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Towards ecologically acceptable flow regimes: in-stream flow requirements of Atlantic Salmon

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Natural flow variability and its impacts on aquatic ecology need to be understood in order to assess the impacts of anthropogenic influences on flow regimes and manage river ecosystems in a sustainable way. This study investigated flow variability in a salmon stream in Scotland in order to define ecologically meaningful periods when feeding patterns of juvenile Atlantic salmon (Salmo salar) might be disrupted by flows. Frequency, magnitude, duration and timing of hydrologically adverse conditions were identified using high temporal resolution (15 minutes) discharge data over a time period of ten hydrological years (1994/95-2003/04). The study shows how empirical discharge data can be used to derive hydraulic parameters to predict Critical Displacement Velocity (CDV) in streams. CDV is the velocity above fish can no longer hold station in the water column and thus may no longer be able to feed. This approach of applying temporally variable critical thresholds allows the variability of hydrological/hydraulic drivers for environmental flow assessment to be examined in relation to ecological response. For assessing the critical time period when foraging behaviour of juveniles salmon is likely to be constrained by hydraulic conditions, percentage time when CDV was exceeded by mean daily stream velocity was determined for 0+ and 1+ fish. Differences were mainly caused by the high inter-annual variability in hydrological conditions. Clear seasonal patterns of CDV were apparent, with values higher during summer; thus, fish are less likely to have their feeding opportunities constrained by high flows during this period. Total time when mean stream velocity exceeded CDV for 0+ fish ranges between 29.3 % (1997/98) and 44.7 % (2000/01). For 1 + fish mean stream velocity exceeded CDV between 14.5 % (1997/98) and 30.7

% (2000/01) of the time. Because of differences in size, hydraulic conditions might constrain 0+ fish at this time more than older (1+) individuals. Understanding how patterns of flow variability may influence feeding opportunities is important both to help to understand inter-annual variability in fish growth and to contribute to broader understanding of the influence of environmental conditions on stream productivity. This improved understanding may lead to better prediction of the effects of natural and anthropogenic induced environmental changes in flow variability on stream habitats and particular species. Moreover, such study can provide a basis for guiding the development of ecologically acceptable flow regimes (EAFs). In particular, they provide a scientific basis for developing such EAFs for salmon rivers with regulation from hydropower schemes.