Automated Procedures for Computing Whole-Stream Metabolism

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Abstract: Nutrients long have been identified as an important water-quality issue. The relation between nutrients and primary productivity in streams and rivers, unlike lakes and reservoirs, is poorly understood because of the variety of physical, chemical, and biological processes in these systems. Modeling and extrapolation of site results to broader areas is challenging scientifically but is an issue of particular interest to those charged with managing nutrients to improve stream quality.

The U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program is conducting field studies in a variety of settings across the Nation to investigate the effects of nutrient enrichment on stream ecology. Determination of the interrelations among nutrient conditions, algal communities, and stream metabolism is an important component of these studies. Two commonly used approaches for measuring stream metabolism are chamber studies and in situ measurement of dissolved-oxygen concentration over a diurnal period at one or two sites. The in situ method is being used in the NAWQA Program and generally is recognized as providing more representative measures of metabolism. Procedures for calculating metabolism from in situ data are fairly well known, although there is no standard set of procedures for all aspects of the calculations. Moreover, as a part of the NAWQA investigation, in situ measurements will be made at more than 200 sites, creating a need for standardized and automated procedures for calculating stream metabolism. As a result, the Stream Metabolism Program software was developed to automate and archive stream metabolism calculations.

Using the Stream Metabolism Program, in situ dissolved-oxygen, temperature, and photosynthetically active radiation time-series data are imported and matched to upstream and downstream readings in time. Dissolved-oxygen and temperature readings are adjusted for instrument fouling and drift based on pre- and post-deployment instrument calibrations. Dissolved-oxygen saturation concentration is calculated at each time step from dissolved-oxygen concentration, water temperature, and barometric-pressuredata. Additional site-specific information, such as depth, wetted area, stream slope, and discharge, is entered into specified fields in the interface. The program provides an option to compute the reaeration rate coefficient from a variety of empirical relations or to directly input a field-measured rate. The calculation period is selected automatically based on the photosynthetically active radiation data, although the user can adjust the calculation period. Gross primary productivity, maximum productivity rate, community respiration, and maximum respiration rates are calculated for a 24-hour period, as well as summary statistics for the time-series data. The resulting data values are in a standard spreadsheet format to facilitate combining and analyzing data from many sources. The program also simplifies determination of calculated variable sensitivity to changes or errors in input data. Results of the analyses will be useful in the development of regional nutrient criteria, the establishment of nutrient total maximum daily loads through water-

quality models, and the overall understanding of the effects of nutrients on ecological systems and water quality.