Modelling the sensitivity of river reaches to water abstraction: RAPHSA- a hydroecology tool for environmental managers

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A key challenge for environmental managers is the determination of environmental flows which allow a maximum yield of water resources to be taken from surface and sub-surface sources, whilst ensuring sufficient water remains in the environment to support biota and habitats. It has long been known that sensitivity to changes in water levels resulting from river and groundwater abstractions varies between rivers. Whilst assessment at the catchment scale is ideal for determining broad pressures on water resources and ecosystems, assessment of the sensitivity of reaches to changes in flow has previously been done on a site-by-site basis, often with the application of detailed but time consuming techniques (e.g. PHABSIM). While this is appropriate for a limited number of sites, it is costly in terms of money and time resources and therefore not appropriate for application at a national level required by responsible licensing authorities. To address this need, the Environment Agency (England) is developing an operational tool to predict relationships between physical habitat and flow which may be applied by field staff to rapidly determine the sensitivity of physical habitat to flow alteration for use in water resource management planning.

An initial model of river sensitivity to abstraction (defined as the change in physical habitat related to changes in river discharge) was developed using site characteristics and data from 66 individual PHABSIM surveys throughout the UK (Booker & Acreman, 2008). By applying a multivariate multiple linear regression analysis to the data to define habitat availability-flow curves using resource intensity as predictor variables, the model (known as RAPHSA- Rapid Assessment of Physical Habitat Sensitivity to Abstraction) is able to take a risk-based approach to modeled certainty. Site specific information gathered using desk-based, or a variable amount of field work can be used to predict the shape of the habitat- flow curves, with the uncertainty of estimates reducing as more information is collected. Creation of generalized physical habitat- discharge relationships by the model allows environmental managers to select the desired level of confidence in the modeled results, based on environmental risk and the level of resource investment available. Hence, resources can be better directed according to the level of certainty required at each site.

This model is intended to provide managers with an alternative to the existing use of either expert opinion or resource intensive site- specific investigations in determining local environmental flows. Here, we outline the potential use of this tool by the Environment Agency in routine operational and investigation- specific scenarios using case studies to illustrate its use.