Geophysical Research Abstracts
Vol. 13, EGU2011-9409, 2011
EGU General Assembly 2011

Development of biological relevant hydrological indicators, and how to include them in model calibration

Lena S. Tøfte
SINTEF, Water Resources, Trondheim, Norway (lenat@sintef.no)

Calibration strategies and new objective functions in hydrological modeling have been developed to meet the needs of reliable simulations in biological life cycle models for Atlantic salmon in their river life stages in a new climate. By analyzing biological and hydrological data together, biologically relevant hydrological events, situations and periods are selected and further analyzed in order to choose relevant hydrological indicators. These indicators are then integrated in the calibration in order to simulate hydrological periods of particular biological interest in a better way.

Observed hydrological data are used to analyze hydrological events using hydrological indicators developed by Richter et al (1996), and tested in Norway by Tøfte et al (2004). The events might be pure hydrological data that are used as proxy for hydraulic conditions in the stream. This includes parameters that describe the extremes and the variability of flows, with a focus on floods and droughts (e.g. Richter et al., 1996, 1998; Clausen and Biggs, 2000, Olden and Poff, 2003). Low flow periods during summer and winter are already known to be biological relevant due to habitat conditions and mortality (Hvidsten 1993), as well as the size, timing and duration of large floods influences fish growth and smolt migration (Jensen and Johnson 1999). A high number of rivers in five different geographical regions in Norway are analyzed in order to find flow indicators from the hydrogram describing the hydrological regime, and statistically independent indicators are chosen. Time series of the hydrological indicators and available fish data from the different rivers are further analyzed to find causal relations between the hydrology and the fish.

Floods are generally taken good care of in calibration in the commonly used objective function Nash-Sutcliffe's efficiency criteria R2. In dry and low flow periods, errors of several magnitudes of the present flow will not necessarily affect the R2 in the calibration much, but might be of large importance in the biological models. This means that the new objective functions mainly deals with low flow calibration. The area distributed hydrological model is calibrated by using the Shuffled Complex Evolution method (Duan er al, 1993).

The calibration results shows that introducing new objective functions emphasizing the low flow, clearly improves the calibration process. The parameter set which gives the best simulation according to R2 and water balance, doesn't necessarily give the best low flow simulation. By introducing new low flow objective functions, the best compromise parameter set due to both R2 and low flow can be found.

References:

Clausen, B. and Biggs, B.J.F. (2000) Flow variables for ecological studies in temperate streams: grouping based on covariance, Journal of Hydrology 237:184-197.

Duan, Q., Gupta, V. K. og Sorooshian, S.: A Shuffled Complex Evolution Approach for Effective and Efficient Global optimization. Journal of Optim. Theory and its Applications, 76(3), p. 501-521., 1993.

Hvidsten, N.A. 1993. High winter discharge after regulation increases production of Atlantic salmon Salmo salar) smolts in the River Orkla, Norway, p 175-177. In R.J. Gibson & R. E. Cutting (ed.)

Jensen, A.J. & Johnsen, B.O. 1999. The functional relationship between peak spring floods and survival and growth of juvenile Atlantic salmon (Salmo salar) and brown trout (Salmo trutta). – Functional Ecology 13: 778-785.

Olden, J. D., and Poff, N.L. (2003) Redundancy and the choice of hydrologic indices for characterizing streamflow regimes, River Research and Applications 19: 101-121.