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From Gaged to Ungaged- Predicting Long-term Environmental Flows, and Ecosystems Responses.

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Abstract

Modern management needs, such as water supply, quality, and ecosystem protection place numerous demands on instream flows. Many regions are interested in developing numeric flow criteria as a way of ensuring maintenance of flow patterns that protect biological resources while meeting other demands. Developing flow criteria requires the capacity to generate reliable time series of the daily flow at any stream reach of interest and to relate flow patterns to biological indicators of stream health. Most stream reaches are not gaged, and it is impractical to develop detailed models for all reaches where flow alteration needs to be evaluated. We present a novel mechanistic approach to efficiently predict flows and flow alteration at all ungaged stream locations within a region of interest.

We used an “ensemble approach” whereby a series of regionally representative models were developed and calibrated. New sites of interest are assigned to one of the ensemble models based on similarity of catchment properties. For southern California, we selected 43 gaged sites representing the range of geomorphology, and watershed characteristics of streams in the region. For each gaged site, we developed a hydrologic model (HEC-HMS) to predict daily flows for a period representing dry, wet and normal precipitation. The final goal is to relate flow alterations to ecological responses, the models were calibrated to three separate performance metrics that reflect conditions important for instream biological communities- proportion of low flow days, flashiness and Nash Sutcliffe efficiency for overall model performance. We cross-validated the models using a “jack-knife” approach. Models were assigned to novel 840 bioassessment sites based on the results of a Random Forest model that identified catchment properties that most affected the runoff patterns. Daily flow data for existing and “reference conditions” was simulated for a 23-year period for current and reference (undeveloped) conditions. The resulting hydrologic changes will be analyzed relative to changes in instream biological community structure across a gradient of disturbance in order to develop recommended flow criteria. Ultimately, we will provide a tool that can be used to evaluate the ecological response of change in hydrology across any region of interest.