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GROUP REF. : 1
PREF. SUBJECT : 2
QUESTION N° : 2.2

Fish and hydropower plants: understanding differences for the adoption of more efficient protection measures

The Cemig Group possesses a generation park of more than 60 hydropower plants, most of which are distributed among several river basins of Minas Gerais, but with others outside of the State. Some of these plants are concessions of consortia or group companies and possess structural peculiarities and their own environmental and operational procedures. In addition, Brazil is a country with enormous biodiversity, with 3512 species of freshwater fish distributed in different hydrographic basins. In this way, the relationship between hydropower plants and fish, presents a wide variety of impacts, of greater or lesser degree, depending on: which hydrographic basin the plant is located; how is its civil structure; which operating procedures are more frequent; if it is in a reservoirs cascade; if there are tributaries arriving at the reservoir and downstream the dam; what is the extension of the lotic stretch to the next plant; among others.

In this way, conservation measures must consider the characteristics of the local biota (i.e., composition, abundance and life strategies), environmental features (i.e., climatic conditions and topography) and design of plant structures and hydropower operation. Considering fish mortality, each event, may be due to different causes, new interactions, or circumstantial situations.

To establish preventive measures against fish death, and to increase environmental safety at its hydropower plants, Cemig, Peixe Vivo Program in partnership with the Federal University of Minas Gerais (UFMG), developed the Risk Assessment of Fish Death (RAFID) methodology for the operation and maintenance of their hydropower plants. Due to the large number of hydropower plants (HPs), and their location in almost all of the state's watersheds, RAFID was created following five steps, which established criteria for prioritizing the inclusion of HPs in the study: (i) analysis of historical data on fish death at Cemig's HPs; (ii) classification of each HP according to its potential risk of fish death; (iii) implementation of a specific service instruction that foresees systematic planning of operational procedures that considers engineering, environmental, and biological aspects in order to prevent fish death; (iv) establishment of standardized fish monitoring by fish biologists prior to the execution of operational procedures risky to fish; and (v) creation of a strategic indicator, named 'affected biomass' (AB), for both periodic audits and monitoring of compliance performance of the measures applied to avoid fish death.

Thus, in this process, the particularities of each plant were evaluated to define controls that are more efficient during the execution of operating procedures that present a risk of fish death. There is a tendency for large hydropower plants to have greater impacts of fish death during operational procedures than small ones. Besides, considering that fish species are heterogeneous in relation to several parameters, such as preferential habitat, size, body shape, ages of individuals, sex, and nutritional status, the definition of method to use during tailrace monitoring considered the selectivity of the different fishing gear and was adapted to attend to risk assessment, yet respect logistic limitations and, especially, the safety of the team near dangerous areas. However, the methodology was standardized for each hydropower plant to allow comparisons to be made among data overtime. In addition, various sampling techniques were tested to determine those most suitable for fish sampling as close to the hydropower plants as possible, especially for the target (most affected) species.

A recent study that evaluated several fish death events in Brazil (Agostinho et al., 2021) found out that events were recorded in all Brazilian hydrographic basins, mainly in rivers and downstream of hydropower plants. The events were more frequent recorded in the Paraná and Amazon basins, due to the high degree of anthropization in the first basin explaining more fish death events and due to high fish species richness in the second basin that may cause more repercussion to media. Thus, conservation measures must take into account these differences that pose different challenges.

Considering other conservation actions, the environmental and hydropower plants particularities must also be considered for an adequate planning of the sample design of monitoring and management to ensure effectiveness in the detection of trends over time and effectiveness of the actions adopted. From construction to operation, hydropower plants impact fish in a variety of ways. By transforming the river's running water (lotic) into the standing water (lentic) of a reservoir, hydropower plants can eliminate habitats that are vital for fish, such as reproduction and nursery areas. Some species of fish prefer lotic over lentic environments, and thus avoid inhabiting reservoirs. Fish that live downstream from dams are also affected by hydropower plants. The quality and quantity of the outflow discharge of a hydropower plant can differ from that present in the river prior to a dam and have a negative effect on spawning and offspring survival of fishes. The outflow discharge could be colder or warmer, has less oxygen, or be less turbid than prior to the dam. Additionally, floods may be less intense and of longer duration than in the pre-dam period. These factors together may decrease the abundance of fish in the river downstream of hydropower plants. A conservation measure that is frequently imposed on companies in the electric sector is the installation of fish passages facilities (FPF), to minimize this impact. However, depending on the spatial distribution of critical habitats (reproduction sites and nursery areas) downstream and upstream an FPF may not be necessary (see Pompeu et al., 2012).

References

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