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DEVELOPMENT OF STATEWIDE NUTRIENT LOADING COEFFICIENTS THROUGH GEOGRAPHIC INFORMATION SYSTEM AIDED ANALYSIS

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Problem and Research Objectives:

The waters of New Hampshire represent a valuable water resource contributing to the state's economic base through recreation, tourism, and real estate revenues. Some lakes and rivers serve as current or potential water supplies. For most residents (as indicated by boating and fishing registrations) our waters help to insure a high quality of life. New Hampshire currently leads all of the New England states in the rate of new development and redevelopment. The long-term consequences of the resulting pressure and demands on the state's precious water resources remain unknown. Of particular concern is the response of our waters to increasing non-point source pollutant loadings due to watershed development and land use activities. While watershed nutrient budget measurements and modeling have been attempted on a number of watersheds in the state, the recent cut in the Clean Lakes Program funding (Section 314) has limited the resources for current and future watershed diagnostic studies. No previous attempt has ever been made to review the existing data provided from previous studies and to investigate whether statewide nutrient loading coefficients can be developed using the powerful statistical and spatial analysis tools now available through GIS.

Current water quality models utilized for lake management and diagnostic purposes (when direct water nutrient budgets have not been measured) rely heavily on nutrient export coefficients derived primarily from out of state (Reckow et al) or limited, in terms of geographic area, New Hampshire data from Hubbard Brook. This research was initiated to finally make an effort to review and integrate together the existing data available from local, state, university, and federal watershed studies. Developing export coefficients from existing studies conducted over different areas of the state will allow for the estimation of watershed loadings with a greater confidence. Such coefficients would also allow for the efficient use of limited resources and provide baseline and benchmark data from which future studies can benefit.

Principal Findings and Significance:

1. The range of export coefficients for various landcover combinations (types) found throughout New Hampshire were summarized for the first time.
2. Initial analyses of the data compiled disclosed that the differences between export coefficients could be better explained by incorporating other descriptive landscape level data available. This ranged through a series of spatial scales which ran from:
    1. Landcover classification and "typing"
    2. Generalized subwatershed slope
    3. Location of potentially impacting land uses to channelized flow, tributaries or shorelines
3. Disturbed land, shoreline development and riparian buffer and wetland complex extent were other factors that had influence on the loadings.

4. The level of development intensity under forest cover oftentimes was a major factor that determined where in the range of loadings a subwatershed fell. GIS data available for analysis did not allow for accurate estimation of development extent.
5. Standardizing the export coefficients to a "normal" precipitation year decreased the variation within the data set analyzed and brought coefficients for similar land classes by different investigators using different techniques slightly closer. However, investigation into each separate study disclosed the importance of major storm events in the outcome of the loadings measured for each month when comparing multiyear studies. Thus, the utility of normalizing the data may be best for general management purposes or setting target levels while non-normalized data would be best for diagnostic lake response modeling for a given year and in management practice evaluations.
6. Prediction improvements should occur through the use of these newly summarized coefficients and ranges over the existing coefficients used currently and in previous studies which might have overestimated forested landcover export and underestimated the range of urban and agricultural land cover export in light of these results.

The results of this investigation will allow for the improvement of predictive models used for watershed planning and management. The benefits of this are wide ranging from assisting watershed stewardship education efforts throughout the state and region to providing existing watershed based programs like the EPA Basins Model Initiative, the statewide Unified Watershed Assessment Initiative (under the federal Clean Water Action Program) as well as the regional initiative (US EPA Region 1 and NE states) to develop total daily maximum loading criteria (TMDLs). The information collected digitized and summarized will further our modeling efforts of New Hampshire's pristine lakes and rivers (and similar systems throughout our region). It will also serve to illustrate the importance (and justification) of proposed and existing regulations, and best management practices, to decision-makers and the public.