Abstract #104

Combining Observed Water-Quality Variables for Trend Analysis

C.E. Zipper[1] and G.I. Holtzman[2]

[1]Department of Crop and Soil Environmental Sciences and [2]Department of Statistics;
Virginia Polytechnic Institute and State University; Blacksburg, VA 24061

Biographical Sketches of Authors

Carl E. Zipper has been a member of the Virginia Tech faculty at since 1986. Current activities are in the areas of mine restoration, water quality, and watershed management. He serves as an Extension Specialist, researcher, and instructor within the Department of Crop and Soil Environmental Sciences. His instructional activities include a junior-level course, Fundamentals of Environmental Science, since 1989, and leadership of his department's Graduate Seminar since 2002. He serves as Director of the Powell River Project, a Virginia Tech program that conducts research and education to address coal mine restoration. He served as Associate Director of the Virginia Center for Coal and Energy Research, which conducts research and disseminates information on energy-related issues, from 1989 through 2003.

Golde Ivan Holtzman is an associate professor in Virginia Tech's Department of Statistics. He has been a member of the Virginia Tech faculty since 1980. He retains research interests in the area of biomathematics, his Ph.D. area, and provides statistical consulting to research in departments throughout the university with emphases on natural resource and medical applications. He has served as president of the Virginia Academy of Science, and as chair of the ASA Committee on Professional Ethics. Within the department he has served as graduate program director, acting department head, and director of the Statistical Consulting Center. Classes he has taught recently include Biometry, Nonparametric Methods, and Introductory Statistics.

Abstract

Water-quality trend analysis is being used increasingly as a scientific and public policy analysis tool. The seasonal Kendall technique is a common water-quality trend analysis procedure. When conducting trend analyses of water-quality data prepared for other purposes, it can be advantageous to aggregate observed variables so as to construct and analyze for trend a combined variable that has not been observed directly. Such analyses are hindered when one or more (but not all) of the observed variables being combined are censored (reported as being below an analytical detection limit); when the data series being combined include variations in censoring levels; and/or the variables being combined have been analyzed and recorded at differing levels of precision.

A method for combining observed values and analyzing the resultant aggregated value for trend using the seasonal Kendall technique, which accommodates these data characteristics, is described and demonstrated through application to Virginia water quality nitrogen data collected from 157 locations by Virginia Department of Environmental Quality over the 1978 – 95 time period. Variables of interest were nitrate-nitrite N (NN), total Kjeldahl N (TKN), and total N (TN) concentrations. TN was not measured directly, but was calculated by combining the NN and TKN forms. NN was calculated by combining measured values of nitrate-N and nitrite-N, where both components were available but NN was not measured directly. Seasonal and overall TN medians were calculated and allocated among NN and TKN components, and analyzed statistically for differences among ecoregions. NN, TKN, and TN trends were analyzed for each location using seasonal Kendall analysis, by ecoregion and for the state as a whole. The distribution of N among NN and TKN forms varies both seasonally and regionally. TN concentrations were found to be increasing in 6 of the state's 7 ecoregions over the study period, with the strongest increases occurring as TKN and in the state's eastern portions.