Published in the Society of American Foresters Water Resources Working Group Newsletter: December 2008

Detecting Effects in Forest Watershed Studies: Emerging Methods

Dr Lisa M. Ganio, Oregon State University

Field-based natural resources research has progressed from localized field studies to broad geographically and temporally based studies such as operationally scaled forestry experiments and paired watershed studies. Large-scale studies are thought to reflect the interactions of system-wide processes more accurately (Monserud, 2002). But along with a broader view of the system, these broad-scale studies also incorporate more geographical and temporal variation making the detection of statistically significant differences more difficult. Emerging methods are able to partition background variation into more identifiable sources, thus reducing the background variation and increasing statistical power. Paired watershed studies use a variation of the before-after-control-impact (BACI) design to account for broad-scale spatial and temporal variation (Watson et al., 2001). Hierarchical statistical models, closely related to structural equation models, use covariates measured on different sized experimental units in a regression-like setting to explain variation at nested scales (Bryk and Raudenbush, 2002). For example, explanatory variables measured at the subbasin scale can be used to explain tributary variables, which in turn can be used to explain stream pool features that ultimately explain the presence or absence of fish. Bayesian belief networks, also known as graphical models are an extension of hierarchical models that loses the distinction between explanatory and response variables. Belief networks allow all variables to be interrelated and relationships among related variables are described by distributions that are conditioned on linked variables. Belief networks are beginning to be used to describe complex systems in natural resources applications and new statistical techniques for dealing with spatial and temporal autocorrelation are being developed (Haas, 1991; Lee, 2000; Borsuk et al., 2004; Gitelman and Herlihy, 2007).

References

Borsuk, M.E., Stow, C.A., and Reckhow, K.H. 2004. A Bayesian network of eutrophication models for synthesis, prediction, and uncertainty analysis. Ecological Modelling 173:219–239

Bryk, A.S. and Raudenbush S.W. 2002. Hierarchical Linear Models: Applications and Data Analysis Methods. 2nd Edition. Sage Publications Inc. 485 pp.

Gitelman, A.I. and Herlihy, A. 2007. Isomorphic chain graphs for modeling spatial dependence in ecological data. Environmental and Ecological Statistics 14:27–40.

Haas. T. 1991. A Bayesian Belief Network Advisory System for Aspen Regeneration. Forest Science 37(2):627.

Lee, D. 2000. Assessing land-use impacts on bull trout using Bayesian belief networks. In: Ferson S, and Burgman, M. (eds), Quantitative Methods for Conservation Biology. Springer, Berlin, Heildelbeg, New York. pp 127–147

Monserud, R.A. 2002 Large-scale management experiments in the moist maritime forests of the Pacific Northwest. Landscape and Urban Planning 59:159-180

Watson, F.G., Vertessy, R., McMahon, T., Rhodes, B., and Watson, I. 2001. Improved methods to assess water yield changes from paired-catchment studies: Application to the Maroondah catchments. Forest Ecology and Management 143(1-3):189-204.