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Managed White Spruce Stands Influenced by Spruce Budworm: How Does the Forest Vegetation Simulator Perform?

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Background

Planted white spruce stands comprise more than 175,000 acres of forest land across the U.S. Lake States. The eastern spruce budworm (SBW) is a native forest insect of particular concern in managing and conserving Minnesota's conifer species, including balsam fir and white spruce. Defoliation and mortality from SBW activity have been observed annually since 1954 in Minnesota, representing a continuous presence of nearly 60 years. Defoliation from SBW occurred in 38,000 acres of Minnesota's northeastern forests in 2013 but has impacted as much as 275,000 acres as recently in 2006 (Minnesota Department of Natural Resources 2013).

Understanding and projecting the impacts of forest health threats can aid natural resource managers in determining appropriate responses to forest insect and disease outbreaks. However, the performance of growth and yield models has not been evaluated for stands with low to moderate SBW defoliations that are common throughout many spruce-fir forest types in the U.S. Lake States.

The objectives of this project were to (1) assess the performance of the Forest Vegetation Simulator in SBW-infested white spruce plantations ten years following thinning and (2) refine model output by applying multipliers to diameter and height increment submodels depending on thinning regime and past SBW defoliation.

Data Analysis

Data for this study were collected from ten white spruce plantations established across northern Minnesota on lands owned and managed by the Minnesota DNR, the U.S. Forest Service, and UPM-Blandin (Table 1; Figure 1). This study was initiated to determine the role that thinning can play in minimizing the impact of SBW in lieu of more costly alternatives (D'Amato et al. 2011). Thinning was accomplished through a combination of row and low thinning, where approximately half the area of each site was thinned and the other half left unthinned. Thinning occurred at ages ranging from 25 to 46 years where, on average, 51% of stand basal area was removed. Tree measurements occurring on inventory plots included DBH, total tree height, and additional crown attributes. The degree of SBW damage was estimated at each site annually through ten years through an assessment of current-year defoliation.

Table 1. Site characteristics for thinned white spruce plantations in northern Minnesota.

Site name	Age at thinning	Date thinned	Site index (ft at 50 yrs)
Aitkin County	26	Fall 1999	77
Johnson Landing	38	Winter 2000	48
Larson Lake	32	Winter 2000	38
Power Line	46	Winter 2000	54
Plantation Road	30	Fall 1998	65
Smith Creek	29	Fall 1999	60
Sam Welch's	35	Summer 1999	65
Spruce Alley	26	Summer 2002	64
Taconite Trail	41	Winter 2001	41
Warba	25	Winter 2002	69

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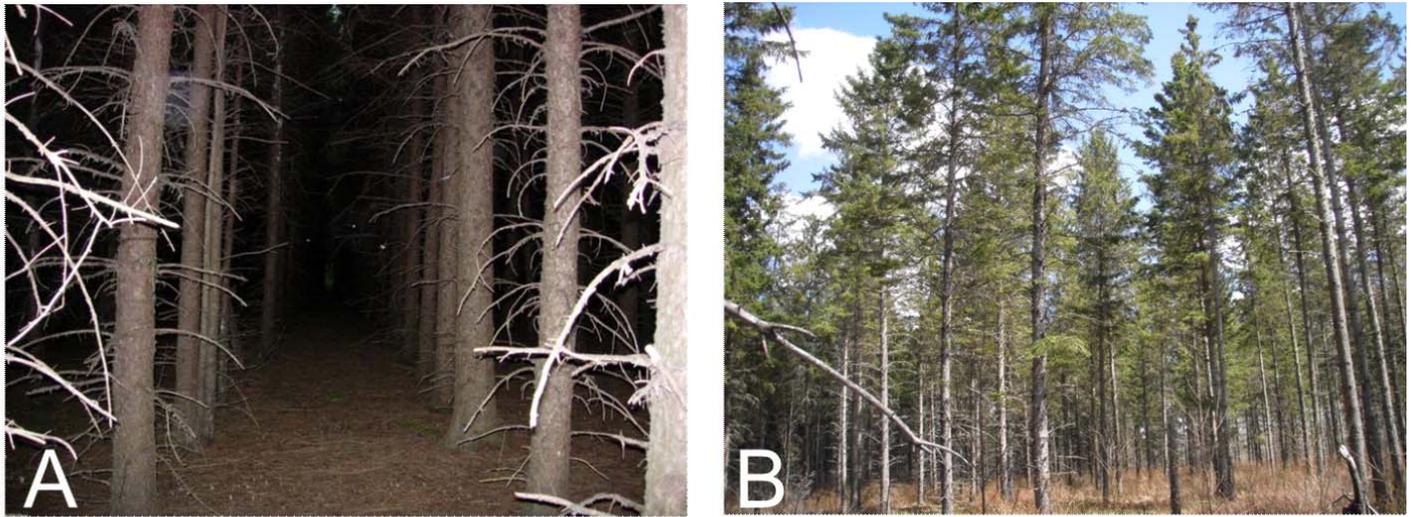


Figure 1. Unthinned (A) and thinned (B) white spruce plantations in Minnesota.

The Lake States variant of the Forest Vegetation Simulator (FVS-LS) was used to simulate the development of these stands using measurements collected immediately following thinning and then ten years later. We refined diameter (Δ DBH) and height increment (Δ HT) predictions provided by FVS-LS by incorporating thinning treatment and SBW defoliation in the form of multipliers.

Main Findings

- (1) FVS-LS estimated live crown ratios for white spruce averaged 46% in thinned stands ten years following thinning. Estimated crown ratios averaged 37% in unthinned stands, pushing them below the recommended 40% crown ratio for ensuring high tree and stand growth rates (D'Amato et al. 2011).
- (2) FVS-LS simulations overpredicted plot-level basal area growth after ten years by an average of 15 ft²/acre. This overprediction was particularly evident in stands with more SBW defoliation.
- (3) Diameter increment was underpredicted by FVS-LS depending on thinning regime and SBW defoliation.
- (4) Height increment was underpredicted by FVS-LS across most stand conditions, on average by approximately 1.4 ft over the ten years.
- (5) Diameter and height growth multipliers can be used to refine the performance of FVS-LS if management and SBW activity is incorporated. Figure 2 suggests appropriate multipliers for these refinements.

References and More Information

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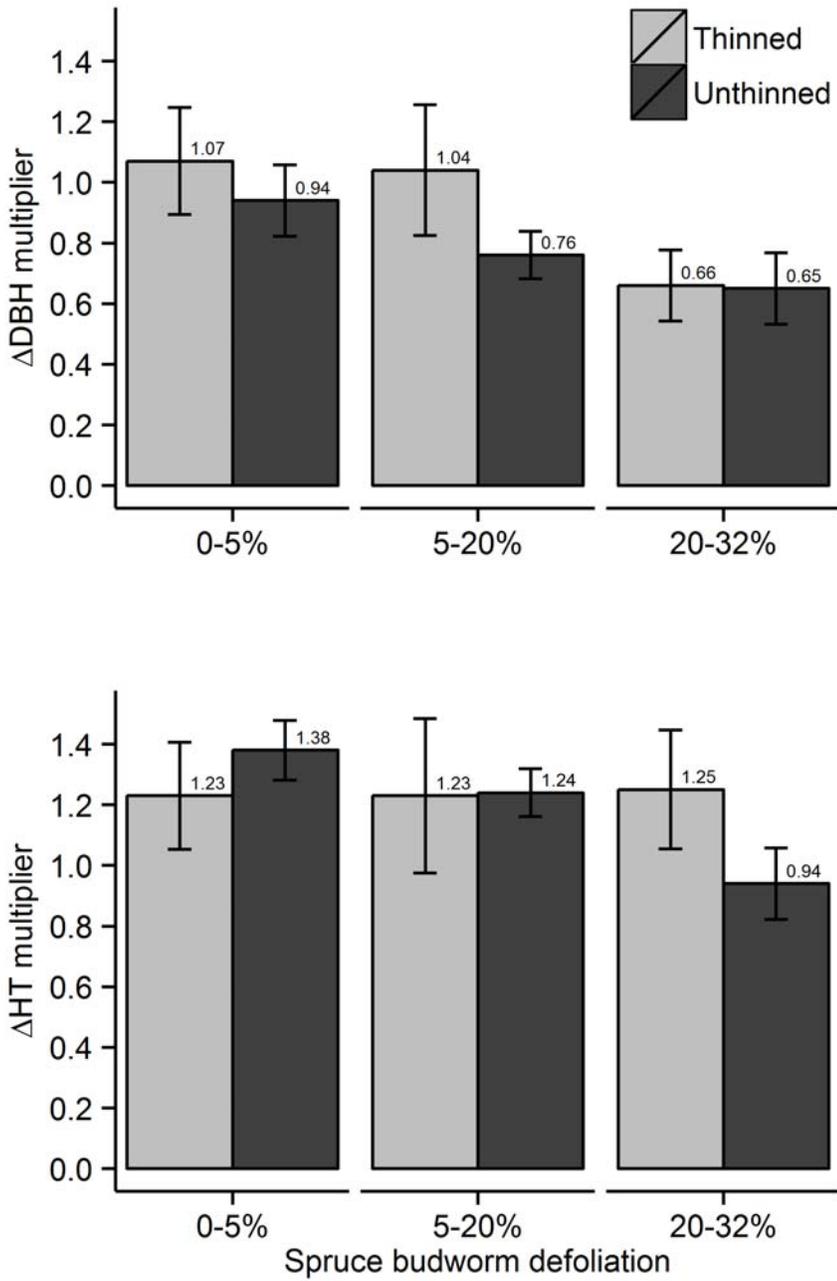


Figure 2. Growth multipliers for FVS-LS predictions based on data from white spruce plantations with spruce budworm activity. Multipliers with values greater than one indicate FVS-LS is predicting slower rates of growth than observed in the data.