USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Estimation of Flow-Duration Curves at Ungaged Stream Reaches in New Hampshire and Vermont

Focus Categories: WQN, SW

Key Words: Flow duration; Instream flow; Water quality management; Water allocation; Streamflow depletion; Aquatic habitats; New Hampshire; Vermont

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Congressional District: NH 01

Critical Water Problem Addressed

The withdrawal of water for offstream use, the pumping of ground water from aquifers adjacent to streams, and the operation of dams for hydropower and flood control all affect the magnitude and frequency of flows downstream of the point of regulation or use, as do significant modifications of land use such as deforestation or urbanization. Magnitude and frequency of flow are two of the components of flow regime that together determine the integrity of aquatic ecosystems through their on impact water quality (e.g., temperature, dissolved oxygen, and nutrient concentrations), energy sources for stream biota (e.g., the flux of allochthanous energy sources), the physical parameters of aquatic habitat (e.g., velocity and depth), and biotic interactions (Figure 1).

Because of the relations illustrated in Figure 1, the problem of instream flows has emerged as one of the region's major water-resource management issues. It has been a central issue in most hydropower dam licensing and relicensing proceedings for the last two decades. New developments such as snow-making threaten to alter stream regimes in pristine upland watersheds. The State of New Hampshire has recognized the severity and widespread nature of these impacts and has been developing an instream-flow program to develop guidelines and rules for protecting instream flows threatened by withdrawal uses and flow regulation.

Expected Results and Benefits

Flow-duration curves (FDCs) are plots showing the magnitude and frequency of daily average streamflows. They can be readily constructed for stream reaches which have been gaged continuously for at least 10 yr. However, magnitude-frequency information is usually required for reaches that have not been gaged. The objective of the research proposed here is to develop improved techniques for estimating natural FDCs (FDCs unaffected by withdrawal or regulation) at ungaged stream reaches in New Hampshire and Vermont. Such curves would provide a baseline against which to evaluate the effects of proposed water-uses, flow-regulation, or land-use developments on streamflow magnitude and frequency.

Dingman (1978) developed a method for estimating natural period-of-record FDCs for New Hampshire streams that uses location, drainage area, and drainage-basin elevation as predictors. This method works well, but there are several reasons for believing that it can be improved: (1) recent research suggests that FDCs derived statistically from annual FDCs are more informative than traditional period-of-record FDCs (Vogel and Fennessey 1995); (2) recent mapping of surficial geology may provide an additional basis for predicting flow regimes, particularly for low flows (Dingman and Lawlor 1995); (3) new approaches to estimating FDCs have been developed [Quimpo et al. (1983) for the Philippines; Mimikou and Kaemaki (1985) for Greece; Fennessey and Vogel (1990) for Massachusetts]; (4) an additional 20 yr of flow records have been accumulated. Furthermore, including Vermont as well as New Hampshire streams will provide an expanded sample that should improve prediction precision, as it has in several previous flow-estimation investigations (e.g. Dingman and Lawlor 1995).

Scope and Objectives

1. Develop FDCs at natural-flow gaging stations based on statistical analysis of annual FDCs and evaluate the uncertainty in the FDCs as a function of record length, basin size, and other factors.
2. Develop a method for estimating the natural FDC at ungaged reaches in New Hampshire and Vermont using predictors that can be readily obtained from maps, DEMs, and/or GIS data bases.
3. Evaluate the uncertainty of the estimated FDCs and compare it to FDCs developed from gaging records.