Geophysical Research Abstracts, Vol. 8, 04967, 2006
SRef-ID: 1607-7962/gra/EGU06-A-04967

High Frequency Data Reveal State Dependant Hyporheic Processes: Implications for Hydroecological Studies

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There is increasing realisation that the hyporheic zone and groundwater-surface water interactions play an important role in the hydrological and ecological functioning of river systems. This increased recognition has now extended to fisheries research and studies of salmon population dynamics. Atlantic salmon deposit their eggs in open gravel structures (redds) to depths of between 100 and 300mm beneath the streambed. Survival between egg deposition (spawning) and hatch time, a period that can be in excess of 5 months is subsequently controlled by the delivery of oxygen and removal of metabolites from the redd environment. Recent studies have demonstrated the temporal and spatial variability of groundwater-surface water interactions, their importance in determining hyporheic water quality and consequently their influence on salmon embryo survival. However, to date it has not been possible to adequately characterise the temporal variation in hyporheic water quality or hyporheic processes at a sufficiently fine resolution to explain observed patterns of salmon embryo survival and performance due to technical (sensor) and logistical (access) limitations that prevent researchers obtaining high frequency data. In this paper we present one of the first examples of high resolution (15 minute) dissolved oxygen (DO) and hydraulic head data, to assess the temporal and spatial variability of groundwater-surface water (GW-SW) interactions in the hyporheic zone of an upland salmon spawning riffle in Scotland. Dissolved oxygen concentrations varied at fine scales, depending on the relative contributions of GW and SW. The effect of sample frequency on observed patterns of variability was assessed with reference to studies of the ecology of salmon spawn-

ing habitat. It was demonstrated that conventional (eg weekly, monthly etc) sampling approaches fail to capture the full range of temporal variability in hyporheic water quality and that there is a need to reassess the interpretations of many previous studies of the hyporheic zone and their ecological inferences.