
Reservoir fisheries in the UPPER Paraná River basin, Brazil

Case study: The Itaipu Reservoir

Angelo Antonio Agostinho and Luiz Carlos Gomes

Principles: 1) Fisheries can be useful indicators of overall environmental change, 2) management of fisheries without monitoring, or sufficient knowledge of fish biology, will fail.

Experience: Management of a reservoir fishery created after construction of the world's largest hydropower installation.

Most important lessons learned: 1) Preservation of critical habitat, especially upstream floodplain, is essential to maintain diversity 2) participation of communities in management can help to maintain a diverse fishery.

Best practice: Consultation with fishing communities and preservation of three new park areas.

The Paraná River is the tenth longest river in the world and flows into the La Plata River in northern Argentina. Its drainage area includes most of south central South America. Surveys in the upper Paraná River remain incomplete, but so far indicate at least 250 species of fish.

The most conspicuous man-made impact on the river is the construction of dams, which have compartmentalized the river and regulated its flow. These changes affect migratory fish, the largest and most commercially important in the basin. These endangered migratory species use several compartments of the basin, for spawning (upper part of tributaries), nursery (lagoons and secondary floodplain channels) and feeding (tributaries, main channel and reservoirs). Preservation of the remaining floodplain is essential for diversity and production of these stocks.

There are three kinds of fishery in the Upper Paraná basin: artisanal (fishers who live in small towns along the river); subsistence (small farmers or day workers); and recreational (inhabitants of major cities).

Fisheries management measures in Brazil

In 1938 a new law stated that dams must allow for the preservation of fish fauna, either by the use of fish ladders or hatcheries. Until the 1950s, the main goal of Brazilian management

programs became to ensure fish migration around small power plants. More than a dozen fish ladders were constructed in Brazilian small rivers before the 1960s, but rarely evaluated. Recently, as a result of public pressure, fish ladders were constructed close to large dams. Studies conducted on these facilities have, so far, been restricted to determining the efficiency of the ladders at transporting fish, and have not considered their effectiveness at conserving fish stocks.

The inefficiency of fish ladders prompted hydroelectric companies to build hatcheries, and in 1971 it became mandatory that one hatchery be built in every sub-basin containing a dam. The management goal changed to increasing fishery yield through stocking, and to regulate fishing. The importance of biodiversity was not explicitly considered during this period.

Stocking of native and non-native species, especially in reservoirs, resulted in the widespread construction of hatcheries. Aquaculture has also been promoted by Brazilian environmental agencies and hydro companies as a management alternative that may reduce the pressure on natural fish stocks and generate jobs for artisanal fishers impoverished by stock depletion.

In addition to hatcheries and fish passages, licensing, equipment and net mesh size restrictions, length limits and seasonal restrictions are used to control the fisheries.

The low yield of artisanal fisheries in South-southeast Brazilian reservoirs and the virtual absence of large fish species in the high parts of the upper Paraná River basin indicate that management results have not been satisfactory. In general, this is because management actions lack a clear purpose and are based on poor technical and scientific information. Regulations for protecting juveniles, spawning grounds and spawning season have not been efficient and have been compromised by a lack of information on fish populations and movements, lack of financial resources, and limited enforcement of regulations.

Case study: Itaipu Reservoir

The filling of the Itaipu reservoir in the main channel of the Paraná River was completed in 1982. Although the Itaipu dam itself is the world's largest hydroelectric power plant, the reservoir itself is modest in size and retains some river-like qualities. The fish fauna of the Itaipu reservoir is the richest of the upper Paraná River and the reservoir has the largest number of exploited species. This great diversity seems to be a result of a large un-dammed stretch of river remaining upstream.

Before the construction of the reservoir, artisanal fisheries were based on a specialized and profitable catch of large migratory piscivores. The lake-like conditions in the reservoir have caused a depletion of large piscivores and an increased density of piranhas. This compels the fishers to use gillnets, increasing both the number of species exploited and the amount of by-catch but reducing overall profitability.

The fishery in the Itaipu Reservoir is now characterized by low profitability and over exploitation of stocks. Habitat changes (especially damming) are the most important factor effecting biodiversity. Among the species considered endangered or threatened in the upper Paraná River, several continue to be exploited, potentially worsening their situation. Approximately 40 non-target species are currently caught in the reservoir and about 30% of these are of no commercial value. However, stock assessment surveys indicate that there are no problems with the stocks of these species.

The Itaipu authorities decided on a management approach different to the prevailing Brazilian model, especially regarding stocking. Stocking with exotic species was not allowed in the Itaipu Reservoir, although efforts to stock the reservoir with the native fish *Piaractus mesopotamicus* failed. In 1983, collection of biological, limnological and social information began, as a way to better understand the fishery. Collection of data relating to landings and social-economic aspects began in 1986. Surveys have registered more than a hundred species, over 60 of which are exploited in the fishery. Six out of the ten principal species in the artisanal fishery use the upstream floodplain for spawning and nurturing.

The first management action taken in the Itaipu Reservoir was construction of a hatchery on the Paraguayan side. Initially, the main goal of the hatchery was to produce fry of native species for stocking.

Due to the ease of access to the fishing grounds, especially in the upper half of the reservoir, and increased unemployment during the last decade, the number of fishers in the Itaipu Reservoir has increased, resulting in a level of fishing effort that exceeds the optimal level.

Mesh size restrictions have been attempted and refined in discussion with fishers, fishery control agencies and scientists.

The reservoir fishery was not seasonally restricted until 1997, when the need to reduce effort and protect the exit of migratory fishes to spawning grounds was considered. Fisheries were forbidden between November 01 and January 31. Positive impacts on reservoir stocks cannot, as yet, be evaluated. This decision has, however, caused many social and economic problems.

Results of management actions

Fishery management actions in Brazil are not usually evaluated or monitored. Unfortunately, many of the management actions taken in the Itaipu Reservoir have not produced the desired results. For example, attempts to increase yield by decreasing minimum mesh size to exploit new species were problematic and taught fisheries management the need to consider the human dimensions when making management decisions. Today, in order to minimize possible weak points in management plans, all stakeholders are consulted before any actions are taken related to the management of the reservoir.

Management actions related to the maintenance of biodiversity have been, on the other hand, very successful. Fish life history studies have indicated that protection of critical habitats is the most important management consideration. So far, the first step toward this goal has been taken through the legal creation of three conservation areas: the Area of Environmental Protection of the Islands and Várzeas of the Paraná River; the Ilha Grande National Park; and the State Park of Ivinheima River. The effective conservation of the upper Paraná River floodplain and its biological diversity will depend on the prompt and effective management of these conservation areas.

Traditionally, management actions in the Paraná River basin, and in Brazil as a whole, have not been properly evaluated or followed by appropriate monitoring. This, in large part, explains why many unsuccessful management techniques (i.e. stocking and fish passages) were not abandoned, or corrected sooner. Important lessons learned from the Itaipu experience are:

- Fishery management in reservoirs needs to give equal weight to both fish production (social reasons) and the maintenance of biodiversity.
- The focus of management actions must be on the integrity of the critical areas upstream of the reservoir, including the flood regime.
- Fishery regulation needs to be defined with the participation of the fisher community.
- No management action should be carried out without monitoring.

Fisheries legislation and control requires realism and clarity of objective, efficient communication, and the involvement of fisher organizations. It must be made clear to the public and all groups involved in the fishery that the fishery is an indicator of environmental change and plays an important role in conservation of biodiversity.

