FGrOW 2021 Fall Field Tour

Density Management and Decision Support Tools from LiDAR

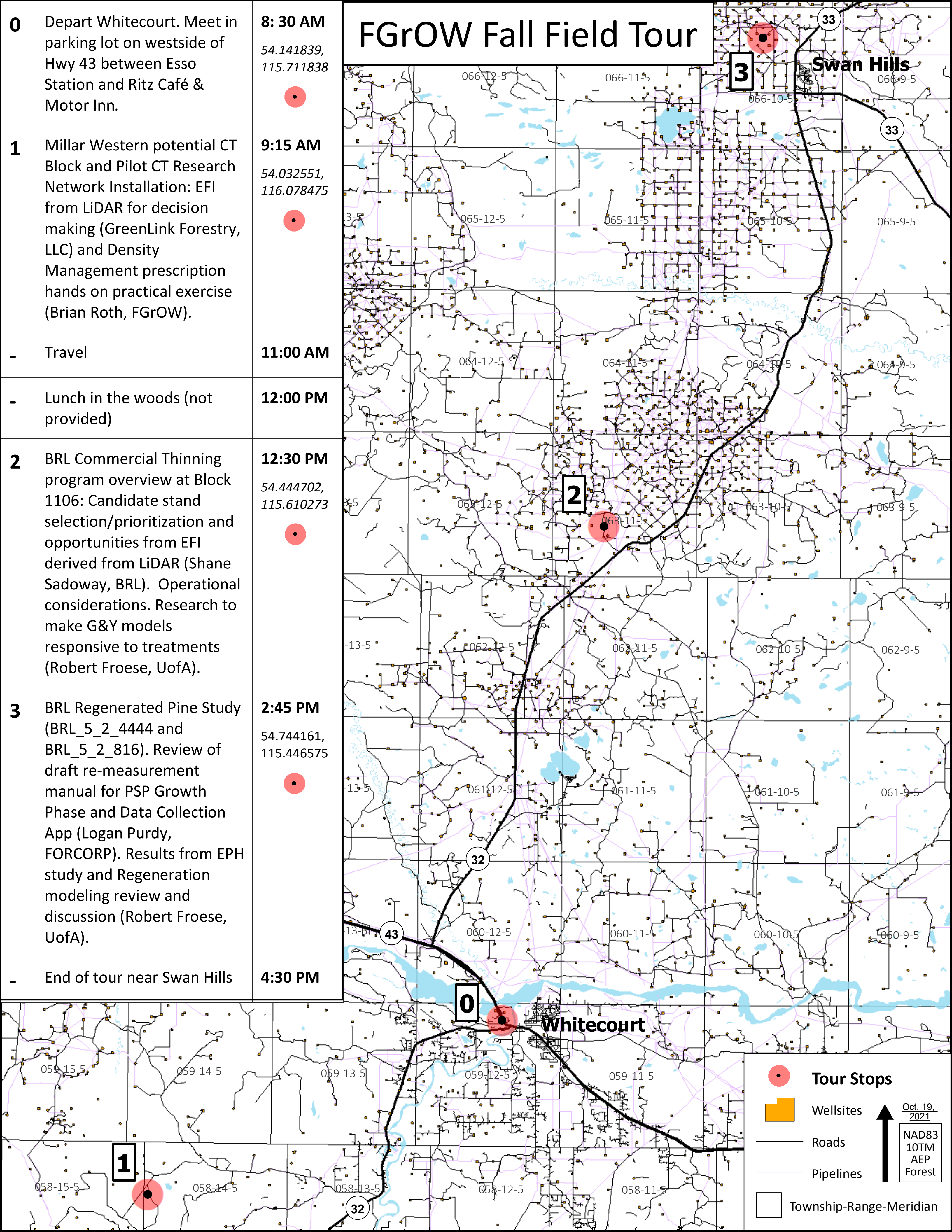
Whitecourt and Swan Hills, AB
October 19th, 2021

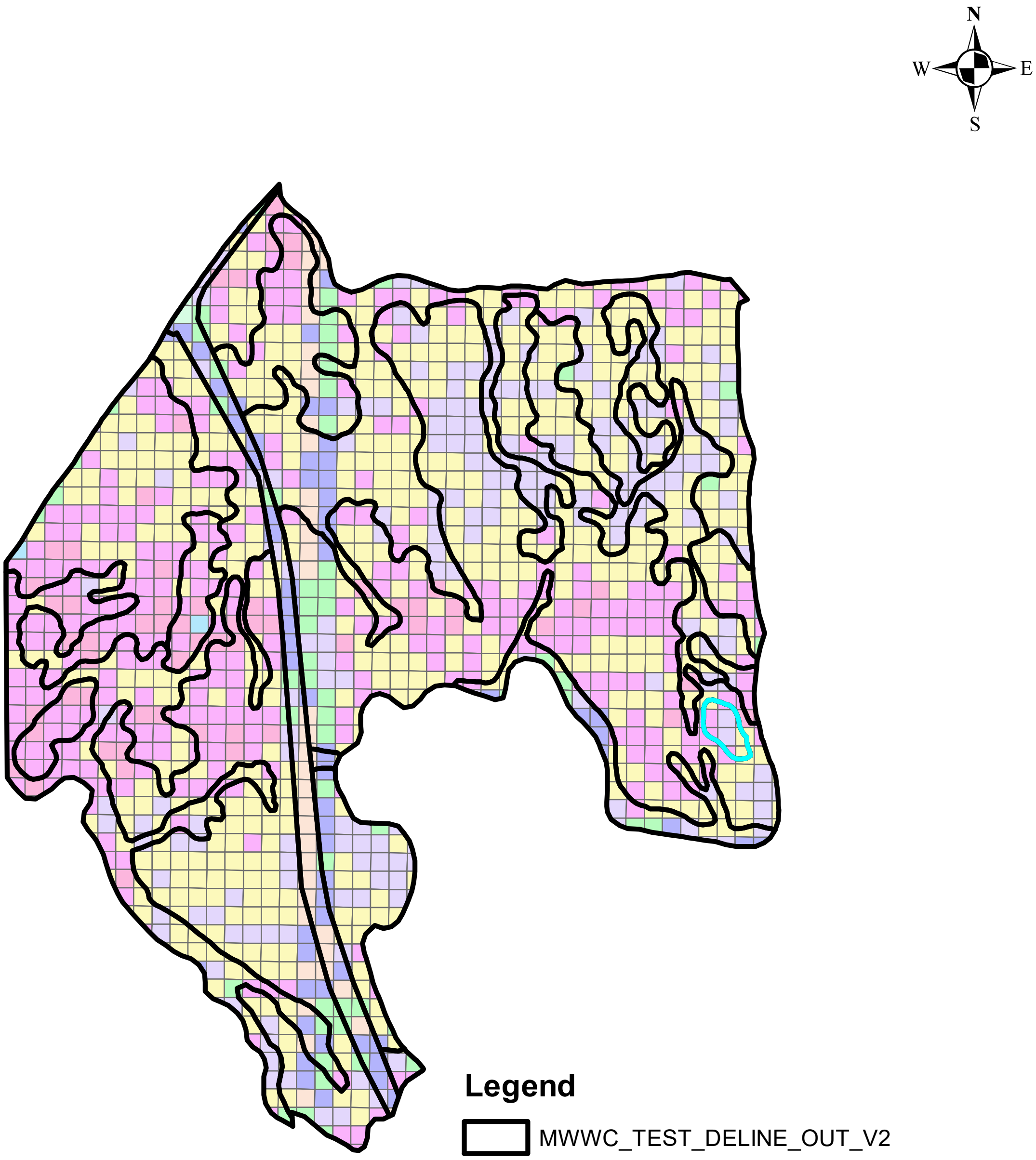
FOREST GROWTH
ORGANIZATION OF WESTERN CANADA

Hosted by:
Millar Western Forest Products
and West Fraser – Blue Ridge Lumber

FGrOW Fall Field Tour

0	Depart Whitecourt. Meet in parking lot on westside of Hwy 43 between Esso Station and Ritz Café & Motor Inn.	**8: 30 AM** *54.141839, 115.711838*
1	Millar Western potential CT Block and Pilot CT Research Network Installation: EFI from LiDAR for decision making (GreenLink Forestry, LLC) and Density Management prescription hands on practical exercise (Brian Roth, FGrOW).	**9:15 AM** *54.032551, 116.078475*
-	Travel	**11:00 AM**
-	Lunch in the woods (not provided)	**12:00 PM**
2	BRL Commercial Thinning program overview at Block 1106: Candidate stand selection/prioritization and opportunities from EFI derived from LiDAR (Shane Sadoway, BRL). Operational considerations. Research to make G&Y models responsive to treatments (Robert Froese, UofA).	**12:30 PM** *54.444702, 115.610273*
3	BRL Regenerated Pine Study (BRL_5_2_4444 and BRL_5_2_816). Review of draft re-measurement manual for PSP Growth Phase and Data Collection App (Logan Purdy, FORCORP). Results from EPH study and Regeneration modeling review and discussion (Robert Froese, UofA).	**2:45 PM** 54.744161, 115.446575
-	End of tour near Swan Hills	**4:30 PM**





Legend

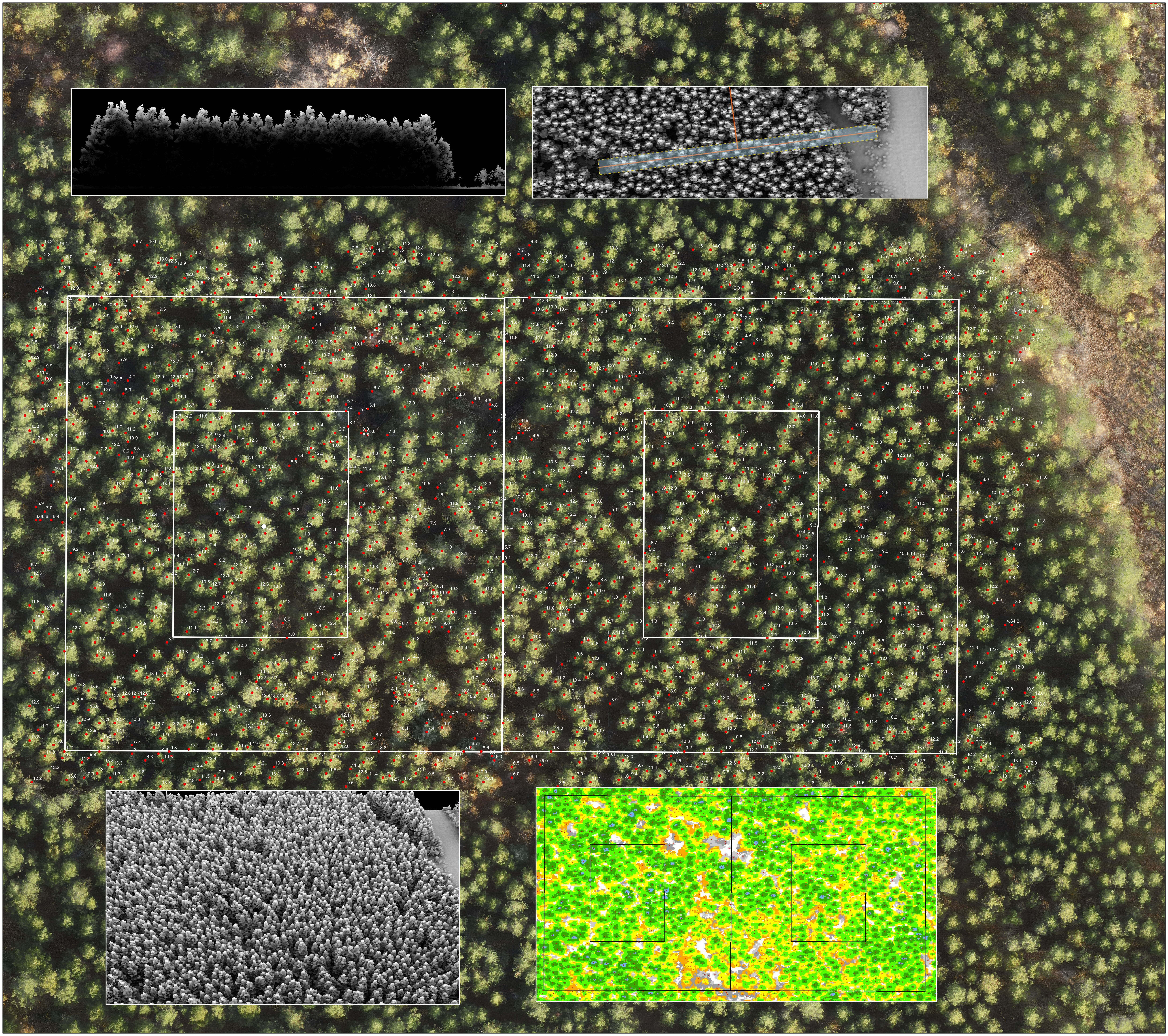
MWWC_TEST_DELINE_OUT_V2

MWWC_TEST_DELIN_wTILE_DEN_40CMv2

<all other values>

CLASS

0000-0499
0500-0999
1,000-1,499
1,500-1,999
2,000-2,499
2,500-2,999
3,000-3,499
3,500-3,999
>=4,000



Flight Date: October 8, 2021
Lidar Point Density: 450 ppm
Ortho GSD: 1.53 cm
Sun Angle: 21.9 degrees
Ortho Flight Time: 10:50 AM

Tree Points generated from 25 cm
CHM using UAV Lidar

Millar Western Block 41

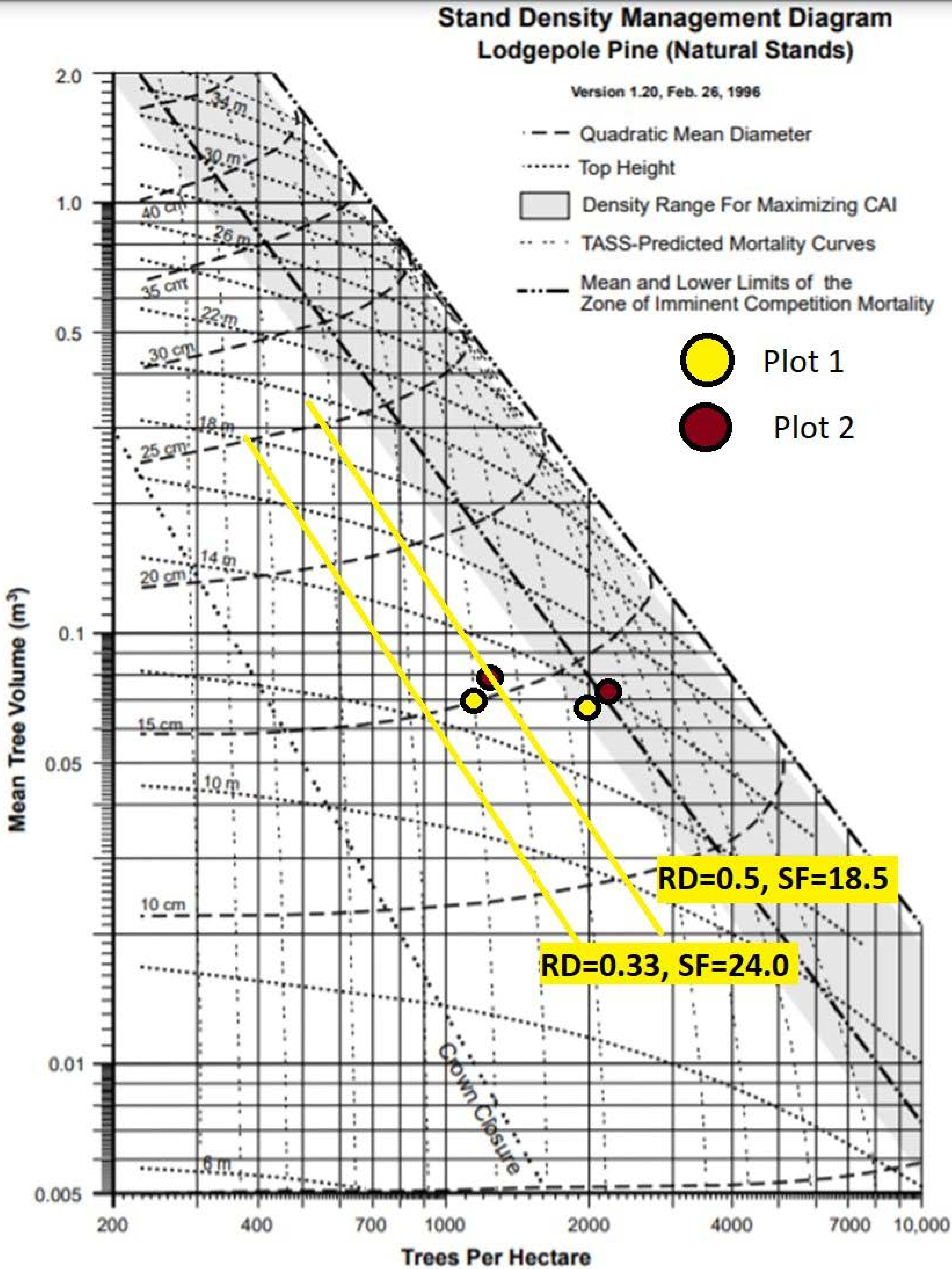
UAV Acquired Imagery & Lidar

1:150

0 5 10 15 20 Meters

N W E S

GREENLINK FORESTRY INC



Produced by: Craig Farnden
Canadian Forest Service
Pacific Forestry Centre

Data Source: TASS-generated managed stand yield tables contained in the computer program WINTIPSY (British Columbia Ministry of Forests, Forest Productivity and Decision Support Section)

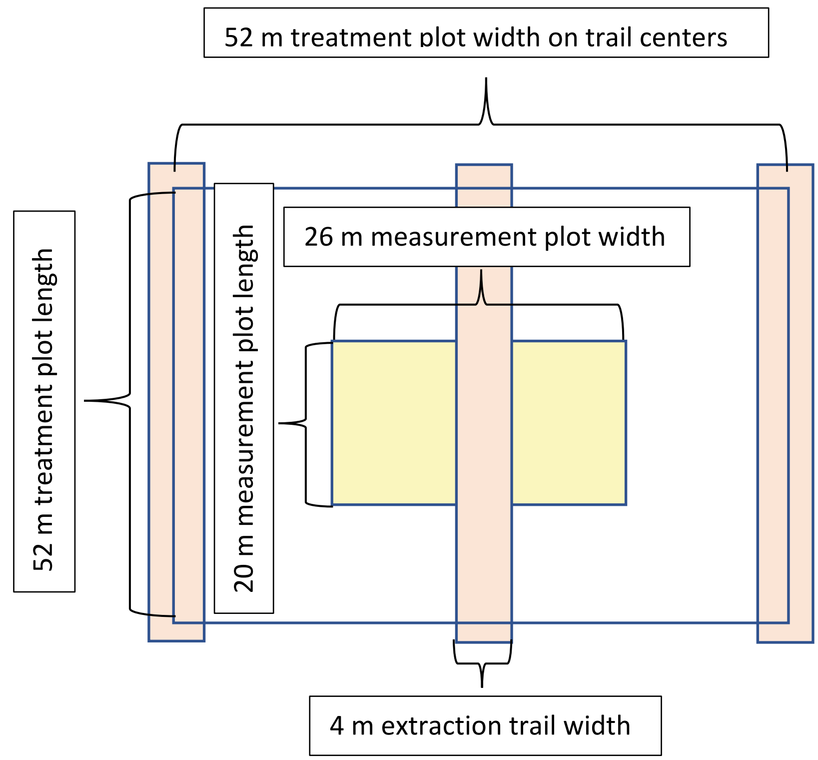
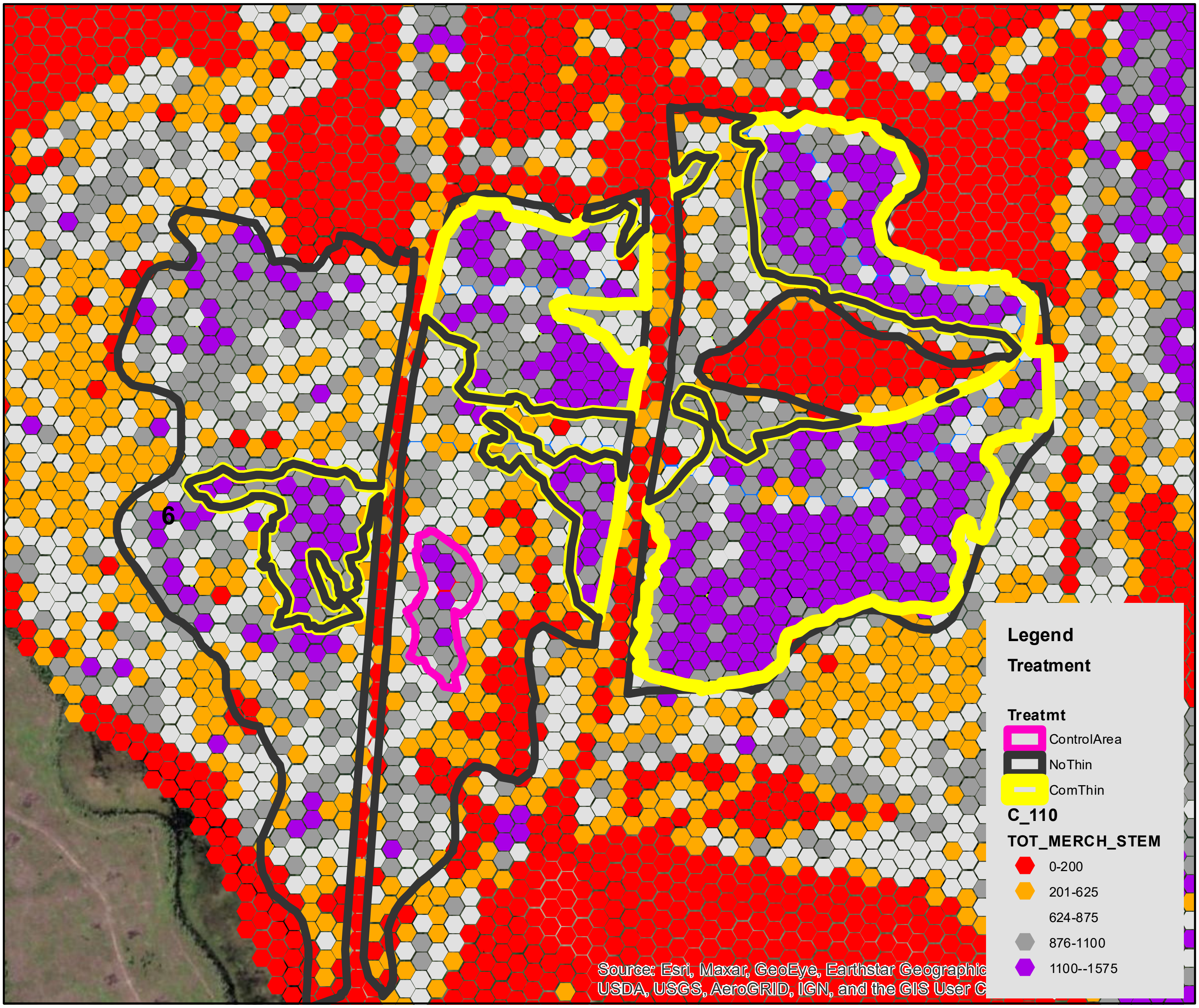
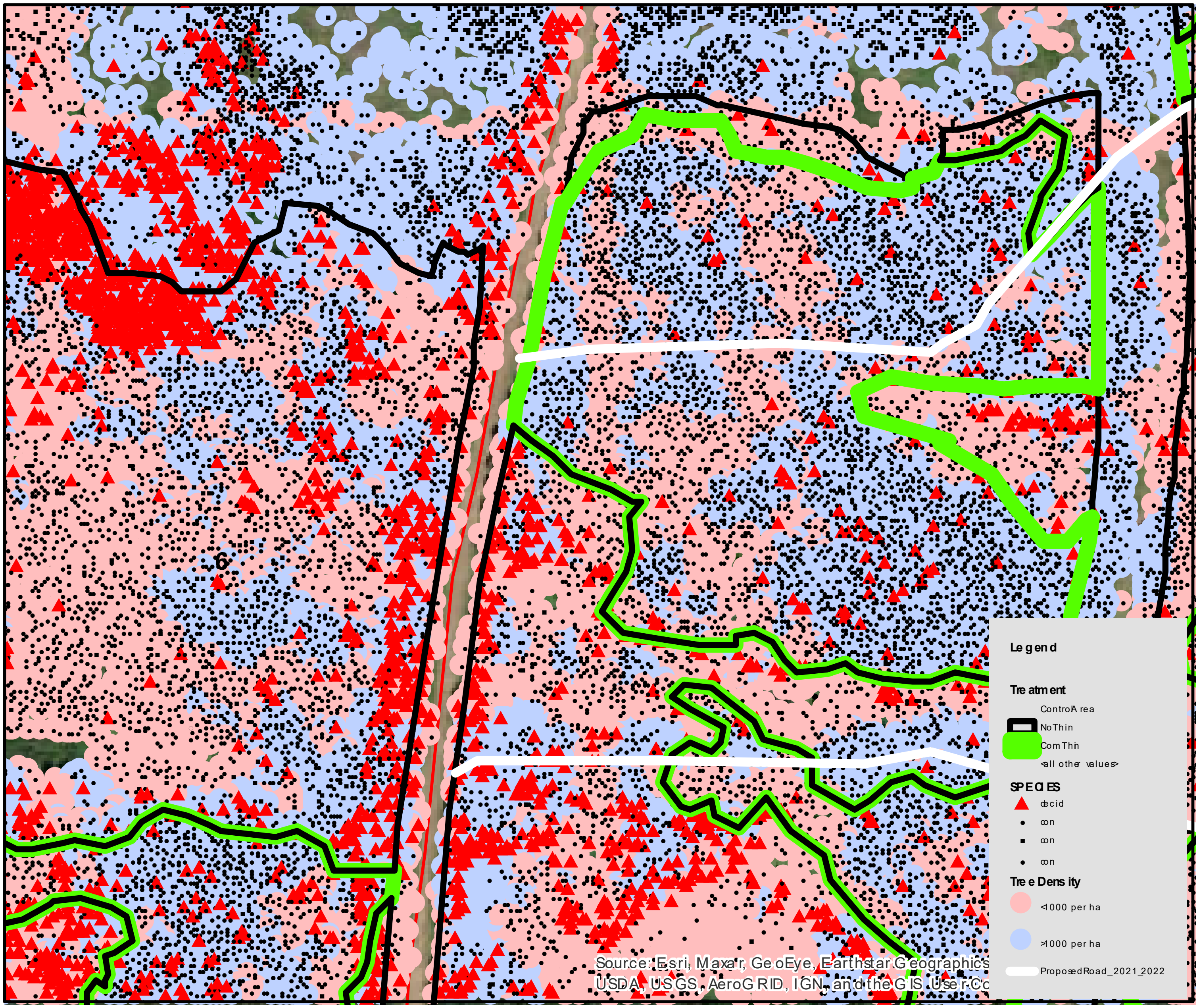


Figure . Schematic of a single commercial thinning plot including treatment buffer and trail spacing (18.2% of area in trails). Trails are 26 meters apart on centers.

BRL Block 1106 CT Based on Merch Con Density



BRL Block 1106 CT Based on Ind Tree Inv - Density and Con vs. Decid




BRL_5_2_4444
BRL_5_2_816

Regenerated Lodgepole Pine Project

Excerpts from the Final Regeneration Phase Report - Dick Dempster

Abstract

The FGrOW Regenerated Lodgepole Pine Trial was established in the year 2000 to monitor, under experimentally controlled conditions, the effects of planting, weeding, and pre-commercial thinning on the development of lodgepole pine stands following harvesting. This report summarizes analyses of data collected at the end of the trial's regeneration phase, between 2017 and 2020.

Planting of lodgepole pine improved stocking and increased projected growth and yield. On modal sites planted trees were often greatly outnumbered by natural regeneration; but on some sites, with either poor or nutrient-rich soils, planting was essential to achieve satisfactory re-stocking.

Herbicide application was demonstrated to be essential for restoration of pine on competitive sites, depending on levels of hardwood competition and associated site factors. It did not usually increase projected total timber production (pine plus hardwoods).

Pre-commercial thinning increased the growth of retained trees, especially in dense stands, and has good potential for reducing pine rotations. It is projected to increase mean annual volume increment of pine in stands with more than 6000 – 7000 stems per ha, and at lower densities in some situations. Thinning on competitive sites, in the absence of chemical hardwood control, was found to stimulate aspen suckering, with uncertain consequences for future stand development.

Responses to the treatments varied greatly depending on soil nutrient and moisture regimes, and other climatic, ecological and treatment factors. As a result, planting, weeding or thinning may be effective to meet management objectives on some sites, but unnecessary on others. A decision support tool has been developed to help managers apply the results to specific site and stand conditions.

Projections of the long-term effects of planting, weeding and thinning cannot currently be verified. Ongoing monitoring is essential to validate, defend and improve predictions over time. Recommendations are made for continued re-measurement of the trial during the growth phase of the rotation.

4 Conclusions and recommendations

4.1 Planting

On the most commonly occurring lodgepole pine site types, densities from natural regeneration exceed those achievable by planting, and planting may not be necessary. However, stocking of natural regeneration is variable. Planting improves site occupancy (i.e. it fills gaps that would otherwise occur in natural regeneration) and reduces the risk of reforestation failure. On some sites it may be essential to achieve satisfactory stocking, particularly those with either poor soil nutrient and moisture conditions, or with rich soils where the favourable nutrient status leads to high levels of inter-specific competition. Increasing planting densities improves the accumulation of basal area at the end of the regeneration phase, and this is predicted to result in increased mean annual volume increment throughout the rotation.

4.2 Weeding

Weeding under most site conditions is not expected to increase the total (combined) MAI of conifers and hardwoods, except where regeneration of tree cover is precluded by excessive grass, herbaceous or shrub competition. However, control of hardwoods is essential for restoration of pine on competitive sites, particularly lowland sites with high levels of aspen density. Chemical herbicide application is effective on such sites in improving survival, stocking and growth of pine. Weeding is seldom necessary for hardwood control on upland sites with medium to low soil nutrient status.

4.3 Pre-commercial thinning

Carefully planned pre-commercial thinning has the potential to accelerate growth and thereby shorten rotations, especially in dense stands, by providing more space for crown development and growth of retained trees. It can also increase MAI of pine in dense stands with more than 6000 – 7000 stems per ha, and may increase pine MAI at lower densities, particularly in planted stands where crop trees are well spaced. The increased rate of aspen suckering, observed following thinning of non-weeded plots, has uncertain consequences for future stand development, and requires ongoing monitoring.

4.4 Factors influencing treatment responses

Responses to the treatments described above vary greatly depending on soil nutrient and moisture regimes, and other climatic, ecological and treatment factors. As a result, planting, weeding or thinning may be essential to meet management objectives on some sites, but unnecessary or counter-productive on others. This report has focused on statistically testing the significance of treatment effects across a broad range of site and stand conditions. Readers interested in treatment responses to particular combinations of site and treatment factors are recommended to explore them with the FRIPSY regeneration model, as noted and referenced on page 3.

4.5 Continued monitoring

Measurements of the RLP trial have been completed for the entire regeneration phase of stand development. Results have provided insights, under controlled experimental conditions, into how pine regeneration develops in response to reforestation treatments. However, predictions of the long-term effects of these treatments currently relies on growth models like GYPSY, which are not based on controlled data definitively representing the different reforestation treatments. Ongoing monitoring is essential to verify, defend and improve predictions over time. Recommendations for achieving this have already been reviewed and approved by the FGrOW Foothills Pine Project Team, and are included in Appendix 1.

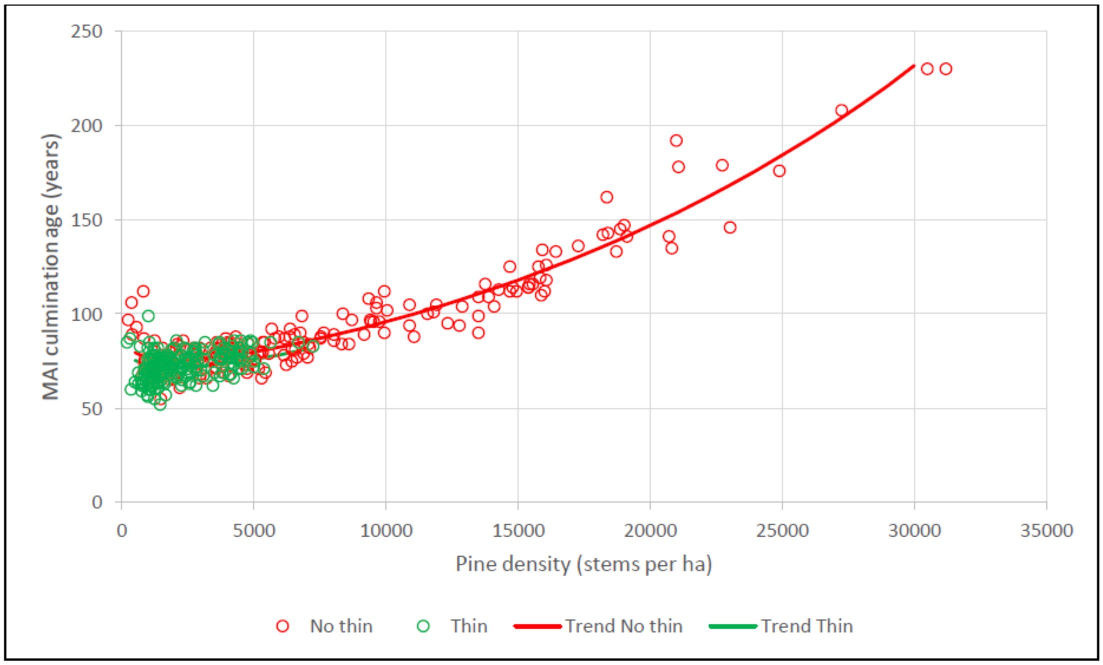


Figure 14. Trend of projected MAI culmination age with pine density

Culmination age of pine is displayed on the Y-axis against pine density at 17 growing seasons after planting (on the X-axis). Data points for individual plots are shown relative to trend lines based on the equation:

$$\ln Y = 4.9065 - 0.0937 (\ln X) + 0.00005 (X) + 0.0254 (Thin[No]) \qquad (R^2 = 0.7914)$$

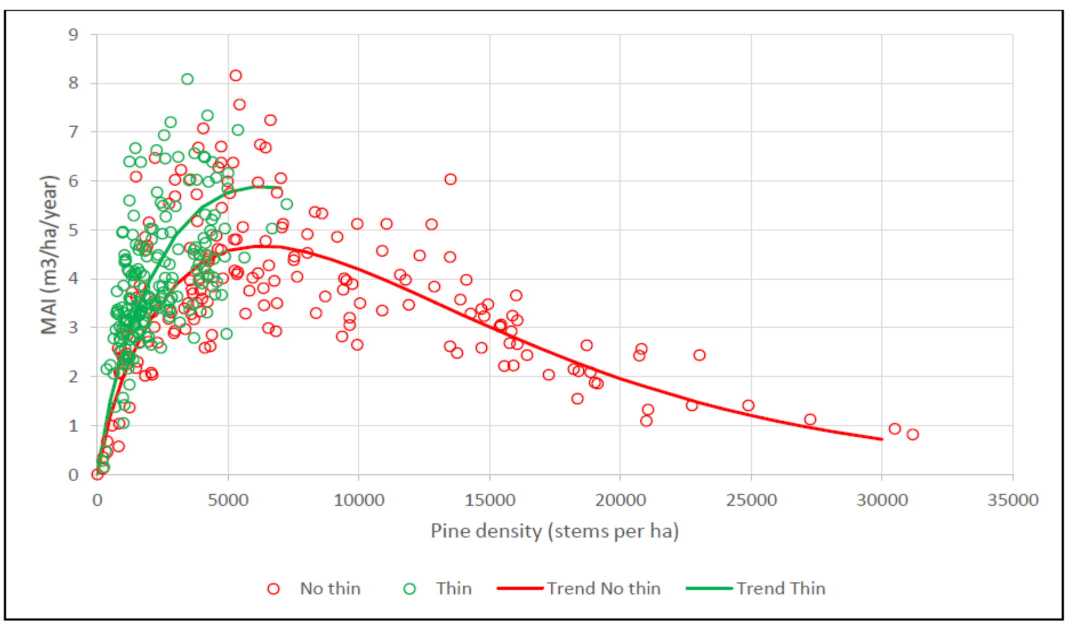


Figure 15. Trend of projected mean annual increment with pine density

Maximum MAI of pine is displayed on the Y-axis against pine density at 17 growing seasons after planting (on the X-axis). Data points for individual plots are shown relative to trend lines based on the equation:

$$\ln Y = -4.9274 + 0.8498 (\ln X) - 0.00014 (X) - 0.1158 (Thin[No]) \qquad (R^2 = 0.0.6041)$$

Appendix 1. Recommendations for continued re-measurement of the RLP trial (April 19, 2021)

Introduction

The Regenerated Lodgepole Pine (RLP) trial was established in 2000 to monitor, under experimentally controlled conditions, the effects of planting, weeding and pre-commercial thinning on the growth and yield of lodgepole pine regenerated after harvesting. At that time, the participating companies considered these effects to be the inadequately understood and therefore the highest priority for research by the newly formed Foothills Growth and Yield Association. During the 20 years since establishment of the trial, the project has focused on quantifying relationships between treatments, site and regeneration performance during the regeneration phase of stand development. This resulted in FRIPSY, which forecasts stand development to the end of the regeneration phase, and inputs the results into GYPSY, which projects growth and yield to rotation.

Having completed measurements and analyses for the entire regeneration phase of the rotation, the Foothills Pine Project Team now needs to consider what ongoing measurements are required for monitoring stand development during the growth phase. None of the models presently available for projection during the growth phase are based directly on controlled data representing different reforestation treatments. Ongoing monitoring is essential if we wish to verify, defend and improve predictions made by FRIPSY, GYPSY, or other growth models.

Objectives

1. Conduct sufficient and suitable re-measurements on an ongoing basis to verify predicted effects of reforestation treatments on growth and yield.
2. Adjust measurement procedures and schedules for this purpose, recognizing that those adopted for the regeneration phase are not all suitable or necessary for the growth phase.
3. Comply with minimum provincial standards for measuring permanent sample plots.
4. Minimize costs, within the constraints imposed by 1 to 3 above.

Current design

Figure 1 illustrates the RLP design as applied from establishment of the trial in 2000 to the latest measurements taken in 2020. Each installation was planted at one of 6 densities, and divided into 4 treatment plots. The 6 planting densities were replicated 17 times, resulting in a total of 102 installations.
A $1000m^2$ measurement plot was placed centrally in each treatment plot, and sub-sampled with 16 circular $10m^2$ sub-plots. All planted lodgepole pine within the measurement plot were tagged and assessed bi-annually for health and mortality. Natural regeneration in the 16 subplots was monitored by species for % stocking, density and height class. In addition, since 2015, all saplings and trees within the 16 sub-plots, plus sample planted trees previously designated outside the sub-plots, were assessed individually for species, height, DBH, DSH, crown class, height to live crown, and health. Top height and age was measured by species on 4 sub-plots, each $100m^2$.

Recommendations

Figure 2 illustrates the recommended changes to the current design. The modified design relies largely on the existing plot layout and demarcation. The proposed reduction in the measurement plot size would require only two additional boundary posts per plot.

Figure 1. Current design (regeneration phase)

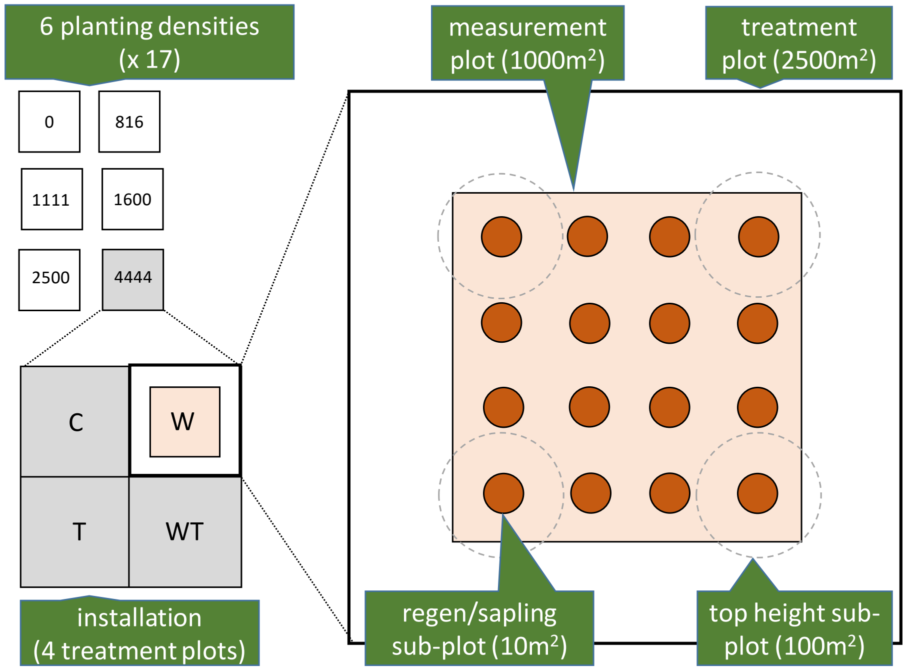
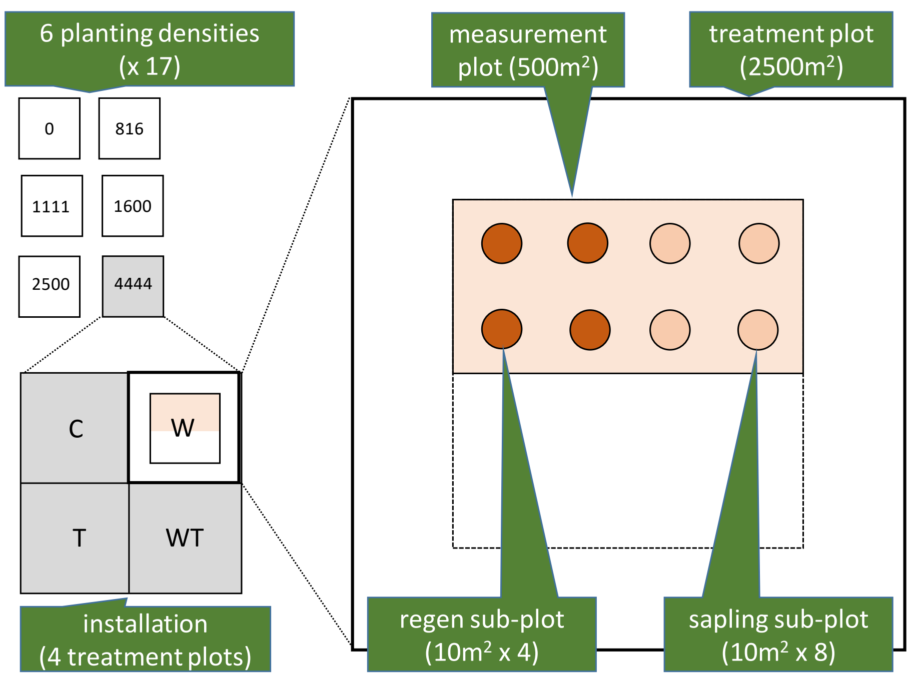


Figure 2. Recommended design (early growth phase)



The recommended standards and requirements for measurement are summarized as follows:

Plot sizes	
Tree (measurement)	500 m^2
Sapling	80 m^2 (8 x 10 m^2)
Regeneration	40 m^2 (4 x 10 m^2)
Tagging limits	
Trees	>5 cm DBH
Saplings	≥1.3 m in height
Seedlings	≥ 0.3 m in height (conifers only)
Ages and top height	
Selection	5 largest DBH trees per species
Planted trees	Height only (age is known)
Natural regeneration	Height and age
Tree and sapling measurements	
DBH	All trees and saplings on respective plots
Height	Every 4^{th} tagged tree or sapling on respective plots
Tree condition code	All trees and saplings on respective plots
Seedling measurements	
Count by species	All seedlings on regeneration plots
Height	Maximum 10 trees per species
Tree condition code	Maximum 10 trees per species

Table 1 indicates the estimated average number of trees, saplings and seedlings to be sampled. The estimates are based on the last measurements made on 53 installations measured in 2019 and 2020, 20 years after harvest. Actual numbers of trees measured will obviously vary between installations and over time. Nevertheless, the table indicates that the proposed plot design should result in an adequate, but not excessive, number of trees being measured during the early part of the growth phase. Reversion to the original tree plot size of $1000m^2$ may be necessary at later stages of the rotation, depending on the extent to which self-thinning reduces stand densities.

Table 1. Estimated average number of trees, saplings and seedlings to be sampled per installation

Treatment	Pine			All species		
plot	Trees	Saplings	Seedlings	Trees	Saplings	Seedlings
Control	98	34	2	182	49	6
Thin	79	4	3	80	25	5
Weed	138	33	2	140	38	6
Weed & Thin	89	3	3	91	6	6
Average per plot	101	19	3	123	30	6
Total per installation	404	74	10	493	118	23

A re-measurement interval of 5 years is suggested. Some flexibility could be provided by permitting installations to be measured a year before or after the default scheduled year. Ensuring that all plots on all installations are adequately demarcated and maintained should be given high priority, to allow for the extended measurement interval and to prevent irreversible loss of future measurement opportunities. This would include maintenance of the original buffer and plot corner posts. Tree tagging, and centre stakes for sapling and regeneration sub-plots, need be retained, and refreshed as necessary, only within the revised $500m^2$ tree measurement plots.