

**TITLE:** Assessment of Forest Health and Forest Sensitivity to Nitrogen and Sulfur Deposition in New England

**LOCATION:** New England states: CT, MA, ME, NH, RI, VT

**DURATION:** 2 years      **FUNDING SOURCE:** Base

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**PROJECT OBJECTIVES:**

Aerial survey data collected as part of the FHM off-plot detection program has allowed identification of areas of chronic defoliation, dieback and mortality, suggesting that site-related factors are involved. The objective of this project would be to incorporate FHM plots into a regional assessment of forest sensitivity to atmospheric deposition. After identifying specific plots sensitive to continued sulfur and nitrogen deposition, and estimating deposition rates required to maintain forest health and productivity, this project will evaluate current ecological indicators (crown health, growth and mortality) at the plot level as a comparison between sensitivity and current health status. To broaden natural resource managers' use of the results, an additional goal is to include collaboration with stakeholders, in particular state forestry agencies, in the assessment process.

**JUSTIFICATION:**

Although sulfur emissions have decreased as a result of SO<sub>2</sub> control programs, projected emissions of acidifying sulfur and nitrogen compounds are expected to have continuing negative impacts on forests. These emissions present some of the most serious long-term threats to forest health and productivity in northeastern North America. Excess sulfur and nitrogen deposition may reduce the supply of nutrients available for plant growth. Nutrient depletion leads to increases in the susceptibility of forests to climate, pest and pathogen stress which results in reduced forest health, reduced timber yield, and eventual changes in forest species composition.

**DESCRIPTION:**

**a. Background:**

Evaluating forest sensitivity to acidic deposition requires information on: pollution loading to forest landscapes; the interaction of pollutants with forest canopies; plant nutrient requirements; the ability of soils to buffer acid inputs and replenish nutrients lost due to acidification; and indicators of forest health. The approach we are using to determine acceptable levels of deposition is an ecological assessment based on a steady-state, ecosystem mass balance for nutrient cations (calcium, magnesium, and potassium). We will calculate the *critical load* of sulfur + nitrogen (the level of deposition below which no harmful ecological effects occur for a forest ecosystem), and the *deposition index* (the difference between the critical load and current deposition), which is used to identify sensitive forest ecosystems. When exports of nutrient cations are greater than inputs to an ecosystem, a condition known as *cation depletion*, inadequate levels of nutrients may develop in both soils and plants and lead to a wide range of forest health problems, reduced growth rates, and

increased mortality.

During the pilot evaluation of these methods in Vermont, off-plot aerial survey data, collected as part of the FHM Detection program, were analyzed to determine if there were areas of chronic forest health problems. We identified nearly 1,500 polygons where forest health problems were present in 4 out of 5 years (1993-1997, pre-ice storm years). Individual forest health plots were then used to relate the pattern of chronic crown dieback to deposition index, indicating that for some areas, acid deposition-induced changes in site nutrition may be related to forest health problems. These initial FHM data, as well as data on tree growth in Québec and on canopy transparency across Canada, demonstrated that our assessment of forest sensitivity (deposition index) is consistent with region-wide tree health data.

The objective of this proposed project is an assessment of the deposition index against a broad array of ecological indicators of tree health (e.g., tree condition, growth, mortality, canopy transparency, and incidence of insect and disease) across all the New England states.

The proposed study would contribute to a larger forest sensitivity mapping project for New England and Eastern Canada (see Pilot Phase Report). The overall project is an initiative of the New England Governors/Eastern Canadian Premiers to develop a map of New England and Eastern Canadian forests sensitive to acid deposition, and includes involvement at the state level, as well as support in disseminating the information to a wide audience of stakeholders (federal, state, private land managers, environmental groups).

## **b. Methods:**

### **Critical Loads calculations**

Calculations of critical loads are based on a simple, nutrient cation mass balance model of inputs (atmospheric deposition, soil mineral weathering) and outputs (nutrient requirement/biomass extraction, leaching). These calculations are data demanding, and will involve using both existing on-plot data, as well as modeled data. Many of these methods have been developed during the Pilot Phase of this regional assessment. Data will be incorporated into our comprehensive regional database and would be publicly available following the study (location information will be reported as general location to keep actual plot locations private).

### **Ecological indicators**

Following the calculations of site-specific sensitivity to acid deposition, a variety of ecological indicators will be employed to assess the current health status at each site, and compare this with the sensitivity analysis. While this will not show cause and effect relationships between acid deposition and tree health, it will be valuable as an indication of how well the sensitivity analysis relates to these indicators, and can identify future research directions that could enhance our understanding of these relationships. Indicators to be used include: crown dieback, density and transparency; growth; and mortality. While several metrics have been developed during the Pilot Phase Project, we will also work with the FHM Indicator Leads to use additional metrics, for example, the complementary FHM study of Auclair and Heilman may allow us to evaluate climatic factors as additional stressors at these sites.

State Collaborators will facilitate data compilation, assist with data evaluation, and be an integral part of interpretation of results.

## **c. Products:**

Peer-reviewed journal article

FHM Report and fact sheet on assessment of forest sensitivity and ecological indicators

Poster for FHM meeting

Web site posting of results and data

