# Soil-Site Influences on Northern White-Cedar (*Thuja occidentalis*) Stem Quality and Growth

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*This project was designed to provide information about the characteristics of soils supporting northern white-cedar (NWC) in Maine. Results indicated that NWC growth and health are positively correlated with forest soil available calcium and magnesium, negatively correlated with acidity and aluminum, and that site drainage class and distinctions between mineral and organic soil systems were critical for NWC site evaluation.*

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http://www.nsrcforest.org

## PROJECT SUMMARY

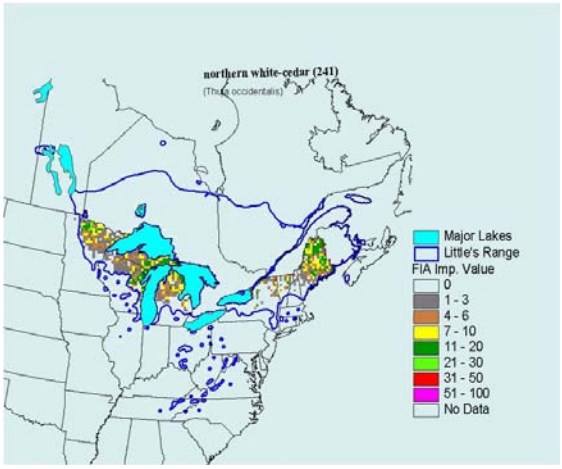
**Rationale:** The objectives of this research were to evaluate soil properties in a subset of sites that had been utilized in research on northern white-cedar that formed the basis of a doctoral thesis (Hofmeyer 2008). One of the findings of that research was that the commonly used "Brigg's Site Classes," largely based on soil drainage properties (Briggs 1994), were not predictive for northern white-cedar growth and health. This resulted in new hypotheses being developed about the potential importance of other soil properties in governing site quality for northern white-cedar.

**Methods:** The original Hofmeyer study included 60 northern white-cedar study sites from Maine. This project selected a subset of 10 of these sites across a range of soil drainage classes (i.e., Brigg's Site Classes) for further study of soil properties. The study was the basis for a Masters degree and was a pilot study to determine if correlations existed between soil chemical characteristics and northern white-cedar growth and health.

**Major Findings/Outcomes:** This project was limited in scope and did not provide definitive insights into soil controls on northern white-cedar. The results did show that northern white-cedar growth rates and health appeared to be positively correlated with lower acidity in the soil, and therefore the results supported the notion that calcium and magnesium have a positive effect on northern white-cedar. There were fewer differences among the soil drainage classes in mineral soils than were originally expected, but the limited data from this study did underscore the need to carefully consider the type of soil system, whether mineral or organic, in applying interpretations to soil drainage class information.

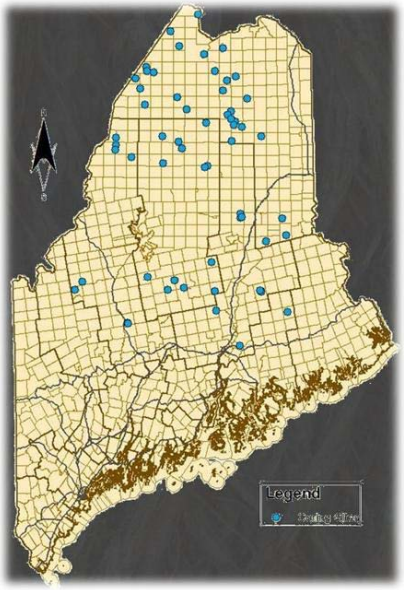
**Implications for the Northern Forest Region:** The most important implication from this research is that it is not likely that either simple drainage class information, or standard soil chemistry testing, will allow us to predict northern white-cedar regeneration success or growth.

## BACKGROUND AND JUSTIFICATION




There is a concern for the future supply of raw material from the northern white-cedar resource. Northern white-cedar distribution in the U.S. is confined to the northern tier of states including Maine (see map). The forest products industry in this region relies on the diversity of forest species present, as does the Canadian forest products industry immediately to the north. One of the concerns for future northern white-cedar supply is the lack of regeneration evident in forest stands on the modern landscape. Some of the primary concerns for the quality of the current resource are the factors controlling the rate of growth and the degree of decay, common in this species.

To better understand the northern white-cedar condition, an extensive study of sites in Maine was conducted by Hofmeyer (2008) that defined growth and health character, and related those factors to a widely used site evaluation index (i.e., Brigg's Site Classes). One of the findings from the initial study was that the Brigg's Site Classes did not seem to be well correlated to northern white-cedar growth and health. Therefore, a subset of the original sites (n=10) became the focus of a Master's thesis (Kell 2009) to analyze chemical properties of soils to see if there was evidence that soil chemical properties would be better predictors of cedar site quality.



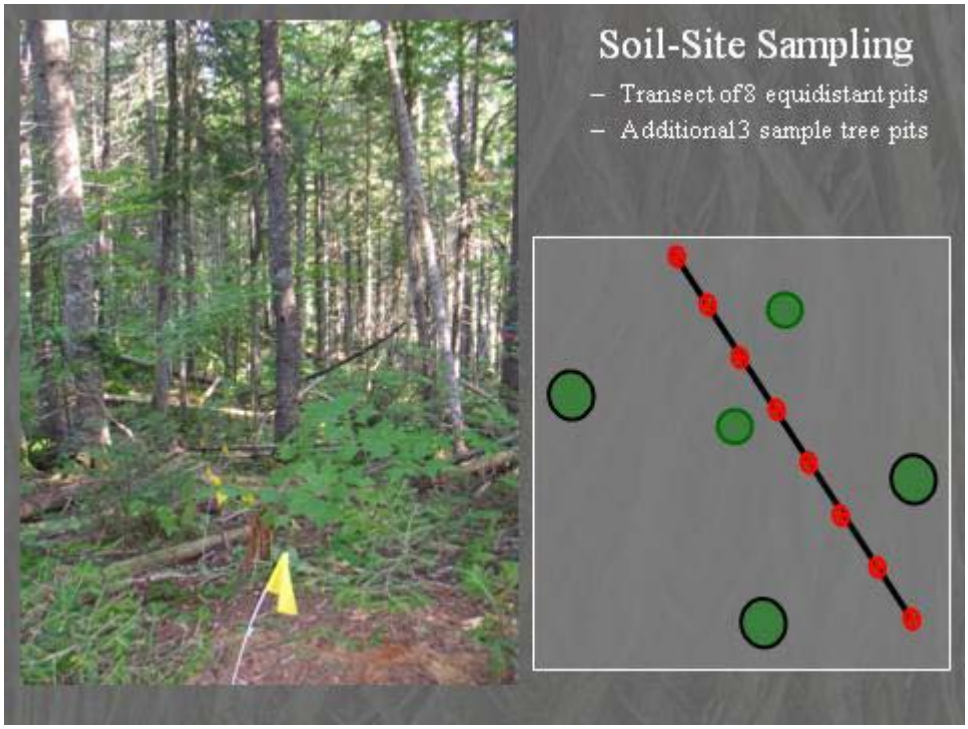

Hofmeyer (2008) Coring Sites

Hofmeyer, P.V. 2008. Ecology and silviculture of northern white-cedar (*Thuja occidentalis,* L) in Maine. Ph.D. Dissertation. University of Maine, Orono, ME.

Kell, Jon. 2009. Soil-site influences on northern white-cedar (*Thuja occidentalis*, L.) stem quality and growth. M.S. Thesis. University of Maine, Orono, ME.

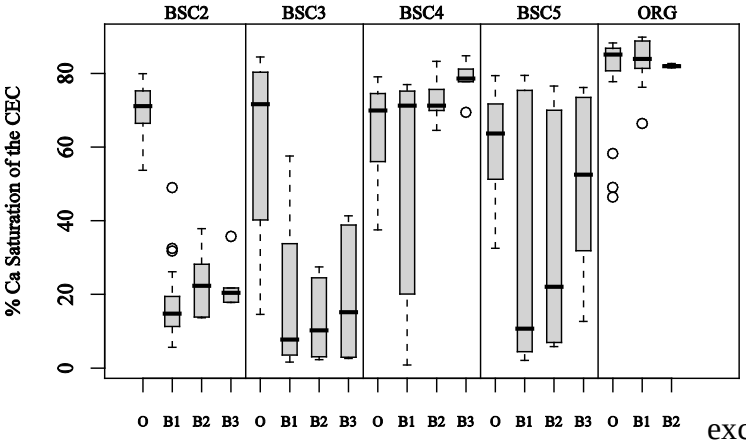
## METHODS

- 10 study sites, 2 per Brigg's Site Class
- At each site 8 soil pits were sampled along a transect
- At each site 3 additional soil pits were excavated co-located with 3 sample trees
- Soil sampling guided by both morphology and depth increments
- O horizon was quantitatively sampled
- Soil chemical analyses included exchangeable cations (Ca, Mg, K, Na), exchangeable acidity and Al, pH, total C and N, and calculations of %base saturation, cation exchange capacity and C:N ratio.



## RESULTS/PROJECT OUTCOMES

This project was limited in scope and did not provide definitive insights into soil controls on northern white-cedar. The results did show that northern white-cedar growth rates and health appeared to be positively correlated with lower acidity in the soil, and therefore the results supported the notion that calcium and magnesium have a positive effect on northern white-cedar. While this is noteworthy, it is consistent with our understanding of typical effects of acid-base balance in the soil on plant growth in many ecosystems. If northern white-cedar is notably more calcium demanding than competing species, additional research will be required to define that effect.




There were fewer differences among the soil drainage classes in mineral soils than were originally expected, but the limited data from this study did underscore the need to carefully consider the type of soil system, whether mineral or organic, in applying interpretations to soil drainage class information. The figure shows the distribution of results for the calcium saturation of the soil cation exchange capacity, with few notable differences among the mineral Brigg's Site Classes (i.e., BSC2 to BSC5) but a notable difference between those and the one organic soil site class (i.e., ORG).

This information is being shared with a group of U.S. and Canadian collaborators, as well as private industry representatives, who are interacting with the goals of advancing our understanding of the northern white-cedar resource. To that end, there is a site guide being developed by this group. In addition, the findings from this research have been presented at several meetings.

## IMPLICATIONS

The implications of this specific project are to eliminate strong simple correlations between standard forest soil chemical characteristics and northern white-cedar growth and health. There are trends in the data to suggest linkages between the acid-base character of forest soils and northern white-cedar site quality, and these insights should guide further research on this species. The findings further the understanding of this species, but further research is essential to define the factors limiting northern white-cedar regeneration, health, and growth.

## FUTURE DIRECTIONS

As discussed above, future research should focus on the ecophysiological interactions of northern white-cedar with site factors to understanding the underlying mechanisms governing the future of this species in the region. Simple relationships between site class, soil drainage, and chemical properties are not adequate to guide management and policy at this time.

## PRODUCTS

This project was just completed with the initial data and results noted in:

Kell, Jon. 2009. Soil-site influences on northern white-cedar (*Thuja occidentalis*, L.) stem quality and growth. M.S. Thesis. University of Maine, Orono, ME.

Future publications to include this research are anticipated.