Summary

Among the negative effects of hydropower on river ecosystems, there is river fragmentation hindering fish migration and threatening freshwater biodiversity worldwide. A widespread mitigation solution is the implementation of fishways, artificial structures supporting fish movement in anthropized rivers. While modern hydropower projects increasingly integrate fishways during the design phase, these structures often fail to accommodate small-bodied fish species, whose passage behaviors and ecological needs are not well understood. The effectiveness of fishways is ruled by a complex interplay of factors between fish and surrounding environment. Although hydrodynamics is a critical factor, it is not the sole determinant of passage success. Notably, light is known to influence various fish behaviors - from predator-prey relationship to migration timing and seasonal movements - but has received limited attention in contexts of fish passage.

This thesis addresses knowledge gaps regarding small-bodied fish species and the influence of light on their passage behavior. Using PIT-telemetry to monitor fish displacements, it investigates the effects of Artificial Light At Night (ALAN) in a flume experiment with a barrier and of an overhead cover in a Vertical Slot Fishway (VSF) on the passage performance of four understudied Italian small fish species. Light and flow conditions were constantly monitored throughout the experiments and, in the second study, the VSF's hydrodynamics was also simulated through a Computational Fluid Dynamics (CFD) model to evaluate the suitability of the flow field with respect to literature thresholds values of hydraulic reference parameters. Passage success was quantified for all species and their behavior in response to the set conditions described, highlighting the significant impact of hydrodynamics and light in fish passage. Additionally, the behavior of one of the species was observed in its natural habitat in response to environmental changes. The research also includes a preliminary investigation on methodological tools commonly used in fishway studies, including a PIT-tag retention study assessing the impact of PIT-tagging procedure on fish survival and behavior, and a literature review on the application of CFD for modeling fishway hydrodynamics.