

# EVALUATING WHITE SPRUCE DECLINE AND MORTALITY IN THE UPPER GREAT LAKES REGION

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## Abstract

Extensive decline and mortality of plantation origin white spruce (*Picea glauca* (Moench) Voss) is currently being observed across the upper Great Lakes region. White spruce stands are showing signs of stress with reduced primary productivity, needle loss, and a high number of occurrences of bark beetle and root rot infestations.

Thinning operations and other treatments have proven ineffective in restoring the health of the trees. To understand the factors contributing to the decline, field surveys of white spruce plantation and natural mixed stands were conducted during summers of 2007 and 2008. Tree-level and stand-level information, tree cores, and samples of insects and diseases were collected in 44 white spruce stands in Michigan, Minnesota and Wisconsin. Data is currently being analyzed through the development of a multi-criterion model. Risk maps will be created to describe the regional extent and severity of decline, characterize the nature of the decline, and identify the risk factors for spruce decline. The results of this study will be useful in determining patterns of decline throughout the region and the relative importance of factors associated with decline. Results will also help land managers assess stands for their vulnerability and susceptibility to spruce decline and develop management recommendations for stands currently affected by decline.

## STUDY QUESTIONS AND METHODS

### What is the extent of white spruce decline and mortality in the Upper Great Lakes Region?

- 44 white spruce plantations and naturally mixed spruce stands were surveyed using variable radius prism plots and FHM/FIA measurement techniques.
- A GIS multi-criterion model will be developed to allow for the combination and weighting of multiple factors to create a single index of evaluation.
- The creation of risk maps will provide a visual for the extent of the decline as well as a prediction to future spread.

### Is white spruce productivity related to climate trends?

- Increment cores from both white spruce and other tree species within each stand were collected for dendrological analysis using the computer program CDendro.
- Tree growth patterns and climatic trends will be compared to determine how weather and climate affect tree productivity.
- Stable isotope Carbon-13 tests on suspicious growth rings will demonstrate tree response to lower moisture levels.

### Is white spruce productivity and decline related to site condition?

- Land Type Phase (LTP) and Land Type Association (LTA) geo-databases are being used to compare the landform, soil type, and habitat type for each sample stand.
- Correlation between low productivity and LTP/LTA would suggest a stand was planted 'off-site.'

### Are insects and diseases contributing to white spruce decline in the study stands?

- Bark beetles including, *Ips pertubatus*, *Dendroctonus rufipennis*, and *Pityogenes spp.* and spruce budworm activity were documented for each stand.
- Needle samples were collected to test for needle cast pathogens such as, *Rhizosphaera kalkhoffii*, *Stigmata lautii*, and *Setomelanomma holmii* (SNEED).
- Trees within the variable radius plots were inspected for root rot fungi including, *Armillaria spp.*, *Inonotus tomentosus*, and *Phaeolus schweinitzii*.



Bark beetle galleries in dead white spruce.



*Inonotus tomentosus* fruiting body in white spruce stand

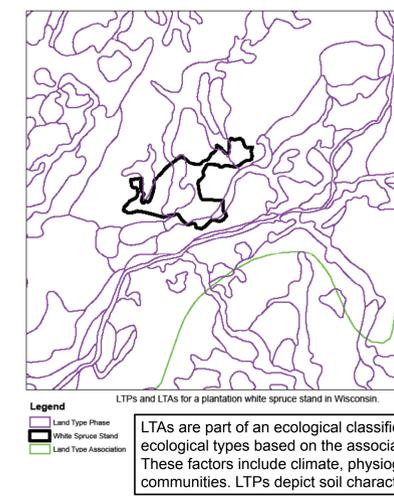
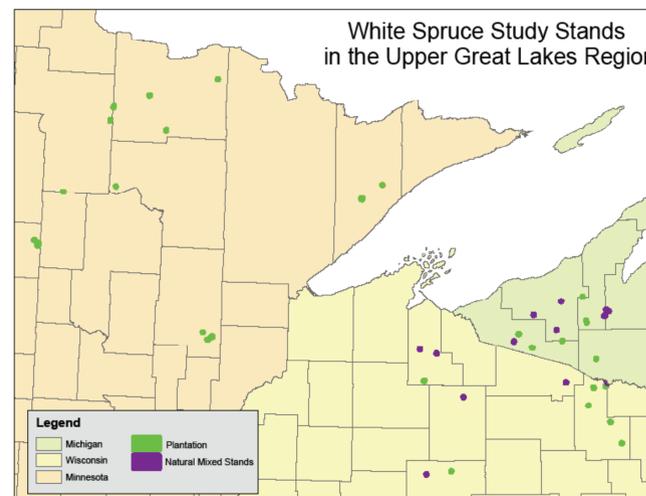


Close up of *Rhizosphaera kalkhoffii* fruiting bodies on a white spruce needle.

## RESULTS

### FACTORS OF SPRUCE DECLINE IN THE UPPER GREAT LAKES REGION

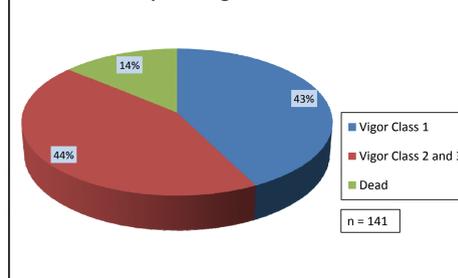
PREDISPOSING FACTORS	INCITING FACTORS	CONTRIBUTING FACTORS
<b>Climate:</b> this region is the southern edge of natural range for white spruce, where they naturally occur in mixed stands rather than pure stands.	<b>Drought:</b> area has experienced several severe droughts since the 1970s.	<b>Wood boring insects:</b> <i>Ips pertubatus</i> , <i>Dendroctonus rufipennis</i> , <i>Pityogenes spp.</i>
<b>Unknown seed source:</b> could be genetically tolerant of a cooler climate.	<b>Spruce Budworm:</b> defoliation from a persistent outbreak species.	<b>Root Rot Fungi:</b> <i>Armillaria spp.</i> , <i>Inonotus tomentosus</i> , <i>Phaeolus schweinitzii</i>
<b>Site conditions:</b> soil fertility and moisture, topography, planting space between trees, and planting methods.	<b>Foliage and twig pathogens:</b> <i>Rhizosphaera kalkhoffii</i> , <i>Stigmata lautii</i> , <i>Setomelanomma holmii</i> (SNEED)	



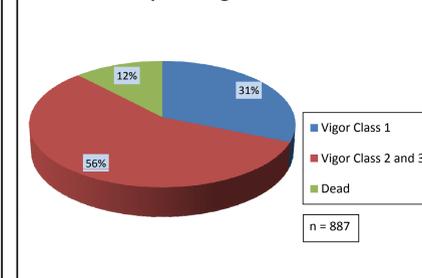
*Armillaria* white mycelial mat spreading up into the bole of a dead white spruce.

LTAs are part of an ecological classification system that classifies and maps ecological types based on the associations of environmental and biotic factors. These factors include climate, physiography, water, soils, air, hydrology, and natural communities. LTPs depict soil characteristics across the landscape.

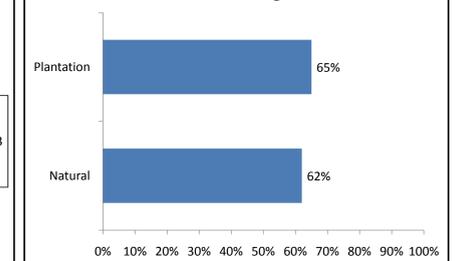
### White Spruce Vigor in Natural Stands



### White Spruce Vigor in Plantations



### Root Disease Occurrence Across the Upper Great Lakes Region



Vigor is a description of how productive a tree is. There are three classes of vigor. Class 1 has more than 1/3 live crown. Class 2 has less than 1/3 of the live crown or 40% of the normal foliage. Class 3 has less than 20% of the normal foliage. These two graphs show there is little difference between the vigor of the white spruce in plantations and natural stands.

These graphs indicate that there may not be a difference between the spruce health in plantations and naturally mixed stands.



White spruce growth rings will be measured and compared with climatic trends.

**CONTINUING WORK:** I am currently working on a complete analysis of all the data collected. This will include a statistical analysis of the prism plot data, tree growth analysis, site condition analysis, the results of the needle pathogen and Carbon-13 tests, and finally the spatial analysis.