Executive Summary

FIA-FSP project Y082254

Project title: Effect of site type on competitive interactions among trees in complex-structured mixed species sub-boreal forests

1. Project Purpose, Management Implications, Scope, and Regional Applicability

Project Y082254 began in April 2006 (Y071254) and will be completed in April 2008. The purpose of this project was to investigate how interspecific competitive interactions of different tree species vary across site types in complex stands. The methodology applied remote sensing technology that created large stem-mapped areas and statistical techniques that allow for spatially-explicit analysis of individual-tree competitive interactions among tree species across resource gradients. These statistical techniques allow tight linkage between field data and parameterization of forest dynamics models.

Initially, through publication of our research, the primary beneficiary from this project will be the research community. The growth functions we develop will be incorporated into decision support tools and communicated through workshops to forest professionals with an interest in the northern interior. This will help managers make better decisions in the management of complex structured stands. This project will provide (1) a new remote sensing technology that allows economic creation of large stem-mapped areas across natural resource gradients, (2) insight into how individual-tree competitive interactions among trees species change across resource gradients, and (3) robust growth functions that can be incorporated into individual tree models.

Completed Objectives:

(1) To sample individual trees and their competitive neighbourhoods in stem-mapped plots
(2) To test how well aerial photography and image processing routines can be used to produce stem-maps
(3) To test alternate hypotheses that may explain competitive interactions among tree species across resource gradients
(4) To produce a draft manuscript related to stem-mapping with aerial photography and image processing routines
(5) To produce a draft manuscript related to competitive interactions among trees species across resource gradients

2. Project Methodology

Study sites were located near Smithers (54°35'N, 126°55'W), northwestern British Columbia, in the Sub-Boreal Spruce Moist Cold subzone Babine Variant (SBSmc2) (Meidinger and Pojar 1991).

Sites were chosen to provide a range of stand age, densities, species, soil moisture regimes, and soil nutrient regimes. These stands were dominanated by lodgepole pine (*Pinus contorta*), interior spruce (*Picea glauca x engelmanii*), subablpine fir (*Abies lasiocarpa*), and trembling aspen (*Populus tremuloides*). Minor species included black cottonwood (*Populus balsamifera ssp. Trichocarpa*), western hemlock (*Tsuga heterophylla*), black spruce (*Picea mariana*), and paper birch (*Betula papyrifera*). Over 70 sites were used ranging from dry poor sites to wet rich sites.

2.1. Field Sampling

Sample trees were based upon species, size, neighborhood conditions, and site type; sampled trees were free of pests and physical deformities, and had a diameter at breast height (DBH) greater than 5.0 cm. Neighborhood trees were any live tree with DBH > 5 cm within an 8m radius of a sample tree. Sample trees were cored at breast height and five annual radial increments were measured; all trees had dbh recorded and were stem mapped. Stem mapping was completed on 5 cm resolution summer or 5 cm resolution winter photographs. Aerial imagery was orthorectified and georeferenced.

2.2. Image Analysis

We developed an algorithm to identify and extract individual tree crowns from high resolution aerial images. The algorithm was developed with Definiens Developer 7.0 (Definiens, 2007). A hybrid of existing techniques including local maxima and template matching concepts were used to identify tree crowns and tree stems and identify trees to species. In particular, we took advantage of GEOBIA methods by using shape, neighbourhood context, and fuzzy logic membership criteria based on statistical measures of already classified objects (see Benz et al. (2004) for an overview of GEOBIA implementation in Definiens Developer, formerly known as Ecognition). The results from the image extraction were evaluated by comparison to existing stemmaps.

2.3. Growth analysis

We used the multiple working hypotheses framework and likelihood methods to analyze these data (e.g. Burnham and Anderson 2002). We developed five alternative models to compare with a null model based on previous knowledge of

northern temperate and boreal forests. A simulated annealing algorithm in the statistical software R v. 2.6.1 (likelihood package) calculated maximum likelihood estimates and support intervals for the parameters in each model (Goffe et al. 1994; R Development Core Team. 2007) and the neighlikeli package (Murphy 2006) provided code for neighborhood calculations. Models were selected based on Akaike's information criteria corrected for a small sample size (AICc).

The amount of above canopy light reaching the canopy of every sampled tree was estimated with a spatially explicit neighborhood model of canopy tree shading explained in detail by Canham et al. (2004). Light was used with a neighborhood crowding index and tree size to predict growth in the null model, and then soil nutrient regime was also included as affecting tree size, light, and or crowding in the five alternative models that were compared with the null model and with each other.

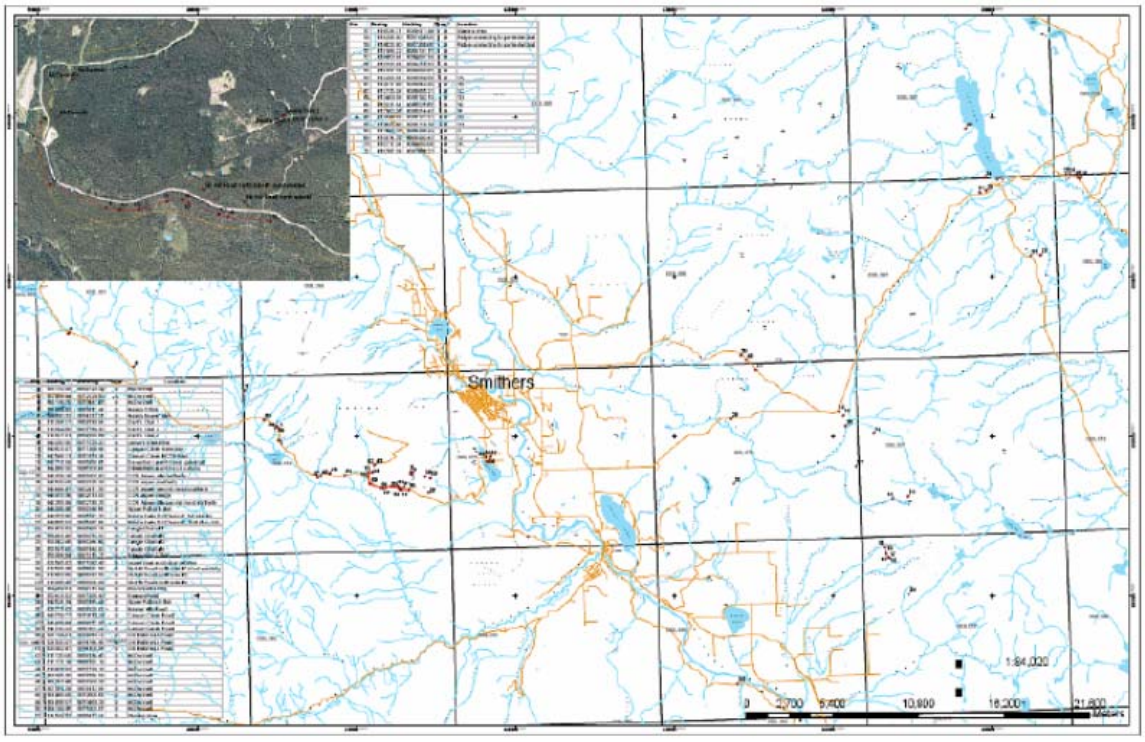

Figure 1: Distribution of study sites around Smithers, BC.

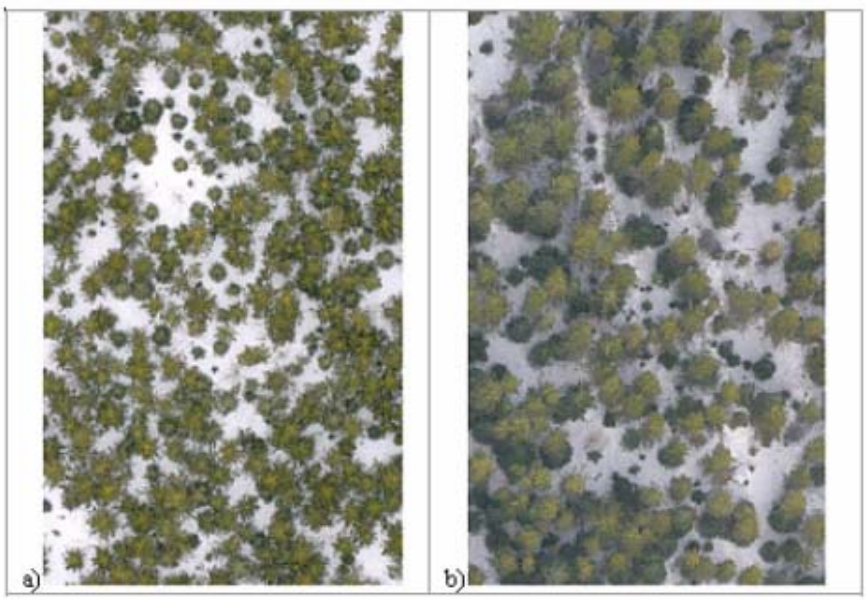

Figure 2: a) representative young single-storied stand,
b) representative mature two-storied stand.

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