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Natural Ingress 15 Years After Salvaging Fire-Killed Timber on TFL 59



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Cover page photo (taken Oct. 2018 by Steve Jones). Site 3 (Pl leading) is the regenerating in the middle right of the image below the fringe of mature timber on the crest of the hill.

Executive Summary

Background

This report summarizes the growth of trees after 15 years that naturally regenerated after salvaging timber burned in the 2003 wildfires in TFL 59 (formerly TFL 15) in the south Okanagan area of BC. The summaries are based on five measurements of a trial established in 2005 by Weyerhaeuser to monitor change in stand density and other attributes in the regenerating areas. The trial includes three sites (separate logging blocks), each sampled with six randomly located clusters of sixteen 1 x 1 m plots. Trees were measured after two, four, six, 10, and 15 growing seasons following harvest.

Stand Density

This measurement (after 15 years of growth) shows significant tree mortality over the last five years. The mortality rate over that time was 45% at Site 1 (Fd leading), 58% at Site 2 (Lw leading), and 65% at Site 3 (Pl leading). Densities are now about 100,000/ha, 150,000/ha, and 50,000/ha respectively. Mortality rates were higher in areas with higher starting stand densities and were similar among species. Mortality may now slow to a more constant rate in future measurements.

Site Index

This was the first measurement where trees were old enough to estimate site index using breast height age. Site index was estimated as 20-25 m for Fd at Site 1, 17-19 m for Lw at Site 2, and 18-19 m for Pl at Site 3. These estimates are similar to or slightly higher than the SIBEC estimates given by the Ministry of Forests.

Height-Growth Repression

There is some evidence that height-growth repression may be occurring at very high densities in Fd at Site 1 (establishment densities in excess of 500,000/ha) and Lw at Site 3 (establishment densities in excess of 200,000/ha and especially on drier sites). Repression in Fd and Lw is not well documented and will require further work to confirm and quantify.

There is no evidence of height-growth repression in Pl at Site 3 that included establishment densities up to about 700,000/ha. If height-growth repression is occurring in Pl, it must be occurring across all densities; which we believe is unlikely. And if it is occurring, the impact on site index appears to small when compared to MOF SIBEC estimates.

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1. INTRODUCTION

1.1 BACKGROUND

In the summer of 2003, wildfires burned about 50,000 ha of forestland in the south Okanagan region of BC. About 7,000 ha were in Weyerhaeuser Company Ltd.'s Forest Licence and Tree Farm Licence (TFL) 59 operating areas.¹ Weyerhaeuser salvaged much of the burned timber from those areas in the 2003/04 winter logging season.

Field inspections by Weyerhaeuser silviculture staff (Ed Collen² and others), in the first growing season after salvage, showed that many areas were regenerating to extremely high densities of lodgepole pine (Pl), Douglas-fir (Fd), and western Larch (Lw). To help monitor changes in stand density and other attributes in some of those areas, Weyerhaeuser established a trial in TFL 59 (Appendix 1) after the second growing season (2005) with subsequent measurements after the fourth (2008), sixth (2009), tenth (2013), and fifteenth (2018) growing seasons.

This report describes the most recent trial measurement after 15 growing seasons. Previous reports describe the installation of the project^{3,4} and growth after two,⁴ four,⁵ six,⁶ and 10⁷ growing seasons. The trial background and description in this report is the same as previous reports.

1.2 TERMS OF REFERENCE

This report was completed by Jim Thrower, PhD RPF under contract to Trena MacLeod, RPF of Weyerhaeuser, Princeton Timberlands. The remeasurement of the plots was completed by Steve Jones, RPF⁸ and his crew.

¹ TFL 59 was formerly called TFL 15.

² Now retired Weyerhaeuser silviculture forester.

³ J.S. Thrower and Associates Ltd. 2006. A trial to monitor post-fire ingress on three sites on TFL 15: interim report. Contract report to Weyerhaeuser, Okanagan Falls, BC. JST project WCF-044. March 31, 2006. 11 pp.

⁴ J.S. Thrower and Associates Ltd. 2006. A trial to monitor post-fire ingress on three sites on TFL 15: establishment report. Contract report to Weyerhaeuser, Okanagan Falls, BC. JST project WCF-050. May 31, 2006. 13 pp.

⁵ Thrower, J. 2009. Natural ingress four years after salvaging fire-killed timber on TFL 59. Contract report to Weyerhaeuser, Princeton Timberlands. Jan. 31, 2009. 21 pp.

⁶ Thrower, J. 2009. Natural ingress six years after salvaging fire-killed timber on TFL 59. Contract report to Weyerhaeuser, Princeton Timberlands. Dec. 18, 2009. 23 pp.

⁷ Thrower, J. 2013. Natural ingress 10 years after salvaging fire-killed timber on TFL 59. Contract report to Weyerhaeuser, Okanagan Falls, BC. Dec. 31, 2013. 22 pp.

⁸ Southern Interior Forestcraft Ltd., Penticton, BC.

2. THE TRIAL

2.1 SITE SELECTION

The trial includes three study sites subjectively located by Ed Collen to include different regenerating stand conditions in the salvaged areas. One site was dominated by Fd ingress, one by Lw, and the other by Pl (Table 1). Harvesting of all sites was done by logging contractors as clearcuts in the winter of 2003/04 using feller buncher, grapple skidder, and roadside processing.

Table 1. Location and general ecological description of the three sample sites.

Site	CP/Block	Ingress Type	Elevation (m)	Sample Points	BEC Classification at Establishment
1	CP 230 / 1	Fd leading	1,000 – 1,060	1-6	IDF _{xh} 1-05(80%) 01(20%)
2	CP 230 / 2, 3, 5	Lw leading	1,250 – 1,350	1-2 3-4 5-6	IDF _{dm} 1-01(90%) 04(10%) IDF _{dm} 1-04(80%) 01(20%) IDF _{dm} 1-01(70%) 04(30%)
3	CP 512 / 3	Pl leading	1,380 – 1,450	1-6	IDF _{dm} 1-01(95%) 05(05%)

2.2 SAMPLES

Six sample points were randomly located in each of the three sites (Appendix 2). Each sample point is a 16 x 16 m area divided into four 8 x 8 m plots. Each plot is subsampled with four 1 x 1 m subplots (Figure 1). Thus, each sample point is described by a cluster of 16 – 1.0 x 1.0 m subplots.

2.3 ESTABLISHMENT & REMEASUREMENT

Sample plots at Site 1 were installed in the fall 2005 and at Sites 2 and 3 in the spring of 2006 (Appendix 3). The spring plots were installed before start of the 2006 growing season, thus the data for all three Sites reflect two growing seasons.

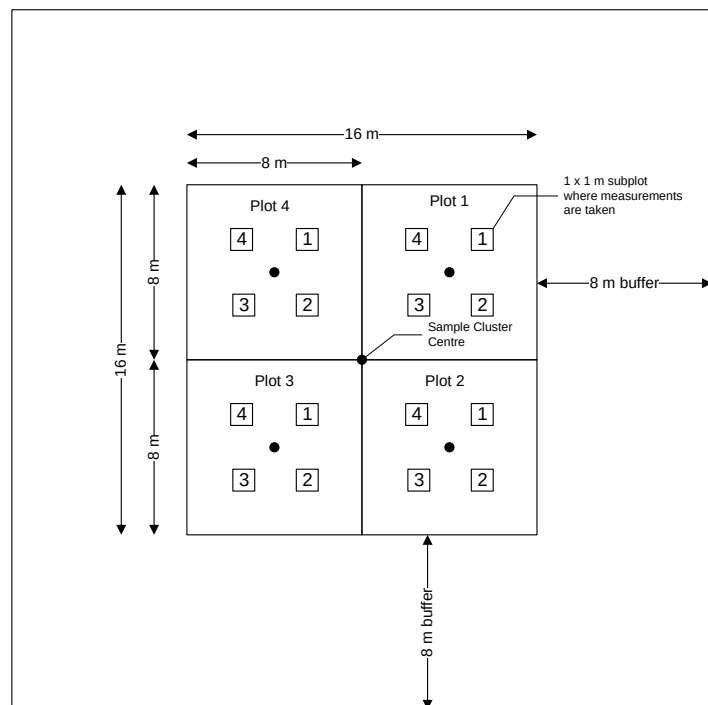


Figure 1. Sample point (plot cluster) layout. The plot buffer was increased from 8 m to 15 m in 2010.

Measurement of trees in the plots were done after:

1. Two growing seasons – fall 2005 and spring 2006 (trial installation).
2. Four growing seasons - spring 2008.
3. Six growing seasons - fall 2009.
4. Ten growing seasons - fall 2013.
5. Fifteen growing seasons – fall 2018 (described in this report).

2.4 SPACING TREATMENT

The area surrounding the sample points at all three Sites were treated to reduce stand density in 2010 and 2012 (Table 2). This was required of Weyerhaeuser to meet Ministry of Forests, Lands, and Natural Resource Operations (MOF) regulations regarding free-growing and maximum density policies. A 15 m buffer was established around each sample point where the stand and trees were not treated.

Table 2. Spacing treatments in the three study Sites.

Site	CP/Block	Ingress Type	Date	Type
1	CP 230 / 1	Fd leading	Aug 2010	Mechanical & Chemical spacing. Triclopyr 4.2 l/ha.
2	CP 230 / 2, 5	Lw leading	June 2010	Chemical spacing. Glyphosate 4.6 l/ha.
	/ 3	Lw Leading	Nov 2012	Mechanical strip spacing (mulcher).
3	CP 512 / 3	Pl leading	Aug 2010	Mechanical & Chemical spacing. Triclopyr 4.2 l/ha.

2.5 MEASUREMENTS

2.5.1 *Stand Density*

Tree measurements included a stem tally by species in each 1 x 1 m subplot to estimate stand density and species composition. This was done for all plots at all measurements.

Aspen (At) trees were not tallied at Site 1 at establishment but were at establishment of Sites 2 and 3. Aspen was tallied at subsequent measurements except this most recent 15-year measurement (omitted in error). Aspen only occurred at Site 3 (Pl leading) and was a relatively small proportion of stand density after 10 years, thus omission in the last tree count should not meaningfully impact the results.

Trees in this study are not tagged and thus we cannot separately estimate ingress and mortality. Thus reported changes in stand density are the net difference between ingress and mortality over a measurement period.

2.5.2 *Tree Height*

Tree height was not measured at establishment (trees were very small) but was for subsequent measurements. This included height of the five tallest trees of each species in each 1 x 1 m subplot. The measure in this report is the average of the tallest tree (of a given species) in each

of the four sample plots (8 x 8 m) at each sample point at each of the three Sites. The measure of height to examine possible height-density relationships was for the tallest single tree in each 1 x 1 m subplot.

2.5.3 *Site Index*

Trees were old enough in this measurement to estimate site index. This was done using standard procedures by selecting a suitable site tree (tallest, undamaged, free growing) of each species from a 100 m² circular plot (located at the center of each of the 8 x 8 m plots) (i.e., four per sample location). Measurements included total height (tree length) and age counted from an increment core taken at breast height. Some portions of the 100 m² site index plots overlapped when centered on the original square plots, thus on occasion the same site tree was selected in more than one site index plot. The height and age data were imported into SiteTools⁹ to estimate site index (using the growth intercept option).

2.5.4 *Brush*

Brush was measured in previous measurements but was not included in this 15-year measurement. Trees in these plots are now much taller than remaining brush and we believe the understory brush is not impacting tree growth or trends in this study.

2.5.5 *Site Conditions*

The predominant ground condition of each subplot was noted at establishment as rock, mineral soil, forest floor, or decaying wood. The proportion of each subplot covered by different plants and material was also noted. This included fireweed (*Epilobium* spp.), graminoids (grass like plants), bryophytes (non-vascular plants), other plants, rock, slash, and decaying wood. Those data are in the master database (on file with Weyerhaeuser) but are not summarized here.

An assessment of BGC site series was made at establishment. This was also done in the 2018 measurement. Those data are in the master database (on file with Weyerhaeuser) but are not summarized here.

2.5.6 *Photographs*

Digital photographs were taken at establishment and each remeasurement including general sites conditions, an overall view of sample point areas, and individual subplots. Photos taken prior to the 2013 measurement were from the same vantage point (immediately outside the area of interest from the south); however, this could not be done in the 2013 as most trees were tall enough to obscure that view. Photos from the 2018 measurement were taken at plot centers and only show the base of trees in high density stands. All photographs and the measurement data are on file with Weyerhaeuser.

⁹ SiteTools is software developed by the Ministry of Forests (etc.) and can be downloaded from their website.

3. SITE 1 - FD DOMINATED INGRESS

3.1 STAND DENSITY

Total stand density fell from 177,083 to 98,125/ha over the last five growing seasons (Figure 2, Table 3). This loss (78,958 trees/ha) is a mortality rate of 45% over five years (about 9%/year).

Table 3. Stand density of trees at all measurements and sites. (NT=not tallied)

	After 2 yrs		After 4 yrs		After 6 yrs		After 10 yrs		After 15 yrs	
	Density (no/ha)	Spp Comp	Density (no/ha)	Spp Comp	Density (no/ha)	Spp Comp	Density (no/ha)	Spp Comp	Density (no/ha)	Spp Comp
Site 1										
Trees										
Fd	251,042	98%	180,417	99%	182,188	98%	174,375	99%	96,563	98%
Py	4,896	2%	1,667	1%	2,396	1%	2,604	1%	1,354	1%
Lw	-	-	-	-	104	0%	104	0%	104	<1%
Pl									104	<1%
At	NT	-	833	0%	417	0%	-	-	NT	
	255,938	100%	182,917	100%	185,104	100%	177,083	100%	98,125	100%
Brush										
Willow	NT	-	33,750	100%	39,271	100%	30,104	100%	NT	
	-	-	33,750	100%	39,271	100%	30,104	100%		
Site 2										
Trees										
Lw	240,417	54%	233,958	58%	231,563	56%	170,938	48%	71,771	48%
Fd	113,958	26%	78,854	20%	91,042	22%	101,146	29%	45,729	31%
Pl	53,750	12%	56,354	14%	55,417	13%	49,583	14%	17,917	12%
Sx	33,125	8%	27,917	7%	35,313	8%	31,458	9%	14,271	10%
Py	-	-	-	-	-	-	104	0%	104	<1%
At	NT	0%	5,000	1%	3,542	1%	729	0%	NT	
	441,458	100%	402,083	100%	416,875	100%	353,958	100%	149,792	100%
Brush										
Alder	NT	-	313	1%	208	0%	1,771	9%	NT	
Willow	NT	-	53,125	99%	43,229	100%	17,083	91%	NT	
	-	-	53,438	100%	43,438	100%	18,854	100%		
Site 3										
Trees										
Pl	118,750	83%	144,583	76%	146,146	75%	130,208	79%	39,479	78%
Lw	13,854	10%	13,438	7%	13,125	7%	13,125	8%	10,208	20%
Sx	-	-	313	0%	208	0%	313	0%	417	1%
Fd	313	0%	313	0%	313	0%	313	0%	208	<1%
At	10,521	7%	32,708	17%	34,063	18%	21,354	13%	NT	
with At w/o At	143,438	100%	191,354	100%	193,854	100%	165,313 143,958	100%	50,313	100%
Brush										
Alder	NT	-	104	0%	313	0%	13,438	13%	NT	
Willow	NT	-	108,229	100%	106,042	100%	90,417	87%	NT	
	-	-	108,333	100%	106,354	100%	103,854	100%		

The last measurement interval was five years and thus we cannot more accurately describe the change in mortality within that period. The Fd mortality rate was 45% and 48% for Py.

Stand density estimates from the 15-year measurement varied greatly among the six sample points ranging from about 23,000/ha to 215,000/ha (Figure 3). Mortality rates over the last five years varied from 12-53% among samples (Table 4) and were proportional to starting density. Mortality rates since establishment were more consistent ranging from about 52-69% (Table 4).

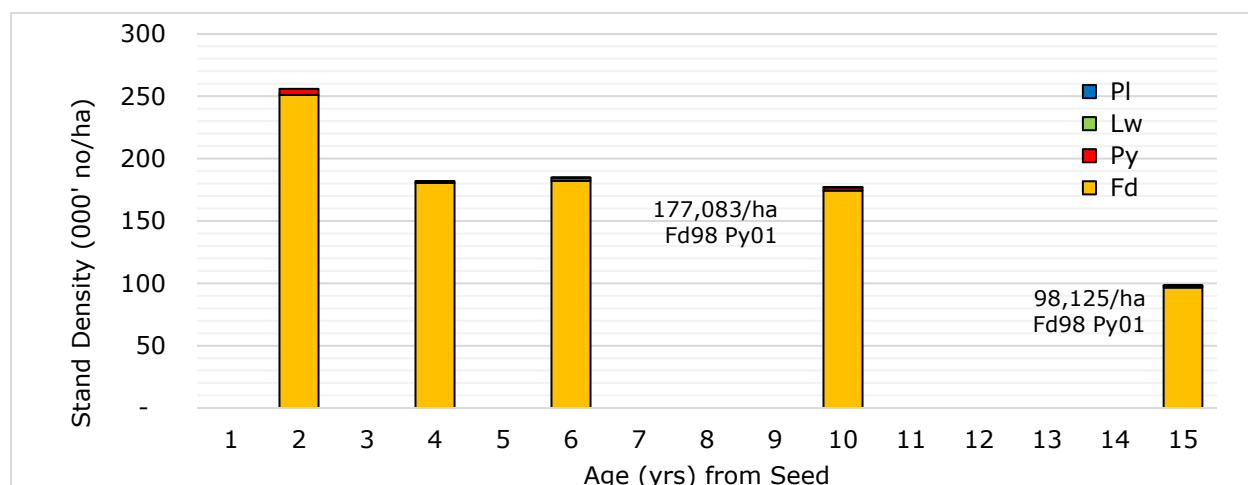


Figure 2. Site 1 (Fd leading) - stand density (average for all sample points). Labels beside the 10- and 15-year bars show stand density and species composition.

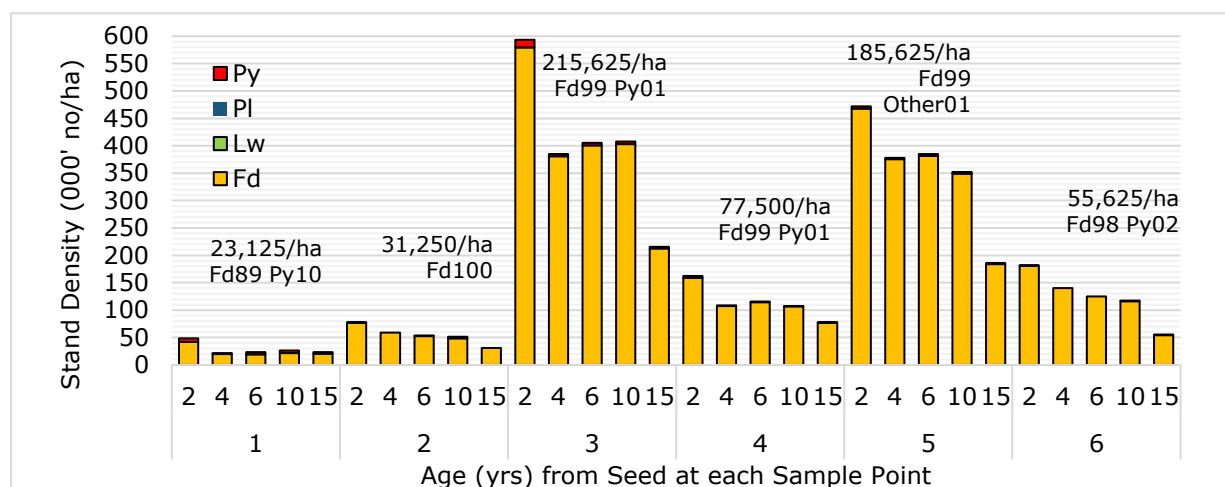


Figure 3. Site 1 (Fd leading) - stand density at each of the six sample points. Labels above each sample are stand density and species composition for the 15-year measurement.

Table 4. Site 1 (Fd leading) - relative mortality rates for the six samples.

Relative Mortality	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	All
Last 5-years	12%	39%	47%	28%	47%	53%	45%
Since establishment	53%	60%	64%	52%	61%	69%	62%

3.2 SPECIES COMPOSITION

There was no meaningful change in overall species composition at this site over the last five years. The 15-year measurement shows Fd 98%, Py 01%, and minor amounts (<1%) of Lw and Pl. The 10-year measurement essentially the same species composition (Table 3).

3.3 HEIGHT GROWTH

Height of the tallest Fd trees at some sample locations doubled over the last five years. The height-growth of those dominant trees showed the expected trajectories when compared to height-age curves (Figure 4). The average height of the tallest trees at five of the six sample sites ranged from about 3.5 – 4.5 m. Trees at sample 5 were shorter than at other samples locations which most likely reflects a lower quality growing site.

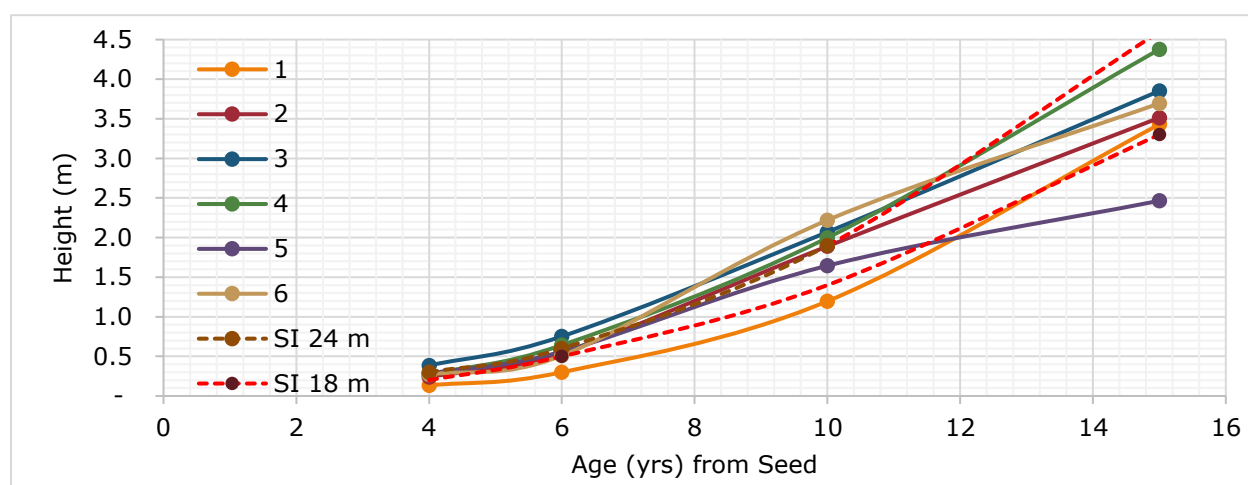


Figure 4. Site 1 (Fd leading) - height of dominant Fd trees at the six sample locations. Fd height growth at site index 18 and 24 m is shown in the dashed red curve (height growth curve from SiteTools).

3.4 SITE INDEX

The site index of Fd at the six sample locations ranged from 20-25 m (Table 5). This IDFxh1-01 site is dominated by Fd and site index could be estimated for other species (Lw) at only one other sample location. The MOF SIBEC (site index-BEC) database estimates the site index for Fd on these sites as 18 m (based on 13 sample plots); which is substantially lower (4 m) than estimated from tree growth in these plots.

Table 5. Site 1 (Fd leading) – site index (m) by sample point.

Species	Sple 1	Sple 2	Sple 3	Sple 4	Sple 5	Sple 6	All
Fd	22	21	25	24	20	21	22
Lw			20				20

4. SITE 2 - LW DOMINATED INGRESS

4.1 STAND DENSITY

Stand density fell from 353,229 to 149,792/ha over the last five years - a loss of 203,437 trees/ha (Figure 5, Table 3). This is a mortality rate of 58% (about 12%/year). The highest mortality was Pl at 64% over the five-years, followed by Lw at 58%, and Fd and Sx at 55%.

Stand density also varied greatly among the six sample locations with the 15-year estimates ranging from about 60,000 to 246,000/ha (Figure 6). Mortality rates over the last five years varied from 28-67% among samples (Table 6) and were proportional to starting density. As with Site 1, mortality rates since establishment were more consistent, ranging from 56-70%, except sample location 2 where stand density was lower.

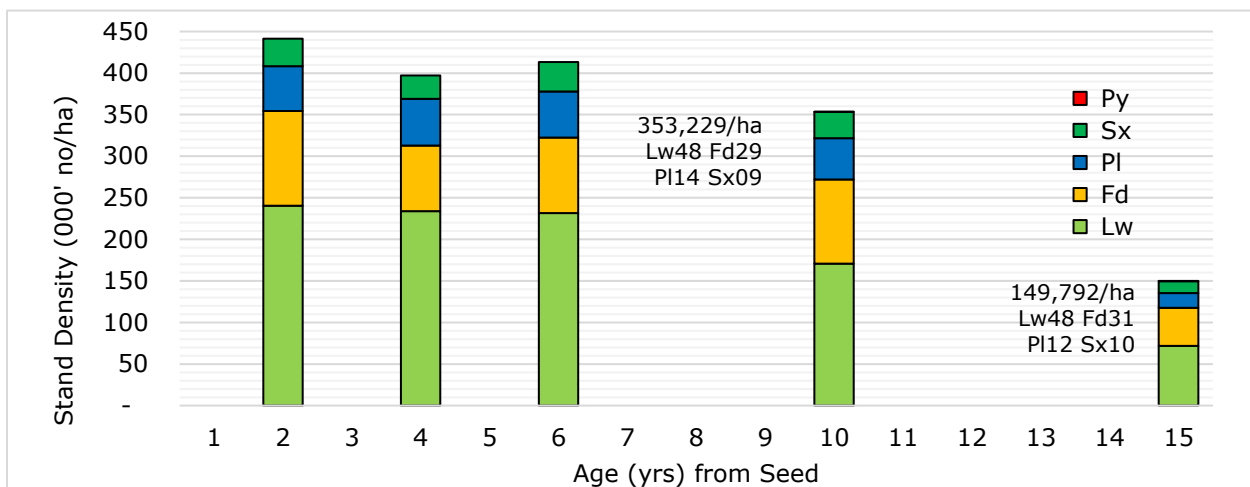


Figure 5. Site 2 (Lw leading) - stand density (average for all sample points). Labels beside the 10- and 15-year bars show stand density and species composition.

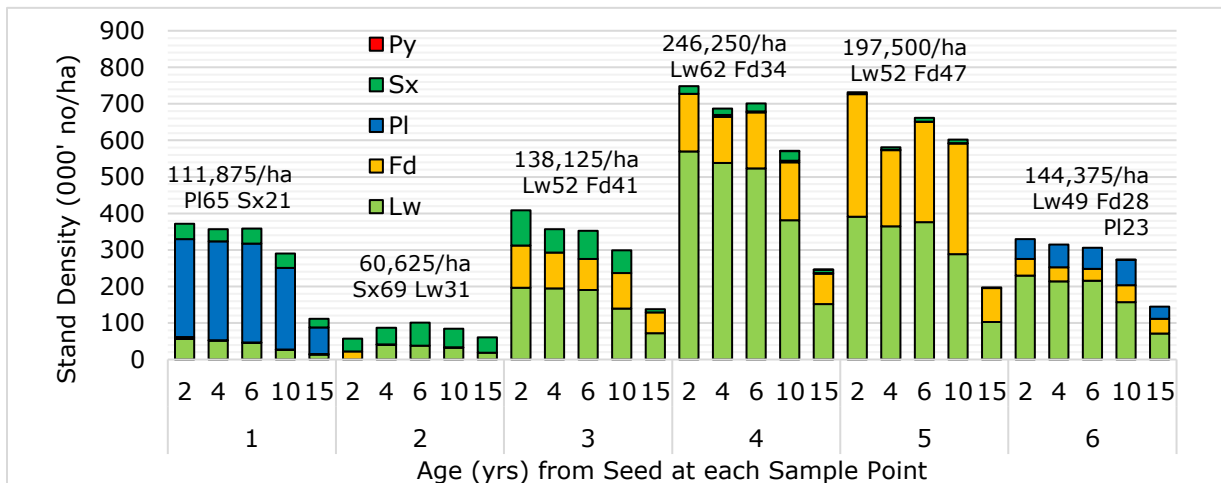


Figure 6. Site 2 (Lw leading) - stand density at each of the six sample points. Labels above each sample are stand density and species composition for the 15-year measurement.

Table 6. Site 2 (Lw leading) - relative mortality rates for the six samples.

Relative Mortality	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	All
Last 5-years	61%	28%	54%	57%	67%	47%	58%
Since establishment	70%	7%	66%	67%	73%	56%	66%

4.2 SPECIES COMPOSITION

As with Site 1, overall species composition did not change much over the last five years. The most recent (15-year) measurement shows the composition as Lw 48%, Fd 29%, Pl 14%, and Sx 09% - essentially the same as the 10-year measurement (Table 3).

4.3 HEIGHT GROWTH

Height growth of dominant Lw trees in the six samples (average of the tallest tree in each of the four plots) showed a lower rate over the last five years than suggested by height-growth curves (from SiteTools) (Figure 7). The average of the tallest trees at each sample was 3.8 m ranging from 3.2 – 4.3 m. The difference in height-growth pattern between the curves and actual trees may be reflecting nuances of the mathematical functions used in the height-growth curves and not actual growth patterns in early years.

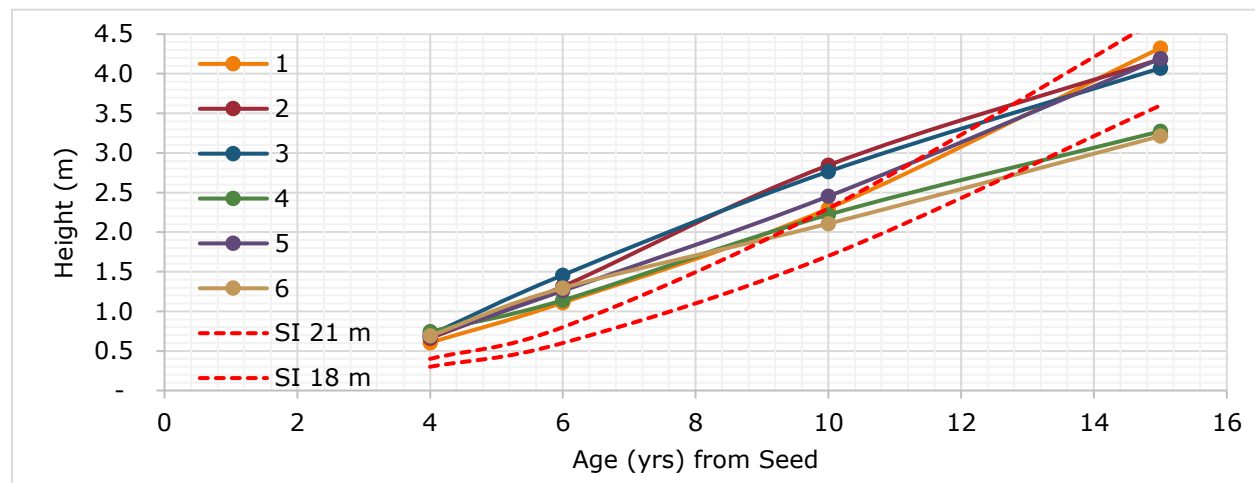


Figure 7. Site 2 (Lw leading) - height of dominant Lw trees at the six sample locations. Lw height growth at site index 18 and 21 m is shown in the dashed red curves (height growth curve from SiteTools).

4.4 SITE INDEX

The estimated Lw site index from tree measurements was 17-19 m at the five sample locations where Lw site trees could be identified (Table 7). Estimates for Pl were available in three of the six sample locations and were all 17 m and about the same as Lw at those locations.

All six samples were in the IDFdm1 (four on 04 sites and two on 01 sites). The SIBEC database estimates site index on 01 sites as 18 m for Lw and Pl (based on no sample data). Our estimates using actual growth were also 18 m. On 04 sites, the SIBEC estimates are 15 m for Lw and Pl

(based on no sample observations). Our estimates based on tree growth were higher at 18 m for Lw and 17 m for Pl.

Table 7. Site 2 (Lw leading) – site index (m) by sample point.

Species	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	All
Lw	17	18	19	17	19		18
Pl	17	17				17	17

5. SITE 3 – PL DOMINATED INGRESS

5.1 STAND DENSITY

Stand density (conifers only) at this site fell from 143,958 to 50,313/ha over the last five years (Figure 8, Table 3). This is a mortality rate of 65% over the last five years (about 13%/year). This is the highest mortality rate of the three sites. The species-specific mortality rates also differed more here than other sites. Pl lost 70% of live stems over the last five years, Fd 33%, and Lw 22%.

Stand density also varied among the sample locations at this site with the 15-year estimates about 19,000 to 79,000/ha (Figure 9). Mortality rates over the last five years ranged from 29-77% among sample locations (Table 8). Again, the rate of mortality was proportional to the density at the last measurements (age 10).

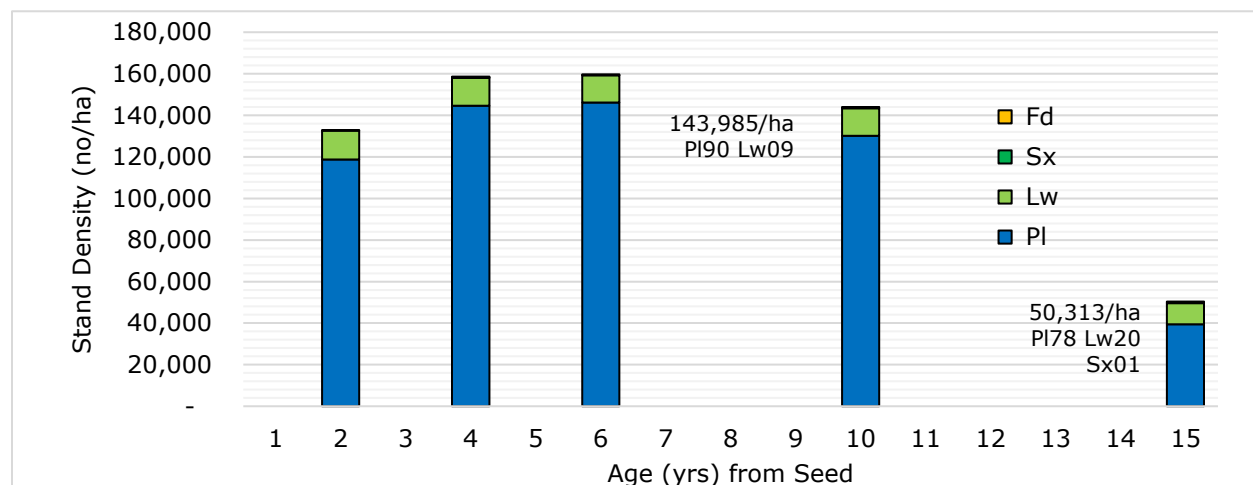


Figure 8. Site 3 (Pl leading) – stand density at the most recent (15 year) and previous measurements. Labels beside the 10- and 15-year bars show stand density and species composition.

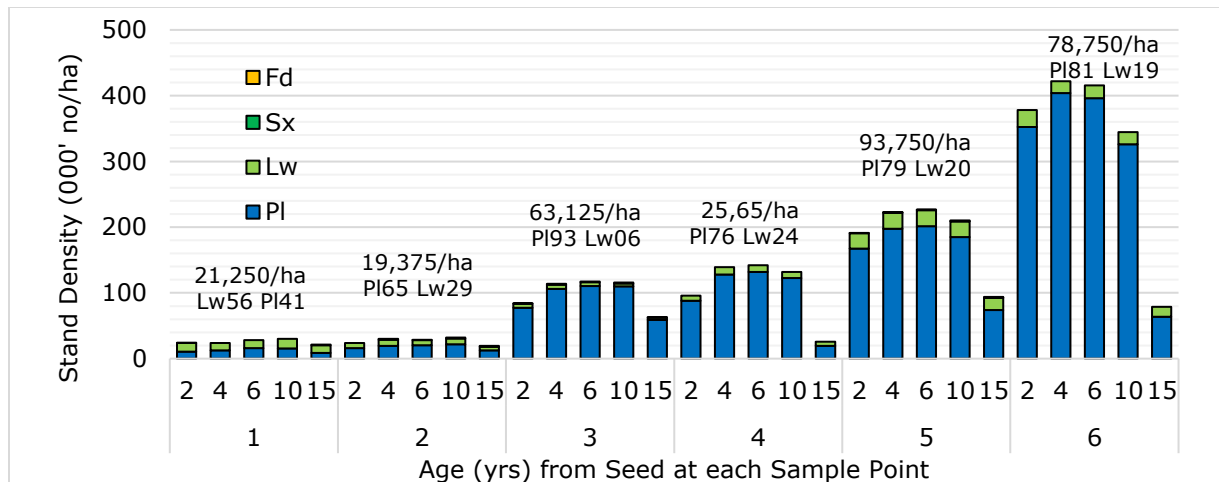


Figure 9. Site 3 (Pl leading) - stand density at each of the six sample points. Labels above each sample are stand density and species composition for the 15-year measurement.

Table 8. Site 3 (Pl leading) - relative mortality rates for the six samples.

Relative Mortality	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	All
Last 5-years	29%	39%	45%	81%	55%	77%	65%
Since establishment	13%	18%	25%	73%	51%	79%	62%

5.2 SPECIES COMPOSITION

Species composition changed slightly over the last five years (resulting from different species mortality rates). The 15-year measurement showed Pl 78%, Lw 20%, and minor amounts of Sx and Py. The 10-year measurements showed about Pl 90% and Lw 09% (not including At that was tallied at the 10 year measurement) (Table 3).

5.3 HEIGHT GROWTH

Height growth of dominant Pl trees (average of the tallest tree in each plot) at the six sample locations followed general patterns indicated in height growth curves (from SiteTools) (Figure 10). The average of the tallest trees at each site was relatively consistent at 3.3–4.0 m.

5.4 SITE INDEX

Although this Site was dominated by Pl, Lw trees were taller and overtopped the Pl. Thus Pl site trees could only be located at two of the six sample locations. To help provide more information on Pl growth, we estimated site index using the tallest tree in each plot with a total age of 15 years. That roughly approximates the tallest 156 trees/ha. The Pl site index was estimated at 16 m at the two samples where site trees could be identified, and about 15 m using the tallest trees in the plot with total age (Table 9). Sample 1 was dominated by Lw and did not

contain Pl site trees. Lw site index was about 18-20 m for the two methods. SIBEC estimates are 18 m for Pl and Lw on these IDFdm1-01 sites; consistent with our estimates.

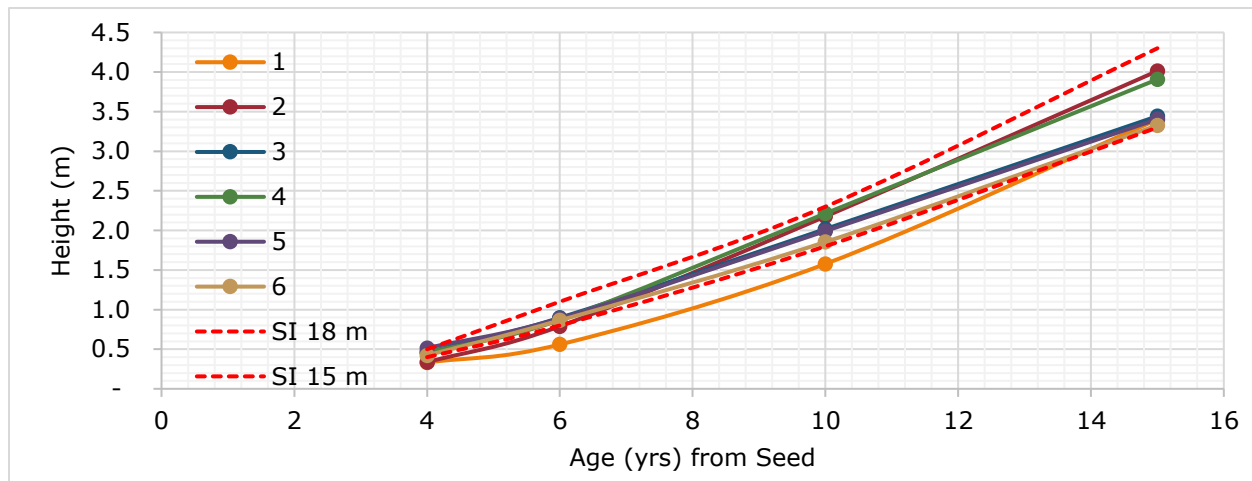


Figure 10. Site 3 (Pl leading) - height of dominant Pl trees at the six sample locations. Pl height growth at site index 15 and 18 m is shown in the dashed red curve (height growth curve from SiteTools).

Table 9. Site 3 (Pl leading) – site index (m) by sample point.

Species	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	All
Pl – Site Trees		18	15				16
Pl – Tallest Trees	15	16	15	16	15	15	18
Lw – Site Trees	19		18	18	18	19	18
Lw – Tallest Trees	20	21	19	20	19	19	20

6. HEIGHT-DENSITY RELATIONSHIPS

6.1 LODGEPOLE PINE

The data from this 15-year measurement do not show a trend of decreasing heights for subplots where Pl is now the tallest tree and increasing establishment densities in those subplots (Figure 11). Data from the previous measurement (after 10 years growth) suggested a possible trend of increasing heights with density but that trend is no longer evident.

The lack of a trend between dominant height and establishment density in Pl is contrary to the general acceptance that height-growth repression occurs in Pl at high establishment densities. This could be explained by all plots being in a state of height growth repression; however, that

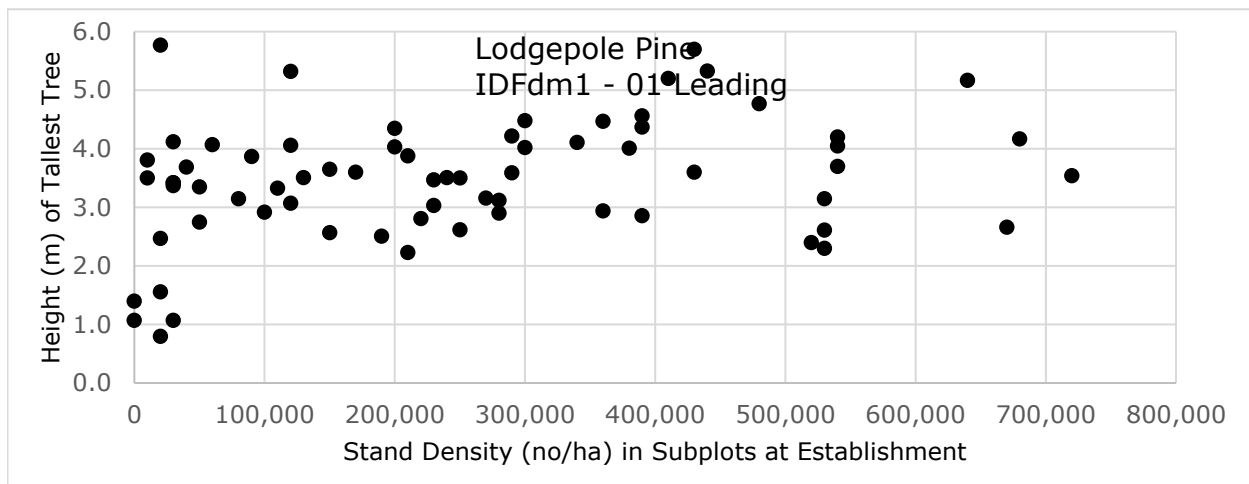


Figure 11. Subplots (1 x 1 m) where Pl is the tallest tree at age 15 and stand density (no/ha) at trial establishment (age 2 yrs).

seems unlikely. The areas where these measurements are taken are very small (1 x 1 m) and there could be repression effects occurring from outside these small plots. It also seems unlikely that this would be occurring everywhere.

More work is needed to further examine possible evidence of repression in this trial. This trial was designed to sample individual cutblocks and is not a statistically designed experiment to investigate impacts of density on dominant height growth. Thus, the ability for this trial to further support that investigation is limited.

6.2 LARCH

Data from the most recent measurement suggest that there is a trend of decreasing height with increasing establishment density in subplots on drier sites (IDFdm1-04) where Lw is now the tallest tree (Figure 12). The same trend is shown for Lw on mesic sites (IDFdm1-01) but it is weaker. Lw is generally not considered to widely experience height-growth repression, but it has been reported in some cases.¹⁰ This is likely not a generally practical issue as Lw in the BC southern interior generally occurs in mixed species stands. Subsequent measurements of this trial may provide more information on this trend.

6.3 DOUGLAS-FIR

The data show a possible weak trend of decreasing heights at establishment densities greater than about 500,000/ha (Figure 13). There are few observations in the range of higher densities and it is possible that the results are confounded with site quality effects. Again, subsequent

¹⁰ Associated Strategic Consulting Experts Ltd. 2016. Repression density treatment decision key. Unpublished Report to Weyerhaeuser Company Ltd., Princeton, BC. April 21, 2016. 54 pp.

measurements and deeper investigation may provide more information relating to possible repression in Fd established at high densities.

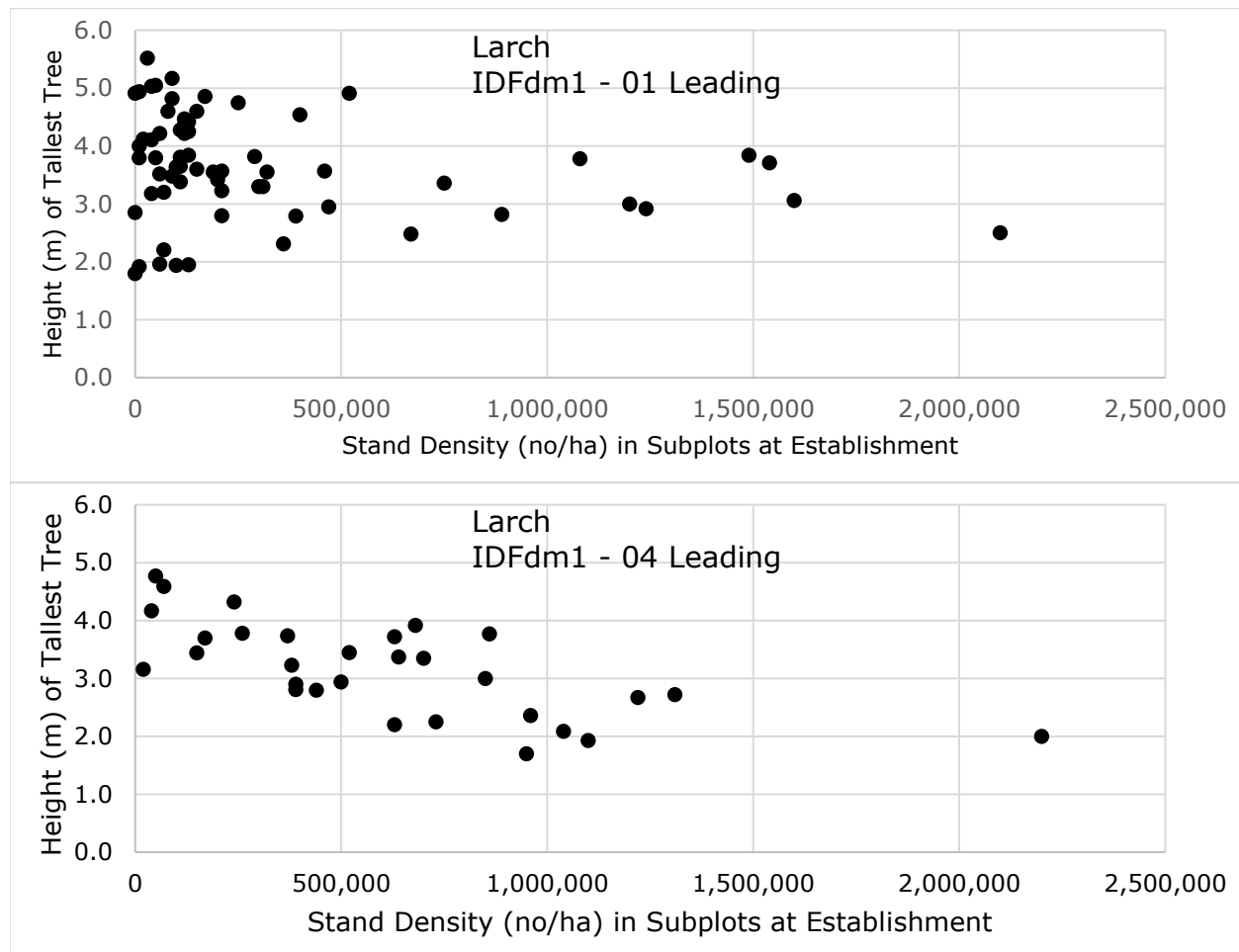


Figure 12. Subplots (1 x 1 m) where Lw is the tallest tree at age 15 and stand density (no/ha) at trial establishment (age 2 yrs).

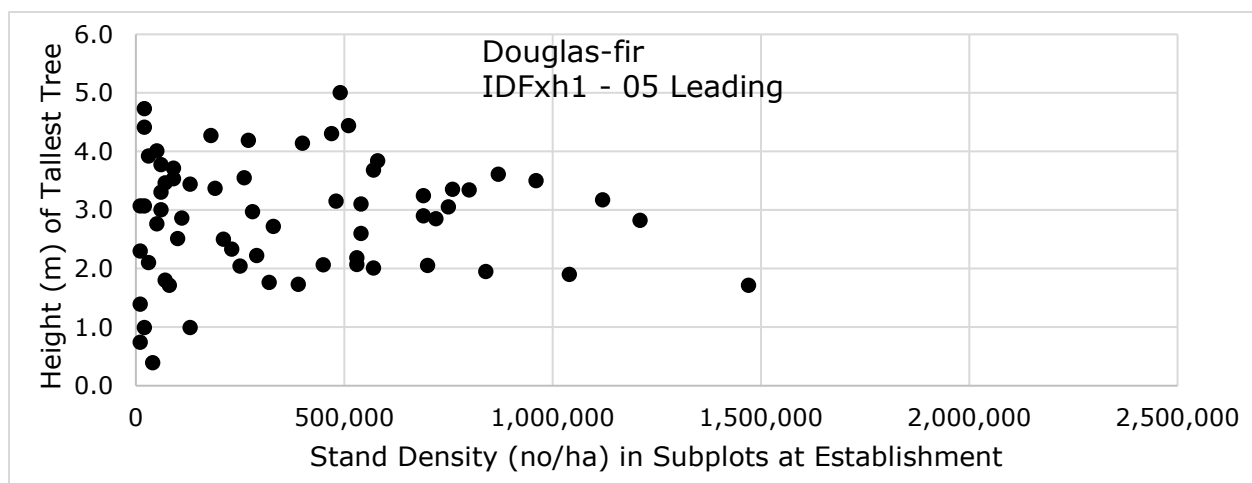


Figure 13. Subplots (1 x 1 m) where Fd is the tallest tree at age 15 and stand density (no/ha) at trial establishment (age 2 yrs).

7. RECOMMENDATIONS

My recommendations to Weyerhaeuser for the continuation of this trial are:

1) **Convert the plot clusters to a standard PSP.**

This would require expanding the plot size to 400 m². Most PSPs are circular (11.28 m radius), but in this case it is probably better to use a 20 x 20 m square plot given the original square plot design and square buffer. This will also require tagging all trees (including At) to allow tracking of individual tree attributes in future analyses. The plots in this trial would then be consistent and compatible with other growth and yield PSPs and research installations in BC.

2) **Maintain a five-year measurement cycle.**

A five-year remeasurement period provides adequate temporal resolution to capture stand dynamics into the future and would be consistent with most research trials in BC.

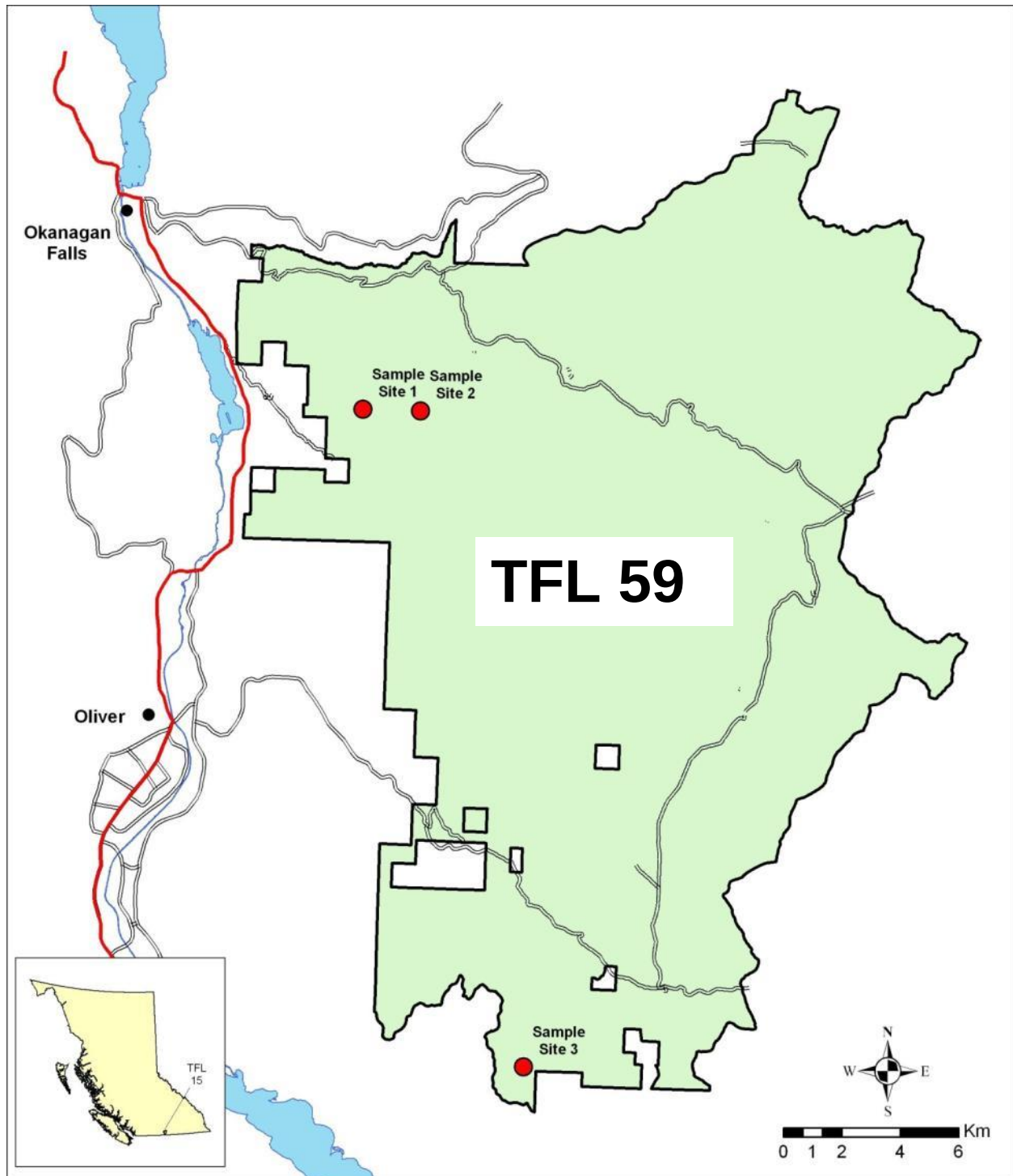
3) **Continue site index measurements.**

Estimate site index for all species in all plots where suitable site trees can be located. This is standard practice in PSPs. Split these 400 m² square plot PSPs into four 100 m² quadrants and select site trees from each quadrant.

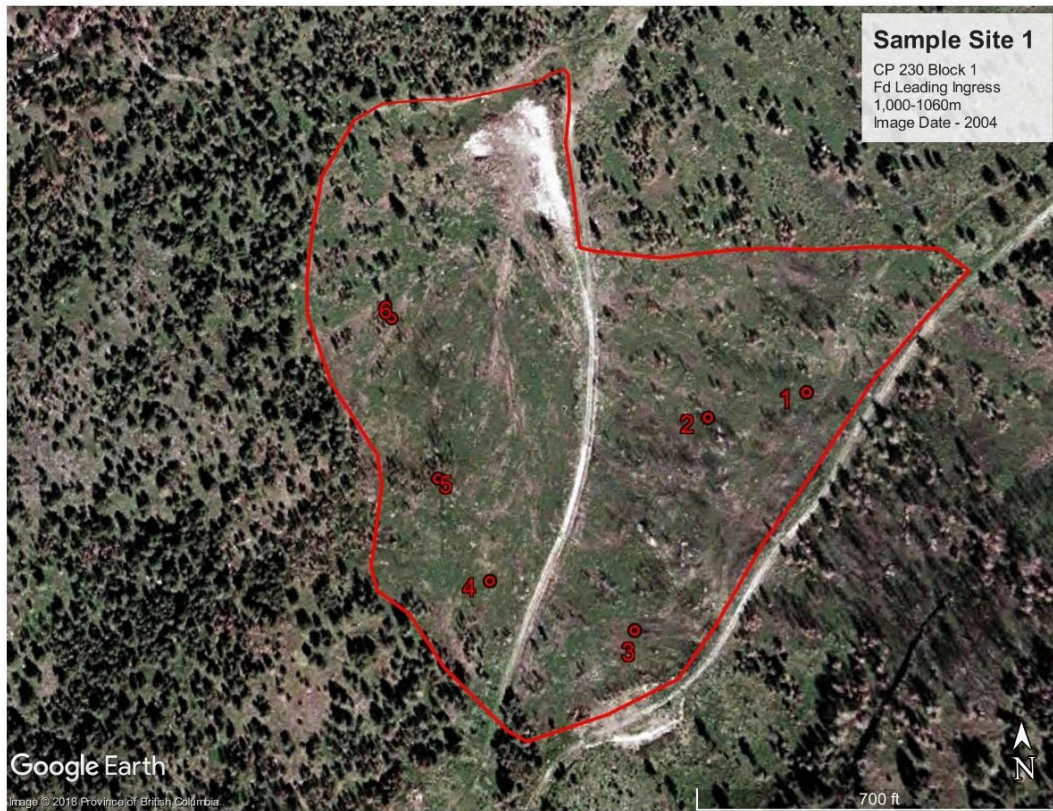
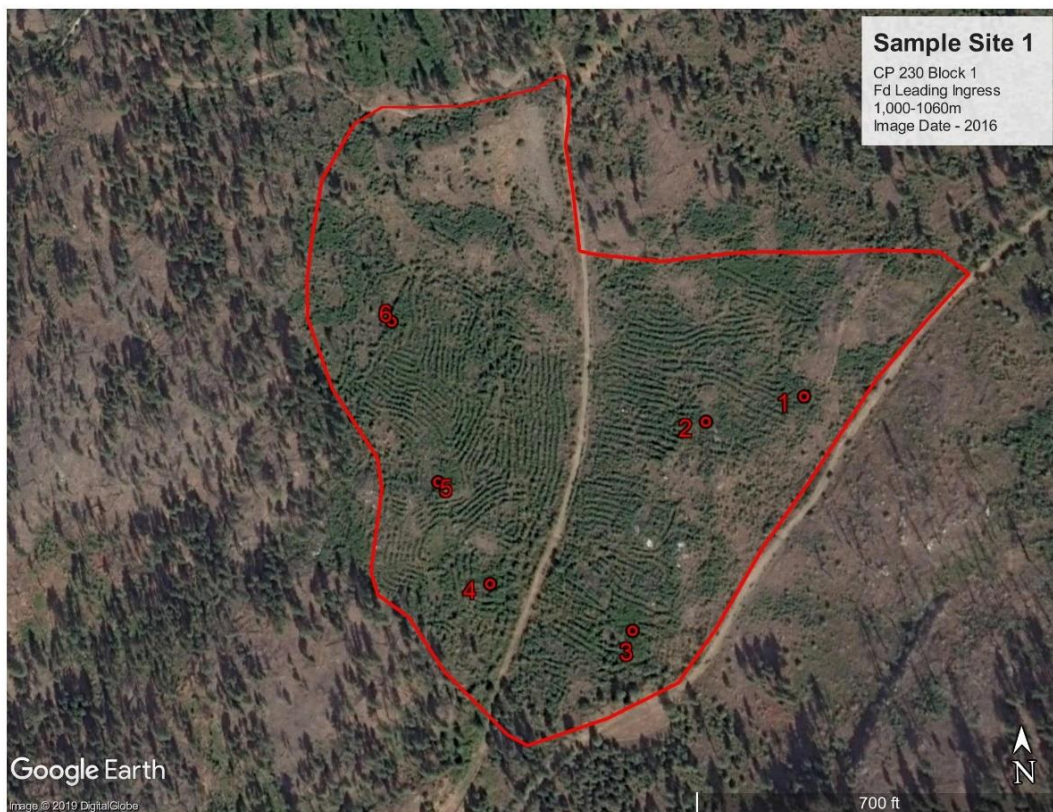
4) **Approach the MOF to include this trial into their program.**

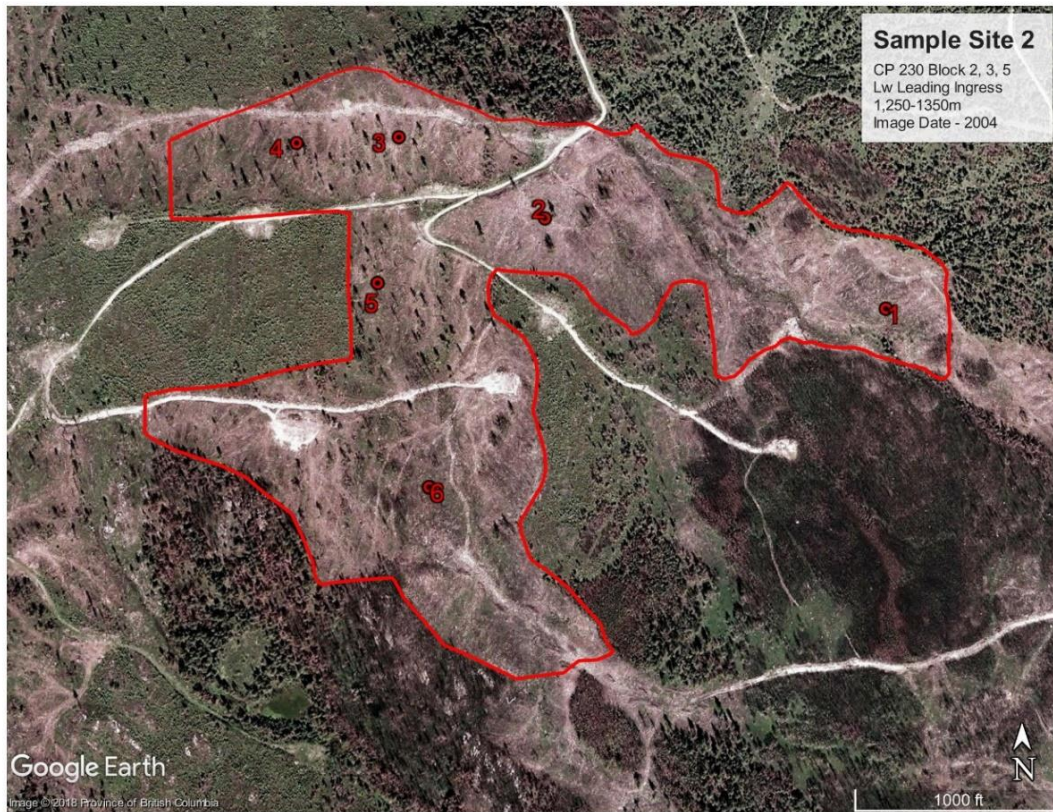
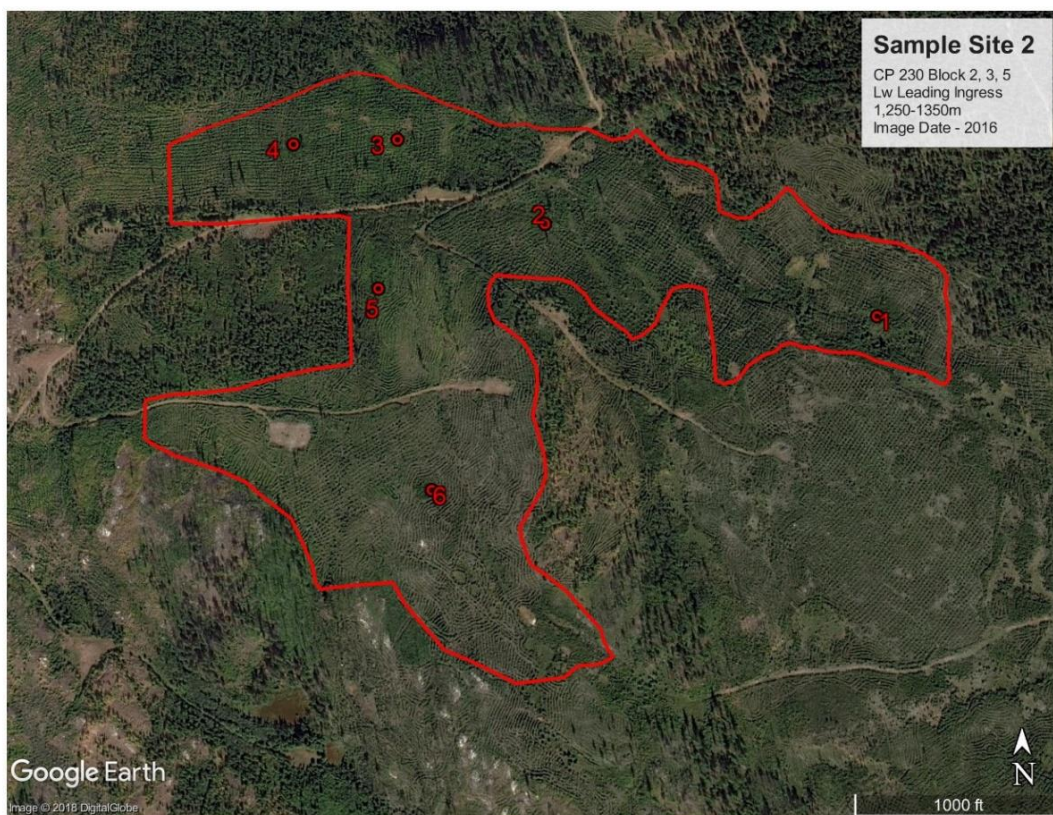
It is probably worthwhile investigating the willingness of the MOF to take over the funding and maintenance of this trial. Converting these plots to standard PSPs could cost \$40,000 - \$50,000. Each subsequent remeasurement could cost \$20,000 - \$25,000. This trial could provide valuable information to supplement existing MOF trials and should be of great value.

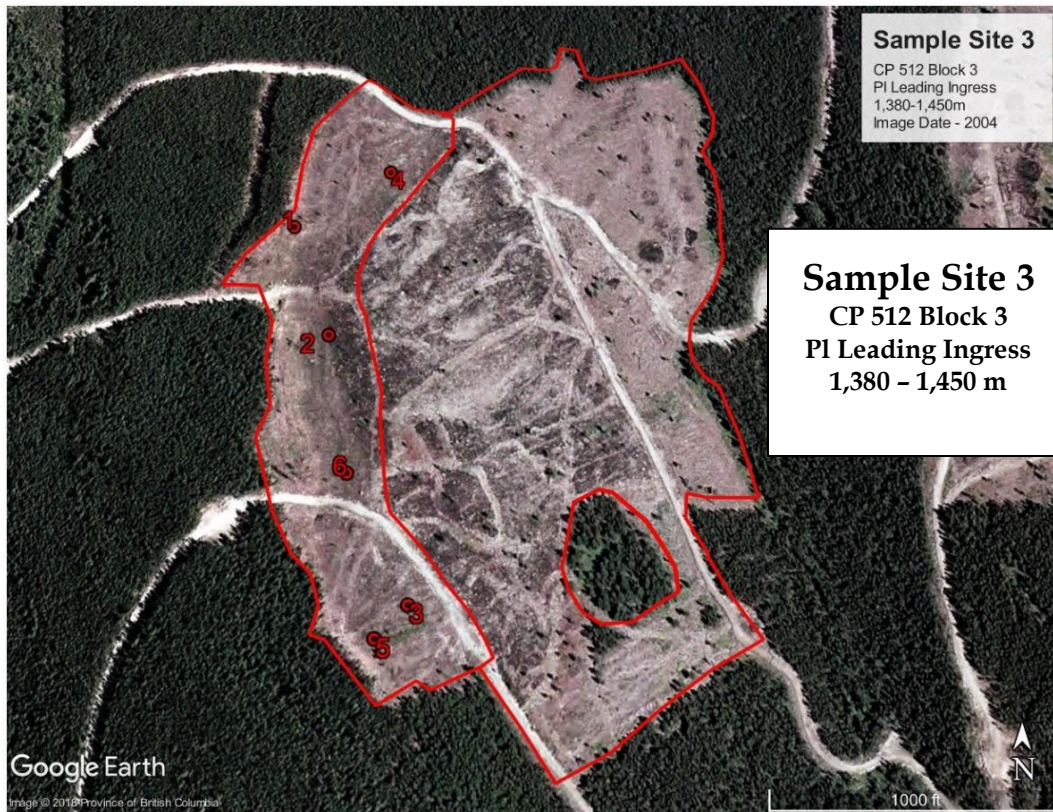
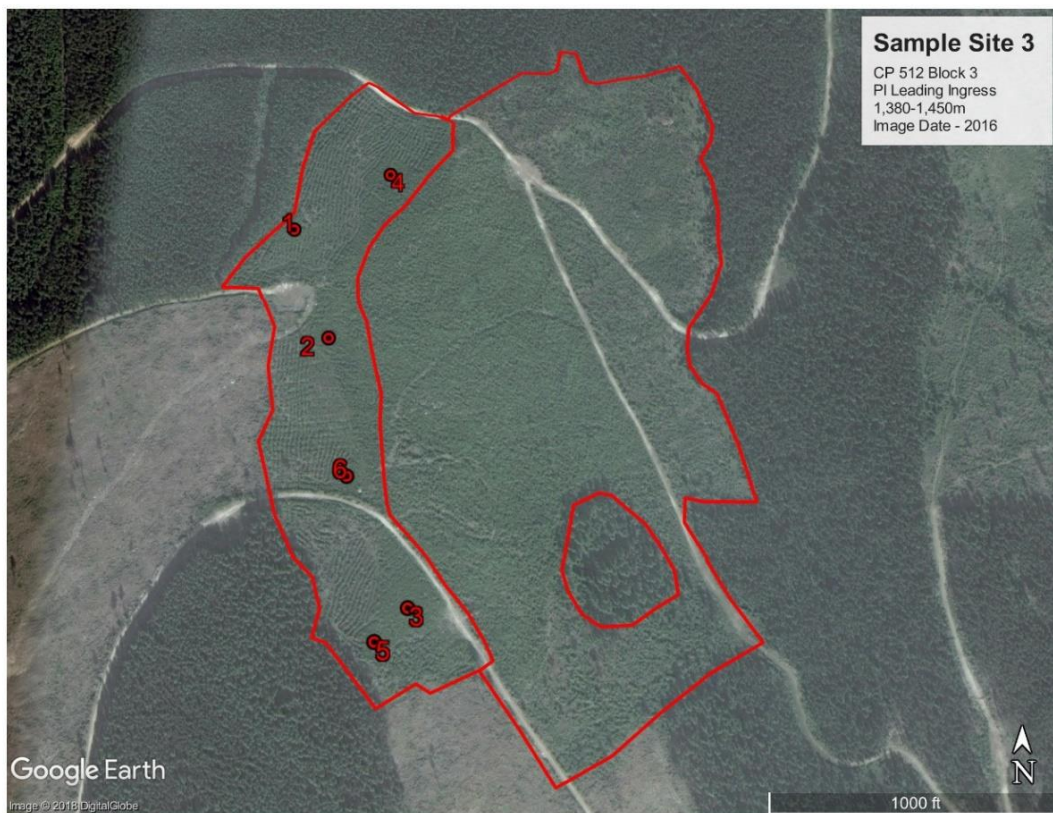
APPENDIX 1 - SAMPLE SITES ON TFL 59



APPENDIX 2 - SAMPLE POINT LOCATIONS







APPENDIX 3 - CHRONOLOGY OF EVENTS

2003	Pre-Growing Season	Wildfires burn timber on TFL 59 and elsewhere. Salvage harvesting of burnt timber.
	Growing Season	
	Post-Growing Season	
2004	Pre-Growing Season	Salvage harvesting of burnt timber. 1 st growing season after harvest. First signs of-high density ingress.
	Growing Season	
	Post-Growing Season	
2005	Pre-Growing Season	2 nd growing season after harvest. First measurement started. Site 1 plots installed.
	Growing Season	
	Post-Growing Season	
2006	Pre-Growing Season	First measurement completed. Site 2 and 3 plots installed. 3 rd growing season after harvest.
	Growing Season	
	Post-Growing Season	
2007	Pre-Growing Season	4 th growing season after harvest.
	Growing Season	
	Post-Growing Season	
2008	Pre-Growing Season	Second measurement completed. Brush and height added. 5 th growing season after harvest.
	Growing Season	
	Post-Growing Season	
2009	Pre-Growing Season	6 th growing season after harvest. Third measurement completed.
	Growing Season	
	Post-Growing Season	
2010	Pre-Growing Season	7 th growing season after harvest. Chemical spacing of site 1, 3, and parts of 2.
	Growing Season	
	Post-Growing Season	
2011	Pre-Growing Season	8 th growing season after harvest.
	Growing Season	
	Post-Growing Season	
2012	Pre-Growing Season	9 th growing season after harvest. Mechanical spacing of parts of site 2.
	Growing Season	
	Post-Growing Season	
2013	Pre-Growing Season	10 th growing season after harvest Fourth measurement completed.
	Growing Season	
	Post-Growing Season	
2014	Pre-Growing Season	11 th growing season after harvest
	Growing Season	
	Post-Growing Season	
2015	Pre-Growing Season	12 th growing season after harvest
	Growing Season	
	Post-Growing Season	
2016	Pre-Growing Season	13 th growing season after harvest
	Growing Season	
	Post-Growing Season	
2017	Pre-Growing Season	14 th growing season after harvest
	Growing Season	
	Post-Growing Season	
2018	Pre-Growing Season	15 th growing season after harvest Fifth measurement completed. Brush and aspen not measured.
	Growing Season	
	Post-Growing Season	