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Supervisors: Prof. Dr.-Ing. Silke Wieprecht
Institute for Hydraulic Engineering, Universität Stuttgart
Dipl.-Ing. Andreas Eisner
Institute for Hydraulic Engineering, Universität Stuttgart

Effects of Embeddedness on Fish Habitats: An Approach for Implementation in the Habitat Simulation Model CASiMiR

Kristin Eastman

New Mexico, USA

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Universität Stuttgart

INTRODUCTION

The assessment of the ecological status of running waters is one of the major issues within an integrated watershed management plan and plays a key role in the implementation of the European Water Framework Directive. A commonly used method for the assessment of river ecology is habitat modeling. The most important input parameters for habitat simulation models are: flow velocity, water depth, and substrate condition. As it currently stands, embeddedness, or the degree to which coarser particles are lodged among finer particles, is *not* included as part of the substrate parameter. The degree of embeddedness is, however, very important for gravel-spawning fish species.

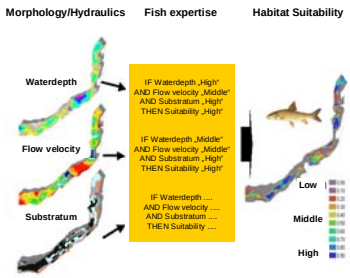
PURPOSE

The purpose of this study was to develop an impartial methodology for mapping substrate conditions, including embeddedness, for wadable gravel-bed rivers focusing particularly on spawning habitats for gravel-spawning fish species. This methodology would then be available for implementation in habitat simulation models such as CASiMiR.

BACKGROUND

Habitat Simulation Model CASiMiR

This model uses expert knowledge to implement fuzzy rules, which determine a habitat suitability index---for a particular species at a particular life stage---based on the combination of the three important parameters. A habitat suitability map is then produced. This is illustrated in the following figure:



Embeddedness Described

While it is generally accepted that the term embeddedness describes the degree to which fine sediment surrounds---or *embeds*---coarser sediment, there is no standard definition. Embeddedness levels may range from negligible to high as depicted below.

PROCEDURE

Methodologies for the Assessment of Substrate and Embeddedness

Two widely accepted methodologies for assessing substrate and three current methodologies for measuring embeddedness were evaluated. Additionally, a sampling methodology for particle-size distribution analyses focusing on embeddedness, that was developed within the scope of this work, was evaluated. Both the existing methodologies and the newly developed one were then compared for their relative advantages and disadvantages.

Investigations

According to the aforementioned methodologies, four initial field surveys to visually assess and measure substrate conditions, including embeddedness, were carried out. Of the four rivers initially surveyed, two---the rivers Danube and Eyach---were selected for the formal investigations carried out in this study.

Danube River

Eyach River

Field Surveys

RESULTS AND CONCLUSIONS

As a result of this study, the following scale mapping methodology was selected: within each habitat type the substrate is defined by the dominant and sub-dominant grain-size classes present. The embeddedness assessment is based on both the Swiss researcher Schälchli's approach, combining three parameters to define five classes of embeddedness levels, and the United States Fish and Wildlife Service - Upper Colorado River Measurement Method, which is a depth-to-embeddedness measure. This combination and classification was so formulated to provide fish biologists with meaningful information to establish fuzzy rules for habitat modeling and based on its field applicability, objectivity, and reliability. A field manual for data collection is provided within the scope of this work.

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