

## Assessment and development of vertical slot fishways for Iberian cyprinids

### Summary

Worldwide, the ubiquitous presence of anthropogenic barriers, such as dams and weirs in river systems cause negative impacts on fish populations by blocking migratory pathways. In the Iberian Peninsula, fish communities are mainly dominated by cyprinids with a large number of endemic species which are currently threatened, most probably due to the loss of river longitudinal connectivity. To mitigate these impacts, fishways are frequently the solution used when barriers removal is not feasible.

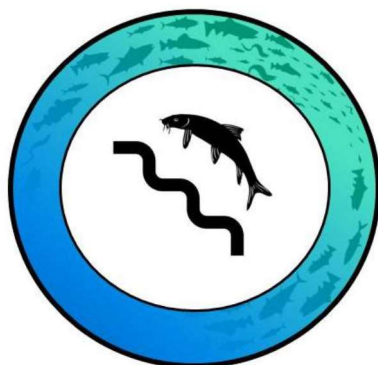
The vertical slot fishway (VSF) is considered one of the best technical fishway solutions to restore longitudinal connectivity when several different species need to overcome the barrier to fulfill their life-cycle requirements. However, until recent years, research has been mostly focused on anadromous salmonid species, which are strong swimmers and hold a high economical value, while cyprinids have received much less attention. Therefore, to bridge this knowledge gap, the present thesis focuses on the assessment and development of VSFs for Iberian cyprinids. To achieve this goal, the passage performance of different cyprinid species was assessed in a full-scale fishway model equipped with distinct VSF designs to evaluate its suitability for Iberian cyprinids. Specifically, the following objectives were outlined in this study: (i) assess the performance of a potamodromous cyprinid and the fatigue condition in a widespread VSF design in distinct seasons; (ii) assess the passage performance of two cyprinids with different ecological traits in two distinct VSF slot configurations; (iii) compare the hydrodynamics and hydraulic suitability of a VSF and a multi slot fishway (MSF) using a computational fluid dynamics model (CFD); (iv) compare the effectiveness of a VSF versus a MSF for a potamodromous cyprinid fish; (v) assess the passage performance of two different cyprinid species in a MSF in distinct seasons.

Results suggest that: (i) VSF is effective for potamodromous cyprinids and the motivation to negotiate the fishway extends beyond the reproductive season, although fish may exhibit a higher effort performing in early-autumn; (ii) changes in the slot configurations of VSFs allow for the reduction of the operational costs without compromising its effectiveness for cyprinids with different ecological traits; (iii) CFD is a valuable tool to analyze the hydrodynamic suitability of fishways, allowing modeling the hydraulic conditions with adequate accuracy, avoiding to the use of physical models; (iv) MSF operates with 26 to 50% less water compared to a standard VSF and displays an equivalent effectiveness for a potamodromous cyprinid; (v) the MSF is an effective fishway design for multi cyprinid species.

Overall, it was found that VSFs can be designed to reduce the operational discharge, while keeping the effectiveness for cyprinid species with different swimming capacities. Nonetheless, field testing should be conducted to reinforce and validate these findings. Finally, it is expected that these achievements may contribute to an increasing number of effective multi species fishways in the field.

### Keywords

Ecohydraulics, cyprinids, vertical slot fishway, passage performance, CFD, ADV, cost-effectiveness, flow velocity, turbulence.



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