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Redesigning reservoir compensation releases for ecological beenfit

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River regulation is commonplace in England and much of the UK. Regulation for the purposes of public water supply causes flows downstream of a reservoir to be attenuated and the flow regime of the channel to be altered. The impact of channel impoundment on a small, upland UK river, has been assessed and methods for mitigation of ecological impacts explored. The method utilised a unique macroinvertebrate data set for pre- and post-impoundment periods to quantify the impact of Derwent Reservoir and the steady, continuous compensation release into the River Derwent, Northumberland. Impacts on the hydrological regime were also investigated and links drawn between changes in flow regime and changes in macroinvertebrate richness and diversity as a result of impoundment. In response to the claim that the impoundment has caused a change in flow regime and had deleterious effects on fish and macroinvertebrates, a compensation redesign tool (CRAB: Compensation Release Assessment at the Broad scale) was employed to design new compensation release regimes from the reservoir which account for the seasonal flow requirements of a number of key fish species. The impact of impoundment on the current flow regime was modelled and the impacts of predicted new regimes were predicted, using a 1D hydrodynamic model (HEC-RAS), as part of a modelling process known as CRAM (Compensation Release Assessment at the Meso-scale). Depth and velocity were the foci of the analysis as they are the two habitat requirements most well documented for the fish species in question, they could be modelled using HEC-RAS and they can act as surrogates for other habitat parameters such as temperature and substrate. The suitability of the depth and velocity combinations predicted using the HEC-RAS model were assessed using fuzzy-rule based modelling, which allowed the habitat quality of a given parameter combination to be quantified.
Based on the results of the investigation it was concluded that there has been a change in flow regime and in ecological community structure since impoundment. The flow regime of the River Derwent has become less flashy with fewer extreme events, while macroinvertebrate richness and diversity have increased. The new flow regimes that were designed by CRAB, based on the depth and velocity requirements of brown trout, grayling and Atlantic salmon were predicted through CRAM to have minimal benefits for the fish populations of the River Derwent and it was concluded that no changes to flow regime should be made based solely on the assessment of habitat for fish. Impacts for the macroinvertebrate communities must also be considered as well as the impacts on other aspects of fish habitat including temperature, substrate and cover. A more detailed, micro-scale investigation into the effects of changing flow regime would be required to warrant a change in compensation release regime from Derwent Reservoir.