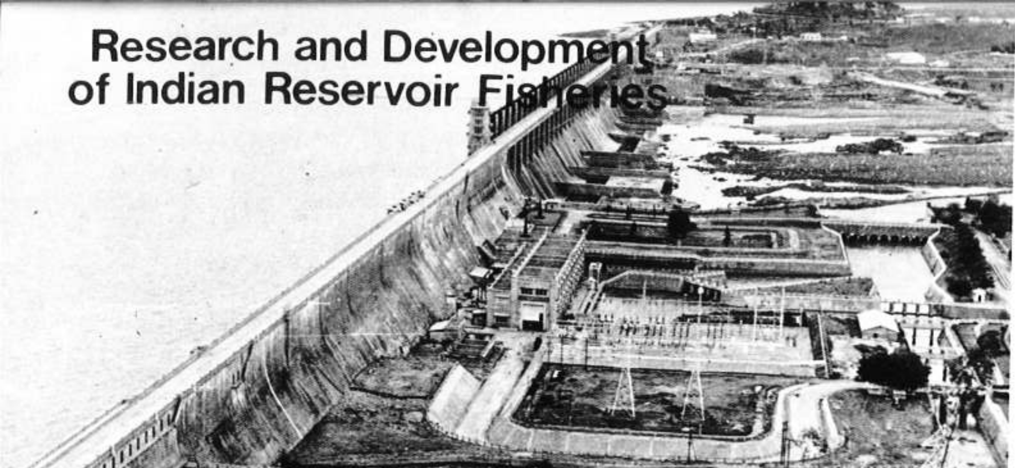
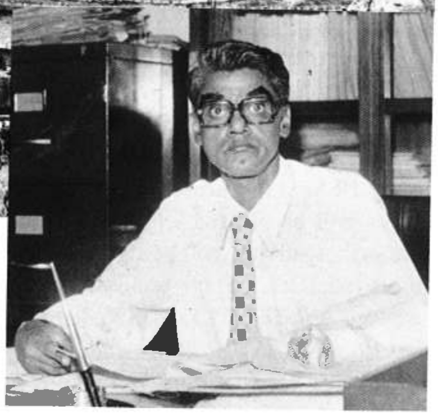
Research and Development of Indian Reservoir Fisheries





A.V. NATARAJAN*
Director (Officiating)
Central Inland Fisheries Research Institute
Barrackpore, West Bengal
India

Reservoir Resources and Status of Fishery Development

Harnessing the water resources of Indian rivers for irrigation and power generation has been given considerable importance in the successive five-year plans of the country. About 800 major and medium projects were taken up after India's independence in 1947, of which 445 have been completed and the rest are in various stages of completion. These, between themselves, cover an estimated surface water area of 3 million ha (which includes impoundments put up prior to indepedence) with an estimated storage capacity of 15 million hectare meters (Mham). According to available projections, the country will have about 6 million ha of surface water area in the next two decades with estimated storage capacity of 23 Mham.

The declared objectives of river valley development projects are to serve the irrigation needs of agriculture, power generation, flood control and water supply for domestic and industrial use. The dam design accordingly varies from reservoir to reservoir. The utilization of this resource for fisheries development, however, took a low priority and this is, in a way, reflected by poor fish yield which, by all accounts available, may not exceed a national average of 10 kg/ha. This low fish yield may be attributed to inadequate understanding of the ecosystem, fish behavior, and fish stocks management. The research and management gaps were sought to be bridged through an All India Coordinated Research Project on Ecology and Fisheries of Freshwater Reservoirs launched in 1971 with well defined objectives, which, *inter alia,* included studies on trophic structure and function of the ecosystem, material (nutrient) recycling, physico-chemical features, ecological production functions, fish behavior, recruitment and other population parameters, and development of management principles with a view to achieving optimum fish productivity and fish yield. These studies, as well as others carried out earlier by the Central Inland Fisheries Research Institute and other state-level research organizations on many man-made impoundments outside the fold of the Project, have resulted in a wealth of information on reservoir ecosystems. They have also led to the development of sound management principles for reservoir fisheries development, which have relevance not only to India, but to tropical impoundments in general in South and Southeast Asia.

Status of Research on Reservoir Ecosystems and Fishery Resources Management

Reservoirs are man-made ecosystems without a parallel in nature. The deep water release confers this ecological distinctiveness from its lake counterpart. The impoundment deviates from conventional evolutionary course and commences with a trophic 'burst' during the first 2 or 3 years, after the dam is 'sealed.' This is the most critical phase for management. The reservoir is amenable for stock manipulation or correction during these initial crucial years by selective stocking with greater emphasis on fishes of a short food chain and close to primary producers like Gangetic major carps.

Studies in a number of reservoirs in India have shown that the amount of oxidizable substances, autochthonous or allochthonous in origin, gives an indirect but dependable measure of productivity. Oxygen metabolism provides, therefore, a dependable index of reservoir productivity, as it also has a similar role in lake productivity.

Silt turbidity is found to lower productivity in many reservoirs in India on account of ineffective soil conservation measures. Poor light transmission interferes with primary production.

Going by the results of investigations in this country it is concluded that the reservoir ecosystem by and large favors facile breeding, recruitment and stock accretions in respect of weed fishes, carp minnows and the economically important catfishes. But Indian major carps need a more critical upstream bed with inundation facilities and scope for free movement upstream during breeding migrations. Physical obstructions, by way of another dam upstream in Nagarjunasagar, or bould-

---

*Summary of the author's report of the Barrackpore Summer Institute on Capture and Culture Fisheries of the Man-Made Lakes in India, August 1979. Details: Summer Institute . . . p. 24.

ers, rock outcrops and too shallow depth in Konar, steep banks with fewer inundation facilities in Rihand, have all placed severe limitations on successful breeding and recruitment of major carps. Limited upstream spawning habitats has led to dominance of one or other of the carps. The severity of competition between species of major carps for the limited spawning habitats is reflected by the frequent occurrence of catla × rohu hybrids in Rihand. The above factors point out that management must take into consideration the ecosystem constraints and plan species quality and stocking rate accordingly.

Reservoir management in India centers largely on the development of the carp fishery, especially of Gangetic major carps. Enlargement of the species spectrum would improve utilization of the diverse ecological niches of the ecosystem and augment fish yields.

Studies carried out under the All India Coordinated Research Project on Reservoir Fisheries have revealed the presence of three ecological populations of catla which can be distinguished morphologically by differences in pectoral fin lengths. The populations with long pectoral take dominantly to zooplankton, while those with medium pectoral to phytoplankton. This finding opens up possibilities of utilizing these populations for optimum utilization of plankton in reservoirs.

Labeo rohita among major carps does not show, with a few exceptions, the same degree of adaptability in many reservoirs in India. Catla × rohu hybrids appear to be an ideal replacement for *L. rohita* for reservoirs in general. The hybrid is detrito-phyto-planktophagic, grows faster than *L. rohita,* with a growth rate closer to *C. catla.* The proneness of the hybrid to take to Dinophyceae, besides detritus, has great application in reservoirs like Govindsagar (Himachal Pradesh) where *Ceratium* forms the dominant fraction in plankton. The hybrid thus holds enormous promise for reservoir fishery development, in general, in India. It was observed that reservoirs rich in Ca^{++} harbor a dense benthic population of molluscs. Such reservoirs especially need to be stocked with *Pangasius pangasius,* a fast growing catfish.

The performance of silver carp in Kulgare reservoir (Madhya Pradesh) and Getalsud reservoir (Bihar) is remarkable. The fish registered a growth of 4 to 5 kg in 1.5-2 yr. These fish, which accidentally found entry into Govindsagar following a breach in an adjoining fish farm, are fast reaching the dimension of a fishery.

The performance of *Tilapia mossambica = Sarotherodon mossambicus* in small reservoirs in peninsular India is equally remarkable. It improved the yield to the order of 187.7 kg/ha in Amarathy reservoir, a small impoundment in Tamil Nadu. Opinion in India is divided about introductions of exotic silver carp and tilapia in reservoirs, as the former is known to compete with catla while the latter with Indian major carps in general. These fishes, placed as they are, at the lower end of the trophic spectrum, may, it is feared, on entry into river systems from reservoirs, cause large scale ecological distortions and endanger the abundance and productivity of indigenous prime carps.

Stock monitoring, vis-a-vis fishing effort, is most important for raising fish yield in reservoirs where breeding and recruitment is normal in respect of important economic species. Reservoirs that show natural recruitment of commercial species offer few problems in management beyond selection of right net meshes and deployment of optimum fishing effort. This implies monitoring of stocks with respect to recruitment and productivity. Such an approach has led to remarkable increases in yield in Bhavanisagar (from 26 to 80 kg/ha/yr in 5 yr) and in Govindsagar (from 25 to 71 kg/ha/yr in 5 yr).

In the latter, there has been a 200% increase in yield for 120% increase in fishing effort. Govindsagar also provides a shining example where sustained stocking of common carp and increased effort have led to a remarkable yield of 160 tons of this fish in 1978 from 30 tons in 1973. The management measures have, thus, led to the happy position of an average catch of 2.6 t/day, easily the best in India for large reservoirs.

The insecticide-carrying run-off from agricultural lands, and effluents from chemical factories, rayon factories, paper mills, sugar mills, etc., have led to fish mortality in a number of reservoirs like Mettur (Tamil Nadu), Bhavanisagar, Hirakud (Orissa), Panchet (Bihar). Scientific appraisal of these lethal wastes and enforcement measures for their safe disposal are indicated. Upstream spawning habitats are biologically sensitive zones for Indian major carps, where discharge of pollutants needs to be strictly prohibited.

The ownership of public waters including reservoirs vests with state governments. The policy governing the exploitation of reservoir fishery resources ranges from free fishing with or without a licensing system to the levy of royalty or outright auctioning.

Ecosystem-Oriented Strategy for Reservoir Fisheries Development

Under scientific management the yield rate of reservoir fisheries in India can be easily augmented to 50 kg/ha/yr. This will generate a national income of 750 million rupees (equivalent to about US$100 million) and open up gainful employment for 50,000 fishermen with a net per capita annual income of 5,000 rupees (US$660). Fish handling, ice plants, packaging, transport and marketing would open up further employment opportunities for skilled, semi-skilled and unskilled workers and unemployed youths, and generate additional income.

Implied in the accomplishment of of above production targets is the development of infrastructure, which includes provision of approach roads to reservoirs, setting up of appropriate capacities of ice plants, improvement of fishing gear and craft suitable for deep-water, upgrading the skills of fishermen for deep-water fishing, and marketing cooperatives.