biology and life sciences forum

MDPI

Abstract

Estimating Fish Passage over Velocity Barriers for Non-Uniform Flow Conditions: A Case Study in Flat-V Gauging Weirs †

Francisco Javier Sanz-Ronda [1,*,‡], Juan Francisco Fuentes-Pérez [1], Francisco Javier Bravo-Córdoba [2], Ana García-Vega [2], Jorge Ruiz-Legazpi [2] and Andrés Martínez de Azagra [1]

[1] Area of Hydraulics and Hydrology, Department of Agroforestry Engineering, University of Valladolid, Avenida de Madrid 44, 34004 Palencia, Spain; juanfrancisco.fuentes@uva.es (J.F.F.-P.); a.m.d.a.p@uva.es (A.M.d.A.)
[2] Centro Tecnológico Agrario y Agroalimentario—ITAGRA.CT, Avenida de Madrid 44, 34004 Palencia, Spain; fjbravo@itagra.com (F.J.B.-C.); a.g.-v.ega@itagra.com (A.G.-V.); jorge.ruiz.legazpi@iaf.uva.es (J.R.-L.)
* Correspondence: jsanz@uva.es; Tel.: +34-979108358
† Presented at the IX Iberian Congress of Ichthyology, Porto, Portugal, 20–23 June 2022.
‡ Presenting author (Oral communication).

Abstract: When the flow velocity over a river structure exceeds the swimming capacity of fish, it behaves as a velocity barrier. Depending on the hydrodynamic circumstances of the structure as well as the fish's swimming ability and motivation, the barrier can be permanent, partial, or intermittent. This is the case of flat-V gauging weirs, a common type of velocity barrier in Spanish rivers and in other European rivers. Flat-V weirs are broadly used as they provide precise information about river discharge for water resource management under different hydraulic scenarios, especially during low flow conditions. However, depending on their size, local river morphology, and the river flow scenario, they can produce excessive velocities and thus, reduce or hinder fish upstream movements. Due to their variable geometry, velocity barriers exhibit a non-uniform flow velocity field, which means that flow velocity varies along the barrier. Therefore, any predictive swimming model to assess the barrier effect on fish must consider the spatial variation to achieve a valuable forecast. This work aims to estimate fish passage over Flat-V weirs by linking their 3D hydraulic performance with the swimming capacity of fish. For this, a predictive model is developed using as target species the Iberian barbel (*Luciobarbus bocagei*), combining research on their swimming ability with 3D models of the structure. Results of the model show the river conditions and weir dimensions that permit the ascent of this species through the sloped wall of the weir. This information has direct implications for the design and assessment of velocity barriers as well as for the retrofitting of velocity barriers, making them compatible with the fish migration.

Keywords: gauging weirs; V-Crump; predictive models; potamodromous cyprinid; Iberian fish; swimming performance

Citation: Sanz-Ronda, F.J.; Fuentes-Pérez, J.F.; Bravo-Córdoba, F.J.; García-Vega, A.; Ruiz-Legazpi, J.; Martínez de Azagra, A. Estimating Fish Passage over Velocity Barriers for Non-Uniform Flow Conditions: A Case Study in Flat-V Gauging Weirs. *Biol. Life Sci. Forum* **2022**, *13*, 20. https://doi.org/10.3390/blsf2022013020

Academic Editor: Alberto Teodorico Correia

Published: 6 June 2022

Author Contributions: Conceptualization, F.J.S.-R.; methodology, F.J.S.-R.; software, J.F.F.-P. and F.J.B.-C.; validation, F.J.S.-R., F.J.B.-C., J.F.F.-P. and A.G.-V.; formal analysis, F.J.S.-R., F.J.B.-C. and J.F.F.-P.; investigation, F.J.S.-R., F.J.B.-C., J.F.F.-P. and A.G.-V.; data curation, F.J.B.-C. and J.F.F.-P.; writing—original draft preparation, F.J.S.-R., F.J.B.-C. and J.F.F.-P.; writing—review and editing, J.F.F.-P., F.J.S.-R., A.G.-V., F.J.B.-C., J.R.-L. and A.M.d.A.; visualization, J.F.F.-P.; supervision, F.J.S.-R.; project administration, F.J.S.-R.; funding acquisition, F.J.S.-R. All authors have read and agreed to the published version of the manuscript.

Funding: This research was financed by the Spanish Duero River Authority (Confederación Hidrográfica del Duero, CHD). J.F. Fuentes-Pérez contribution was funded by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (Smart fishways—grant agreement n° 101032024).

Institutional Review Board Statement: The study was conducted according to the European Union ethical guidelines (Directive 2010/63/UE) and Spanish Act RD 53/2013 and approved by the competent authorities (Regional Government on Natural Resources of Castilla y León and Water Management Authority of Duero river basin) and the Ethics Committee of University of Valladolid (protocol code 7904309; 3 August 2018).

Informed Consent Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.