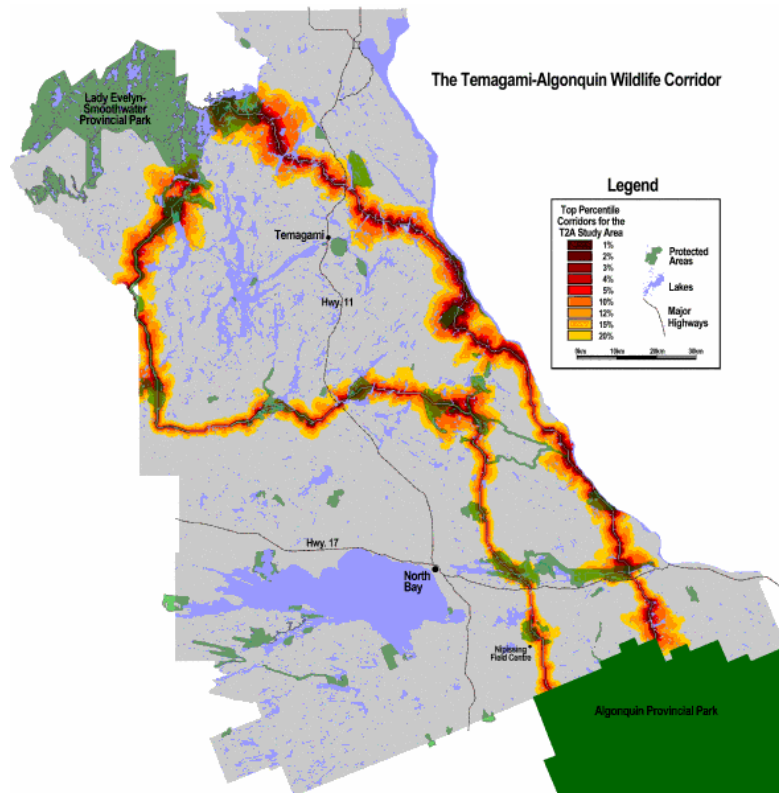


Predicting Regeneration in White Pine Forests Using Forest Resource Inventory Maps and Topographic Maps

by P. A. Quinby, M. Henry & T. Lee

Introduction

Because there are no wildland parks in North America that are large enough to sustain a full range of native species and communities (Noss et al. 1997), we must protect more than isolated, large wild parks. Linking wild areas to each other by establishing functional ecological corridors will ensure a healthy, naturally functioning landscape (Dobson et al. 1999, Soule and Terborgh 1999). In order to identify ecological linkages between two large parks in central Ontario, Lady Evelyn-Smoothwater Provincial Park (upper left on map) and Algonquin Provincial Park (lower right on map), Ancient Forest Exploration & Research recently completed a regional ecological analysis of the Temagami and North Bay Districts. A primary result of this analysis was a map (see below), which connects some of the highest quality wildlife habitat between these two parks (Quinby and Lee 2002) – we call this ecological linkage the *Temagami-Algonquin Wildlife Corridor*.



Although this map shows us the general location of the Corridor, more detailed, site-specific data are required to facilitate land-use decisions necessary to establish the exact location of Corridor boundaries. Field studies must be used to obtain these site-based data. For the field study reported here, the objective was to identify and quantify the relationships between white pine regeneration at the stand level and the variables that are used to characterize forest stands on Forest Resource Inventory (FRI) maps, which are produced from the interpretation of aerial photos. Not only do FRI maps provide information describing the relative abundance of the tree species that dominate in the canopy of a forest stand, but for those canopy trees, FRI maps also provide information describing canopy density, stand age, stand size, tree height, and site productivity. Large-scale topographic maps can also be used to assess site conditions including slope aspect (e.g., south-facing, north-facing,

etc.) and slope position (e.g., hilltops, lower slopes, etc.). Relationships between and among white pine regeneration, FRI variables, and topographic map variables can then be used to predict the location of old-growth white pine stands in the T2A Corridor area that are regenerating most productively and thus have the greatest probability of self-replacement or maintaining themselves as old-growth pine stands over the long-term (Quinby 1991).

Methods

The stands selected for this study were pristine (no historical logging), were relatively accessible, and represented a range of white pine composition. Roughly half of the stands were selected in the Anima Nipissing Lake area of Temagami and the other half were located in the Cassels-Rabbit Lake area of Temagami. Tree species composition was determined from FRI maps. Sampled stands were distributed approximately equally for each overstory white pine percentage category including 10%, 20%, 30%, 40%, 50%, 60%, and 70%. Within each selected FRI stand, sampling was carried out along a transect of maximum elevation change within each stand, including entire hill systems from lower slopes to hilltops when possible, and oriented in a north-south direction when possible.

At 50-meter intervals along each transect, a 20 x 20 m plot was established. Within each plot, trees (>10 cm dbh) were tallied as either white pine or as "other species" as a single group and by diameter class as either small (10-30 cm), medium (30-60 cm), or large (>60 cm). To sample the trees less than 10 cm dbh, ten 1 x 1 m quadrats were placed contiguously along each side of the plot center line for the first 10 metres of each plot for a total of 20 quadrats per plot. In each quadrat, seedlings were distinguished as white pine or as other species and were categorized into one of four height classes including 0-4.9 cm, 5-19.9 cm, 20-49.9 cm, and >50 cm height to <10 cm dbh. A total of 21 stands and 162 plots were sampled. For each stand the following data were recorded from FRI maps: % composition of all tree species, stand age, mean tree height, canopy density, productivity (described as site class on the maps), and stand area. Topographic maps (1:20,000 scale) and field observations were used to determine slope aspect and slope position. Each of the eight map variables was divided into two groups for comparison based on the nature of the variable and to minimize an unbalanced sample design. The t-test (using Minitab) was used to compare means of the two groups for each variable and the .10 probability level was used for determining significance.

Results and Discussion

Variables mapped at the stand and landscape levels that are associated with the success of white pine regeneration include stand size, stand age, productivity, slope aspect, slope position, canopy density, and amount of overstory white pine (Table 1). When stratified into two groups (above and below 21 m), tree height did not influence any of the regeneration categories. White pine regeneration in the 0-4.9 cm height class was 292% greater in stands less than 50 ha (1239 stems/ha) relative to stands greater than 50 ha (425 stems/ha). Normally stand size is important as a consequence of fragmentation, however, because all stands were located in relatively pristine landscapes, this finding is likely the result of sampling intensity being greater and thus more representative in small stands versus larger stands. For this reason, stand size is not included as a map-based predictor of white pine regeneration.

For stands older than 120 yrs., white pine regeneration in the 20-49.9 cm category was 262% greater relative to stands younger than 120 yrs. (590 stems/ha vs. 225 stems/ha), and for all height categories combined, regeneration was 60% greater in stands older than 120 yrs. (2949 stems/ha vs. 1845 stems/ha). Stands with medium productivity (619 stems/ha) had 319% greater regeneration than stands with low productivity (194 stems/ha) in the 20-49.9 cm height category, and for all regeneration categories combined, regeneration was 61% higher in the medium productivity stands (2977 stems/ha vs. 1847 stems/ha). Regeneration was 97% and 234% higher on southwest-facing aspects compared with northeast-facing aspects for both the 20-49.9 cm (551 stems/ha vs. 279 stems/ha) and 50 cm-10 cm dbh (468 stems/ha vs. 140 stems/ha) categories respectively. In the 5-19.9 cm height category, hilltops had 180% more regeneration than mid-slopes (1121 stems/ha vs. 400 stems/ha) and upper-slopes had 72% more regeneration than mid-slopes (688 stems/ha vs. 400 stems/ha). Stands with a canopy density less than 75% (505 stems/ha) had 202% greater regeneration than stands with greater than 75% canopy density (250 stems/ha). And finally, for all regeneration categories except 0-4.9 cm, regeneration ranged from 111% (950 stems/ha vs. 450 stems/ha) to 325% (510 stems/ha vs. 120 stems/ha) higher in stands with more than 35% white pine in the overstory.

Table 1. Relationships between White Pine Regeneration and a Variety of Landscape Features Assessed from Maps (n=number of plots unless otherwise stated)

Map Features	Height Categories of White Pine Regeneration (no./ha)				
	0-4.9 cm	5-19.9 cm	20-49.9 cm	50 cm-10 dbh	all
Stand Size (ha) <50 (n=109) >50 (n=53)	1239 425 (p=.001)	ns	ns	ns	ns
Stand Age (yrs) <120 (n=71) >120 (n=89)	ns	ns	225 590 (p=.011)	ns	1845 2949 (p=.019)
Productivity medium (n=88) low (n=72)	ns	ns	619 194 (p=.003)	ns	2977 1847 (p=.018)
Slope Aspect northeast (n=68) southwest (n=79)	ns	ns	279 551 (p=.068)	140 468 (p=.009)	ns
Slope Position hilltop (n=29) mid-slope (n=20) upper slope (n=69) mid-slope (n=20)	ns ns	1121 400 (p=.080) 688 400 (p=.064)	ns ns	ns ns	ns ns
Canopy Density (%) <75 (n=110) >75 (n=52)	ns	ns	505 250 (p=.041)	ns	ns
Tree Height (m) <21 (n=83) >21 (n=79)	ns	ns	ns	ns	ns
% White Pine <35 (n=11 stands) >35 (n=10 stands)	ns	450 950 (p=.027)	275 665 (p=.097)	120 510 (p=.073)	1245 3490 (p=.010)

Combining all significant results, stands with the greatest probability of having the highest regeneration densities are greater than 120 yrs. old, on site class two (more productive sites), with less than 75% canopy density, with more than 35% overstory white pine, located on hilltops and upper slopes facing south and west. These relationships between map variables and white pine regeneration must be field tested for accuracy and adjusted where necessary. Following that, digital FRI and topographic data in combination with GIS software can be used to predict the location of those white pine stands in the T2A region with the highest probability of self-replacement. These stands should be protected and managed for their long-term biodiversity values.

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