

Spatial Assessment and Optimization of the Synoptic Sampling Network in the Great Smoky Mountains National Park using Multivariate Techniques

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Abstract

A multivariate analysis of the synoptic water quality monitoring network in the Great Smoky Mountains National Park was performed to develop a scheme for scoring the information content of each sampling site based on cluster centroid distances. This information would be used to spatially optimize the network using a simulated annealing (SA) algorithm. Analysis methods included principal components analysis, cluster analysis, and discriminant analysis. The data analyzed for the 83-site network included historical water quality data (pH, ANC, conductivity, chloride, nitrate, sulfate, sodium, and potassium) and watershed characteristics (geology, morphology, and vegetation). The monitoring network was analyzed in each of the four categories (water quality, geology, morphology, and vegetation) rather than performing the analysis on the data as a whole so that a composite score could be calculated for each sampling site. The composite score was then used to apportion monetary benefits to each of the sampling sites in the SA algorithm where the objective function was to maximize the net benefits. One SA algorithm was written to optimize the network as a whole and a second SA algorithm was written to generate an optimized network based on a user-specified number of sampling sites in the final network. The first SA algorithm identified an optimized network consisting of 67 of the existing 83 sampling sites. The second SA algorithm bracketed the same 67 sites in terms of maximized net benefit. Additionally, the second SA algorithm also provided a tool for an ordered discontinuation of sampling sites should this ever become necessary.