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# Boulder placement for aquatic habitats

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## ABSTRACT

The use of boulders simulates naturally occurring river habitats and has been acknowledged as a tool to reintroduce habitats into channelised river systems. This investigation aimed to provide guidance for increasing and quantifying suitable habitat heterogeneity for aquatic biodiversity. Boulders create hydraulic diversity by altering the velocity and flow depth of water in the immediate surroundings, of which the change in flow depth is small and localised around the boulder edge while changes in velocity can extend from several to hundreds of metres.

Boulders placed in a channel reduce the velocity upstream and downstream of the object and increase the velocity on the sides. The upstream and downstream regions showed much larger areas of disturbed flow when compared to the sides of the boulder. Low percentage variations from uniform flow also occupied the greatest disturbed region areas.

Experimental velocities were compared to the results of a two-dimensional hydrodynamic finite element software, namely Argus ONE and RiverFLO-2D. The software was found to neglect the turbulent wakes downstream of boulders and correction factors were developed to calibrate software output.

The fundamental variables which affect the size of any velocity distribution were identified; these consisted of hydraulic (Froude number) and geometric variables (channel width and boulder diameter). Using these variables empirical relationships were developed to determine the distance from the boulder where a certain velocity percentage variation from uniform velocity was experienced in the upstream, downstream and side directions respectively. The geometric variables were found to be the dominant variables and practical approximations were also developed to determine the velocity changes using only the channel geometry.

The investigation of one boulder revealed that a limiting boulder diameter exists above which blockage of the channel will occur. Following the identification of the blockage ratio limit it was found that below the limit the downstream velocity disturbance is the largest and above the limit the upstream velocity increases to such an extent that flow conditions are changed hundreds of metres upstream.

Two boulders placed on the same axis perpendicular to the direction of flow showed that the disturbed velocity area increased as they were moved closer to each other. A relationship to determine the optimum spacing between boulders was developed. The resultant velocity change caused by two boulders at the optimum spacing was found to be equivalent to one boulder with double the volume. Again, empirical relationships were developed to determine the distance from the boulder where a certain velocity percentage variation from uniform velocity was experienced.

Application of the velocity distribution equations was illustrated by design examples of boulder size selection.