**Fish Escaping Routes – FiER: Modelling escaping routes for fish larvae under rapid flow changes during hydropeaking**

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The operation of high-head storage hydropower plants can generate hydropeaking, an unnatural and abrupt change in discharge that affects downstream river reaches. The resulting changes in habitat availability and location can cause stranding and mortality of aquatic biota, which are frequently reported along the shores of these reaches. Currently, flow discharge rate of change is used as a discriminant metric to predict habitat suitability during hydropeaking for fish at different life stages. In this approach, habitat spatial distribution as well as distance and connectivity between patches of suitable habitat are not accounted for. In this study, a novel modelling approach – the Fish Escaping Routes (FiER) – is presented as a tool to quantify the consequences of hydropeaking on habitat suitability. The FiER model integrates a spatial-temporal assessment of habitat shifts to existing hydrodynamic and habitat models. The FiER model was developed based on three altered (channelised) river reaches of Hasliaare river in Switzerland. The reaches show different bed morphological patterns, namely i) flatbed; ii) alternate gravel bars; and iii) artificial groynes. These altered reaches were further compared against a reference reach with a natural braiding morphology. The distributions of flow depths and velocities at different discharge rates were determined from simulations with a 2D hydrodynamic model from previous studies. Based on this data, FiER determines the routes connecting habitat patches based on analysis using a modified Dijkstra shortest path algorithm. The algorithm evaluates the shortest distance between suitable habitat patches, given a certain flow field and accounting for potential constraints, such as disconnectivity due to low water depth or the presence of obstructions that can impede access to a habitat. FiER quantified habitat shifts and the pathway distance connecting habitat patches. Results show that model predictions are sensitive to river morphology and hydropeaking discharge regime. For example, longer escaping routes were obtained for the natural braided river morphology, compare to altered morphologies, indicating that for the same hydropeaking regime, fish have to relocate longer distances in the same amount of time. These results show the potential of FiER to contribute to the understanding of habitat shifts following hydropeaking and to the identification of hotspots for fish stranding along river reaches affected by hydropeaking. By enabling comparisons of fish relocation rates at hydropeaking affected reaches, FiER can aid in the development of a relocation index and, therefore, a ranking of impacted areas. Thus, FiER could support the prioritization and design of hydropeaking mitigation actions.