromis mossambicus*, *Cyprinus carpio*, *Ctenopharyngodon idella* and *Hypophthalmichthys molitrix* have been introduced into the reservoir. These species are showing up in the catches of Bhadra reservoir too, contributing to 20% of the total catch.

L. Habitat Improvement

The upper reaches of the reservoirs and top waters are protected, to enable carps to make spawning migrations. Planting leguminous plants during draw-down helps nitrogen fixation and provides food through periphyton and detritus (Sreenivasan,1989-

90).

II. DISCUSSION

Nevertheless, the failure of the authorities to observe proper closed season, to undertake judicious and regular stocking programme, to arrange for guarding the spawning grounds, to keep a check on the mesh size regulation and to control wanton killing of brooders adversely affected the fish stocks (Kuldip Kumar,1989-90). The physico-chemical parameters of the Bhadra reservoir water proved highly congenial for the breeding of fishes. Maintaining a high sustained yield is the backbone of the reservoir fisheries management. A conservation unit with a speed boat moves round the clock in the reservoir to protect the spawning grounds. In this way, the department has been able to control the illegal fishing in the reservoir to a considerable extent.

III. CONCLUSION

The production, conservation, exploitation and marketing is imperative for the development of reservoir fisheries. Fish seed stocking is a major input and fish catch is a output in the management of Bhadra reservoir fisheries. Freshwater fish diversity in Bhadra reservoir is in peril. Checking the entry of exotic species coupled with more awareness on the indigenous species would go a long way in preserving our rich reservoir fishes.

IV. RECOMMENDATIONS

- A. A small well-equipped field laboratory may be established at Bhadra reservoir for monitoring the hydro biological parameters and other ecological conditions.
- B. The data on fish production and socio-economic conditions of fishermen should also be maintained by the laboratory.
- C. It is necessary to develop biological criteria for assessing the quality of water. Hence, attention must be devoted to the critical analysis of the biological data. Field oriented biology is highly desirable at the moment for the real progress on biomonitoring studies.
- D. Awareness among the public about the importance of fishes and water bodies and their sustainable exploitation should be created.
- E. It is obvious that, to maintain the healthy conditions of reservoir the catchment area should be protected from the adverse effects of human activities.
- F. The reservoir has to be utilized for productive purposes by introducing some Indian major and Chinese exotic carps that can be harvested periodically.

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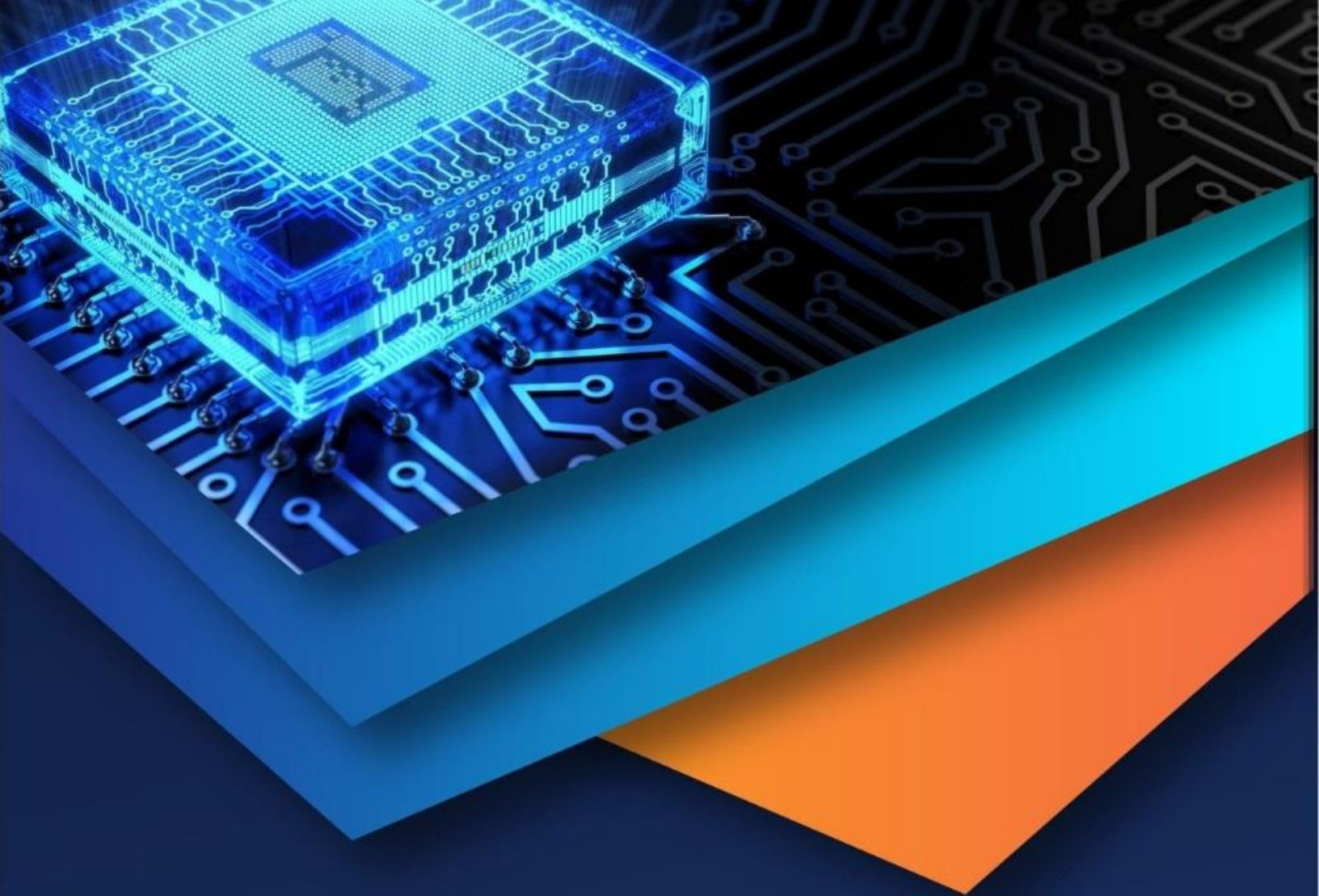
Figure 1: Coracle with oar used for fishing



Figure 2: Monofilament gillnet used for fishing of small fishes



Figure 3 :Sundried *Salmostoma untrahi*



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