



Free Growing Into What?

What works on the BC coast?



Image courtesy of: D. Piggot



Image courtesy of: D. Piggot

Summer Workshop June 19th & 20th 2013

Nanaimo/Ladysmith, BC



Image courtesy of: M. Vallee

Free Growing Into What?

"Free Growing into What?" is the theme of the 2013 CSC Summer Workshop - we will follow-up on the 2013 CSC Winter Workshop principles, where concepts and practical aspects related to Free Growing were re-visited. As we are all aware, Free Growing is simply a milestone on the journey through time to create a desired forest, be it future timber supply, winter deer habitat, visually pleasing landscape, or trees resilient to current and future climates. Usually, all these objectives are assessed at the stand level although there are many implications to wider landscape levels. So, to discuss the "Into What?" CSC has chosen a range of sites to promote knowledge transfer and discussion, including several long-term research trials as well as operational sites in the Nanaimo area on Vancouver Island. We will look at mixtures of grand fir with alder, trials of resistant white pine, progeny trials of genetic gain in Douglas-fir, application of biosolids, and processing facilities of wood products, just to name a few. Each stop will be described and explained to facilitate discussion on ways Free Growing practices may influence Coastal forests both short-term and long-term.

The Coast Silviculture Committee wishes to thank the organizing committee, all the presenters and their employers for their contribution of time and effort in making this workshop a valued and enjoyable learning experience.

Special thanks to...

Organizing committee

Chairs – Craig Wickland & Michel Vallee

- | | |
|------------------|--------------------|
| - Bryce Bancroft | - Doug Corrin |
| - Ron Elder | - Cosmin Filipescu |
| - Lauchlan Glen | - Lisa Meyer |
| - Don Pigott | - Jack Sweeten |
| - Dave Weaver | |

Presenters

Rod Negrave, MFLNRO
Ed Korpola, MFLNRO
Mike and Peter Steeves, Otter Point Timber
John King, MFLNRO (retired)
Rick Monchak, TimberWest Forest Corporation
Cosmin Filipescu, Canadian Wood Fibre Centre
Brian Saunders, Consultant
Les Jozsa, FPIinnovations (retired)
Dean Stewart, MFLNRO
Stefan Zeglen, MFLNRO
Charlie Cartwright, MFLNRO
Brian D'Anjou, Consultant
Michel Vallee, Vancouver Island University

Coast Silviculture Committee
2013 Summer Workshop Program
Day One

| Wednesday June 19 th 2013 | | | |
|--|---|--|--|
| Time | Location | Activity | Presenter |
| 8:30 to 9:30 – Workshop Registration at the Vancouver Island University Parking Lot “J” | | | |
| 9:30 | Depart VIU parking lot “J” for stop #1 | | |
| 10:00 to 11:00 | Stop# 1 South Watts road Ladysmith | Mixed Species Management. Grand fir/red alder plantation trial...what we’ve learnt after 20 years. Stocking standards with a fire management objective. | Rod Negrave, PhD – Research Team Leader, MFLNRO Ed Korpela, PhD – Fire Management Specialist, MFLNRO |
| 11:00 - 12:00 | Stop #2 Thicke road Ladysmith | Quality and Value Added from Breeding – what pole producers look for from our second growth trees. | Mike and Peter Steeves, Otter Point Timber Cosmin Filipescu, PhD – Research Scientist, Canadian Wood Fibre Centre(NRCAN) |
| 12:05 to 13:00 | Transfer Beach park - Ladysmith Lunch – provided | | |
| 13:30 to 14:30 | Stop #3 Bush Creek road | White pine provenance trial Pw and blister rust. Operational considerations of using Pw. | John King, PhD – Forest Genetics Researcher (retired). Rick Monchak, RPF – Operations Forester, TimberWest Forest corp. |
| 14:45 to 16:45 | Stop #4 Nanaimo River park | Douglas fir breeding trial. - Overview of the 34 year old trial. - Fdc breeding program - Wood properties - Sampling and quality assessment using LiDAR | Don Pigott, Yellow Point Propagation Michael Stoehr, PhD – Forest Genetics Researcher, MFLNRO Cosmin Filipescu, PhD – Research Scientist, Canadian Wood Fibre Centre(NRCAN) Brian Saunders, RPF – Forestry consultant |
| 17:00 | Libations and Dinner | At... Chez Pigott’s of Yellow Point | |
| 19:00 | Speaker | IMPACT OF STAND TENDING ON WOOD QUALITY | Les Jozsa, PhD – Research Scientist Emeritus, FPInnovations, Forintek. (2010) |
| 20:00 | | Bus #1 returns to VIU parking lot | |
| 21:00 | | Bus #2 returns to VIU parking lot | |

Coast Silviculture Committee
2013 Summer Workshop Program
Day Two

| Thursday June 20 th 2013 | | | |
|-------------------------------------|---|---|---|
| Time | Location | Activity | Presenter |
| 8:30 | Buses leave VIU parking lot "J" | | |
| 8:30 to 9:30 | Stop #1 Nanaimo Lks road | Site treatment option for root rot in a 20 year old plantation. | <i>Dean Stewart, RPF - MFLNRO</i> <i>Stefan Zeglen, MS - Forest Pathologist, MFLNRO</i> |
| 9:45 to 10:15 | Stop #2 Mt Benson road | 15 year old tree improvement demonstration trial – Yc/Ss/Hw/Fdc | <i>Don Pigott, Yellow Point Propagation</i> <i>Charlie Cartwright, MS - Forest Genetics Researcher, MFLNRO</i> |
| 10:15 to 10:35 | Coffee break stop | | |
| 10:45 to 11:45 | Stop #3 Mt Benson road | Spacing and thinning in an 70 year old plantation | <i>Dean Stewart, RPF - MFLNRO</i> |
| 12:00 to 13:30 | Lunch at VIU | | |
| 13:45 to 14:45 | Stop #4 VIU WL020 BLK 17 | Forest fertilization with Biosolids – a performance study | <i>Brian D'Anjou, MS, RPF, Forest Research Consultant (tentative)</i> |
| 14:45 to 15:15 | Stop #5 VIU WL020 BLK SC1 | Biosolids applications and plantation management. - considerations when fertilizing with biosolids | <i>Michel Vallee, RPF – VIU Forestry Department</i> |
| 15:15 to 16:00 | Adjourn and return to VIU | | |

June 19th 2013

Stop #1

South Watts Road

Mixed Species

Trial

CSC – Summer Workshop 2013 – Day 1 Stops #1 and 2



Presenter Biography and Abstract

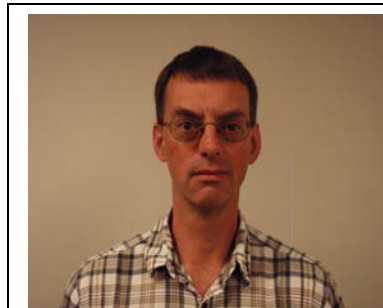
Biography:

Name: Rod Negrave
Affiliation: FLNRO, Coast Area
Position: Research Section Head/Research
Silviculturist

Responsibilities: Research Section administration
Silvicultural research

Academic training: PhD (Forestry), UBC 2004; MSc,
Forest Science, U of Alberta, 1993; BSc (Agr), UBC, 1988

Previous employment: Alberta Parks & Protected Areas, Northern Lights College, self-employed.



Presentation Abstract:

Grand Fir – Alder Replacement Series Experiment

In 1993, a trial was established to study the effects of growing red alder (Dr) and grand fir (Bg) in mixture. An incomplete replacement series was established with three levels of species combination: 100% Bg (BG100); 85% Bg - 11% Dr (BG89); and 75% Bg -25% Dr (BG75). The trial was established at an initial spacing of 3 x 3 m (1111 sph). Plots were randomly assigned and replicated three times. The trial site was located in the CDFmm/01,04,05 with soil texture ranging from LS to SL., supported a dense shrub community dominated by salmon berry and was heavily impacted by ground traffic during logging.

The five year measurement, in 1998, showed mean Bg treatment heights of 1.78 m, 1.66 m, and 1.95 m respectively for BG100, BG89 and BG75. Mean height of Dr was 5.85 m and 6.23 m in the BG89 and BG75 treatments, respectively. Cumulative mean Bg mortality was 15 %, 6% and 3 %, respectively for Bg100, Bg89 and Bg75. Mortality was significantly greater ($p = 0.0094$) in BG100. Dead trees were replaced annually with replanting. Replanted trees were not included in the 1998 estimation of treatment heights.

The 17-year re-measurement (2010-'11) of the site indicated a trend where Bg had greater height growth than Dr. Annual height increments for the period were 0.84 m, 1.05 m, and 0.97 m, respectively, for Bg in the BG100, Bg89, and BG75 treatments. Comparable measures for Dr were 0.48 m and 0.57 m in the BG89 and BG75 treatments. Heights were 12.2 m, 12.1 m and 11.7 m, respectively, for Bg in BG100, BG89, and BG75 treatments. Heights of Dr were 11.6 m and 11.7 m in the BG89 and BG75 treatments. Volume of Bg was 129.2 m³/ha, 130.5 m³/ha, and 93.2 m³/ha in BG100, BG89, and BG89 treatments respectively, while total volume (Bg + Dr) was 148.0 m³/ha and 142.3 m³/ha in the BG89 and BG75 treatments. Grand fir generally exceeded growth of Dr due to site climate, moisture regime and repeated die back of the alder. Sites in the CDF, such as this one, experience summer soil moisture deficit, which stresses alder, causing mortality and die back. This is particularly true during open early plantation conditions, when sun scald of Dr is also a factor.

Growth of Grand Fir in Mixture with Red Alder

In 1993, a trial was established to study the effects of growing red alder (*Alnus rubra*) and grand fir (*Abies grandis*) in mixture. It was theorized that, since grand fir had more shade tolerance than Douglas-fir, its growth would be less impacted by alder, especially when grown in drier areas.

Methods

The trial site was located in the CDFmm/01,04,05 with soil texture ranging from LS to SL., supported a dense shrub community dominated by salal and salmonberry and was heavily impacted by ground traffic during logging.

An incomplete replacement series was established with three levels of species combination: 100% Bg (BG100); 85% Bg - 11% Dr (BG89); and 75% Bg -25% Dr (BG75). The trial was established at an initial spacing of 3 x 3 m (1111 sph). Plot dimensions were 33 x 63 m for BG100 and BG75 treatments, for a core measurement area of 15 x 45 m (675 m²) and 36 x 63 m for the BG89 treatment, with a core area of 18 x 45 m (810 m²). Plots were randomly assigned and replicated three times. The experiment was subsequently organized into three blocks, to account for differences in site conditions. Analysis was conducted using a replicated complete block design with the mixtures as a fixed effect, block as a random effect, and $p < 0.05$ as the significance level. The site was measured in 1998 and again in 2010.

Results

The five year measurement, in 1998, showed mean grand fir treatment heights of 1.78 m, 1.66 m, and 1.95 m respectively for BG100, BG89 and BG75. Mean height of Dr was 5.85 m and 6.23 m in the BG89 and BG75 treatments, respectively (Figure 1).

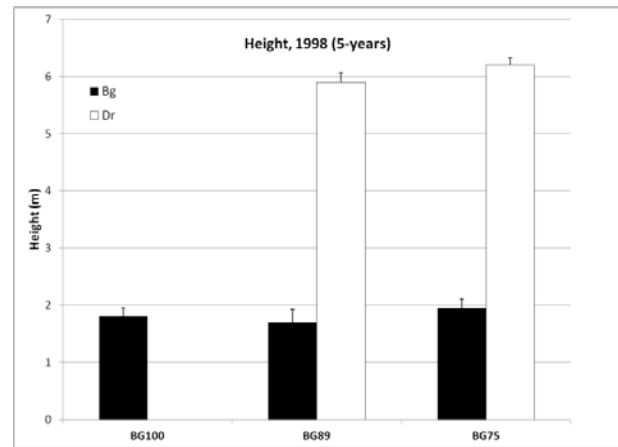


Figure 1.

Cumulative mean grand fir mortality was 15 %, 6% and 3 %, respectively for Bg100, Bg89 and Bg75. Mortality was significantly greater ($p = 0.0094$) in BG100 (Figure 2). Dead trees were replaced annually with replanting. Replanted trees were not included in the 1998 estimation of treatment heights.

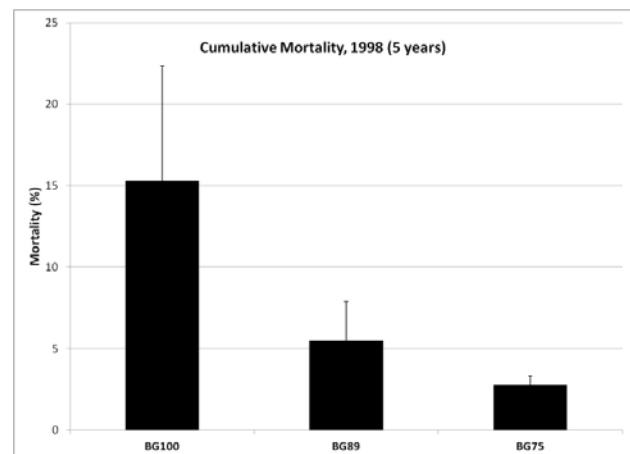


Figure 2.

The 17-year re-measurement (2010-'11) of the site indicated a trend where grand fir had greater height growth than alder. Annual height increments for the period were 0.84 m, 1.05 m, and 0.97 m, respectively, for grand fir in the BG100, Bg89, and BG75 treatments (Figure 3). Comparable measures for Dr were 0.48 m and 0.57 m in the BG89 and BG75 treatments. Heights were 12.2 m, 12.1 m and 11.7 m,

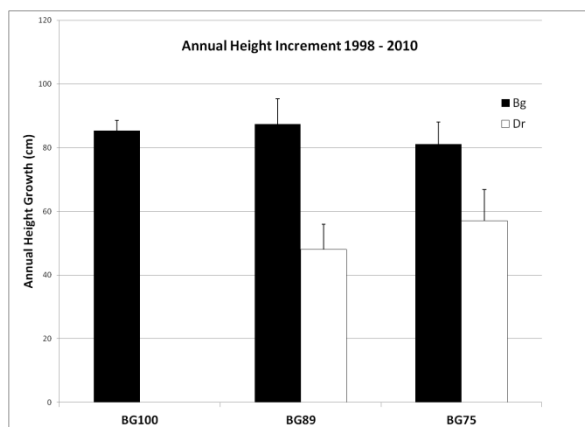


Figure 3.

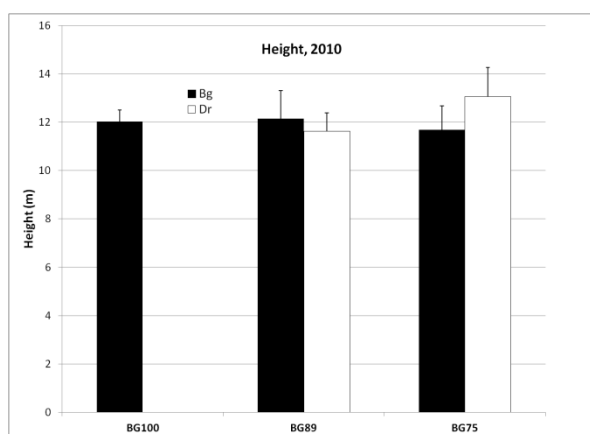


Figure 4.

respectively, for grand fir in BG100, BG89, and BG75 treatments. Heights of alder were 11.6 m and 11.7 m in the BG89 and BG75 treatments (Figure 4). Volume of grand fir was 129.2 m³/ha, 130.5 m³/ha, and 93.2 m³/ha in BG100, BG89, and BG75 treatments respectively, while total volume (grand fir plus alder) was 148.0 m³/ha and 142.3 m³/ha in the BG75 and BG89 treatments (Figure 5). Size of individual grand fir trees was not reduced by inclusion of alder in the stand (Figure 6)

Grand fir growth generally exceeded that of alder due to site climate, moisture regime and repeated die back of the alder. Sites in the CDF, such as this one, experience summer soil moisture deficit, which stresses alder, causing

mortality and die back. This is particularly true during open early plantation conditions, when sun scald of alder is also a factor.

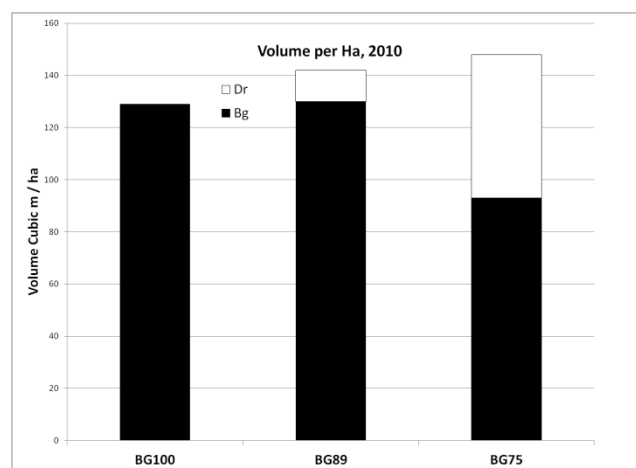


Figure 5.

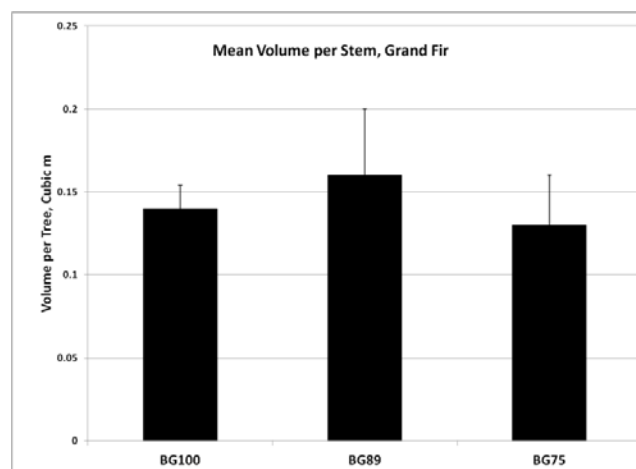


Figure 6.

Conclusion

Red alder did not significantly reduce grand fir growth at a substitution of up to 25%. The site was thinned to reduce the proportion of grand fir in 2012 and future plans are to introduce a cohort of western red cedar (*Thuja plicata*) into the understory.

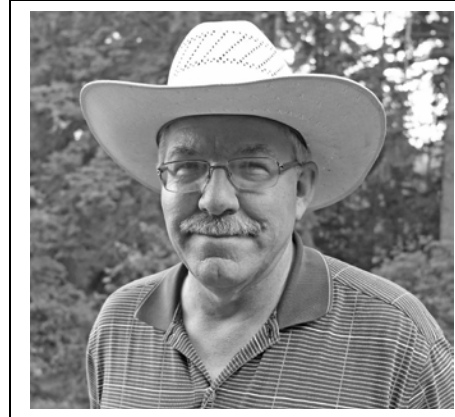
Prepared by:

Rod Negrave PAg, RPF, PhD Research Section, Coast Area, FLNRO
Paul Courtin RPF (Ret) Research Pedologist (retired). MoF

Presenter Biography and Abstract

Biography:

Name: Ed Korpela
Affiliation: MFLNRO
Position: Fire Management Specialist
Responsibilities: Fire Management Planning and
Fire Effects/Ecology
Academic training: BS Forestry, BS Range Mgmt,
MS Forestry/Range, PhD. Range Science
Previous employment: Alberta Research Council,
Consultant, Oregon State University, Humboldt State
University, Bureau of Land Management



Presentation Abstract:

The Province is working on developing stocking standards for fire management purposes. The purpose of this presentation is to both review the basics with respect to stocking standards and to present current thinking on stocking standards for the purpose of fire management.

The discussion will focus not only the why, where and when of fire management stocking standards, but also upon the principles behind the proposal of a fire management stocking standard. This is essentially a discussion of the relationship between fire management and tree production objectives relative to proposed stocking. Associated issues and activities will also be discussed. Your feedback will be very helpful in the continued development of these standards.

Stocking Standards with a Fire Management Objective.

Ed Korpela

Fire Management Specialist WMB FLNRO

(The following is condensed from draft Guidance on fire management based stocking standards. Please note it is draft and presented here to help with the discussion.)

Fire Management Stocking Standards

Why – Protection of values and potentially landscape fuels management – a stocking standard is one of the tools we have to achieve landscape and local fire management objectives.

Some Stocking Standard Basics:

- Stocking standards provide the basic linkage between the harvest of a forest stand and the regeneration of a new stand.
- Within BC “Stocking Standards” means the tree stocking standards that apply when (a) establishing a free growing stand AND b) meeting the requirements of FPPR section 44 (4) - covers commercial thinning, intermediate cuts and harvesting for special forest products “
- As such stocking standards typically include:
 - 1) A description of the regeneration. The description of the regeneration includes a list of ecological suitable species, stand density (target number and minimum number per hectare), minimum inter-tree distance, free growing height and height to brush (i.e. competition) ratio.
 - 2) A description of the remaining overstory if it is intended to contribute to stocking (e.g., partial harvest). This description typically includes maximum and minimum basal area, a listing of ecologically suitable species and appropriate leave tree criteria.
 - 3) Stocking standards also include a description of where and when the standard would be applied (e.g., situations and circumstances) – within or near interface (in BC within 2 km of 10-1000 structures per sq km communities), other values on the landbase, fuels management.

What is a Fire Management Stocking Standard?

A Fire Management Stocking Standard is a combination of:

- Fire management objectives,
- Other compatible objectives (e.g. acceptable timber production, ecosystem restoration, hardwood production, etc),
- and stand structure considerations.

Fire Management Objectives

- Site specific, Local landscape or broad landscape

- Enhance suppression effectiveness, reduce impact to values, provide for ecologically good fire
- Involved with changing fire characteristics – type, intensity, rate of spread, size, impact
- Crown fire is a function of canopy bulk density, crown base height, burnable ground fuel and weather (wind).

Stand Structure and Composition Considerations

The following is a brief discussion about several stand structure considerations relative to fire and fuel concerns. Note that this is not a complete discussion but is intended to highlight some of the ways in which these factors can potentially interact for consideration in the development of a fire management stocking standard. Those developing a fire management stocking standard are encouraged to consult with qualified professionals.

- **Topography.** Fire travels upslope faster than downslope due to preheating of fuels. Southerly aspects tend to be warmer and drier than northerly aspects.
- **Species.** Different tree species have different characteristics with respect to fire. Species differ with respect to canopy characteristics, flammability and fire resistance and resilience. Generally deciduous species are less flammable than coniferous species and as a result may reduce fire behaviour. Canopy bulk density is a key variable driving the development of crown fire and species with less dense crowns may be less likely to initiate or promulgate crown fire. As crown base height is an additional variable driving crown fire some species have a greater tendency to lift crown base heights than others as a result of less available light. Those species with a greater tendency to self prune may also be less likely to promote crown fire. Species that do not self prune well enough may require pruning treatments in order to achieve fire management objectives. Different species also contribute variably to ground fuels which may enhance ground or crown fire. As a result of differences in bark characteristics tree species have differing ability to withstand the effects of fire, enhancing resilience are different reproduction strategies whether it be sprouting or fire enhanced regeneration from seed.
- **Inter-tree Distance.** Inter-tree distance influences stand density and hence influences canopy bulk density, canopy base height and within stand environmental parameters (e.g. temperature, humidity, etc) and moisture relations. Denser stands may increase the probability of crown fire while less dense stands may reduce the probability and provide greater suppression capability. More open stands may also result in additional surface and ground fuels.
- **Ecological Suitability.** Tree species selected for a fire management stocking standard do need to be ecologically suited. Use of maladapted species, within a fire management stocking standard, because of their desirable fire characteristics is not likely to result in achieving the desired fire management objectives.

- **Genetics.** Genetic considerations in tree selection for stocking may be a key factor in the success of a fire management stocking standard. Planted species selected for height growth may be able to grow rapidly enough to suppress understory and competition thus perhaps achieving one or more of the fire management related objectives.
- **Tree/Competition Height Ratios.** Opportunistic use of tree/competition height ratios may also enhance the ability to achieve fire related objectives in a stocking standard. Given that deciduous species reduce fire behaviour the use of deciduous competition as part of the standard may well contribute to achieving fire management objectives.
- **Forest Succession and In-Growth including Understory.** Fire management stocking standards need to consider the vegetation response of a site post harvest. The response may enhance or hinder the ability of a standard to achieve fire management stocking standard objectives. The rate at which the response occurs may also impact the design of the stocking standard. Depending upon circumstance the stocking standard may need to address maximum density.
- **Climate Change Considerations.** Climate change considerations may influence the design of the standard particularly choice of species but may also impact the assessment of what the fire management objectives are or should be.

Additional Considerations

Additional considerations not necessarily directly related to the standard developed are important to the efficacy of a fire management stocking standard. These include:

- Hazard abatement. Hazard abatement following an industrial activity (i. e. harvesting, thinning, etc) is required under the Wildfire act and associated regulation. Fuel loading pre- and post-harvest are important considerations for the development of a fire management stocking standard. Continuity and loading particularly of fine fuels has a major influence on fire rate of spread as well as intensity. Guidance around hazard abatement has been developed by wildfire management branch.
- The implementation of a fire management stocking standard does not necessarily have to apply to an entire harvest block. The fire management stocking standard should be applied adjacent to the value requiring protection from fire and should be applied on other appropriate standard units within the harvest area. In essence the objective is to both protect the value and create diversity in fuel types by incorporating fuel types with reduced fire behaviour potential within the local landscape. A fire management stocking standard need not be uniformly applied but can be intermixed with other resultant fuel types resulting from stocking other standard units within the harvest unit. In fact one can define more than one fire management stocking standard if desired. It is important that due consideration be given to resultant and remaining fuel types (likely fire behaviour and spotting potential) as well as their spatial arrangement on the local landscape.

- Maintenance of hazard free conditions – retreatment. Development of a stocking standard needs to consider changes in vegetation and fuels as a result of succession. While a stocking standard does define a “target” stand - what occurs or is done to the vegetation complex from the starting point to the point at which the standard is aimed may reduce the effectiveness of the standard assuming it is achieved.

Assessment for Development and Use of a Fire Management Stocking Standard

- Professional Reliance and the use of qualified professionals

Site question

From a fire management stocking standard perspective what are the pluses and minuses of what you see around you?

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June 19th 2013

Stop #2

Thicke Road

Quality & Value Added

From Breeding

Day 2 – Stop #2 Otter Point Timber.

Mike and Peter Steeves - Proprietors

Introduction:

There are two overruling criteria that pole producers consider when evaluating logs – strength and form. On strength, higher density is indicative of higher strength but defects such as bunch knots and double whorls can result in the tree not meeting the standards for pole classification. On form, sweep and crook are the most common defects that render a tree unsuitable for a pole. Taper is occasionally an issue – perfect taper is approximately one inch in eight and a half feet. Usually in our wood basket there is too little taper resulting in tops bigger than necessary for the class of pole. As forest managers and scientists how can we influence trees to optimize characteristics that meet our needs better?

NOTES

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June 19th 2013

Stop #3

Bush Creek Road

White pine Provenance Trial

Day 1 – Stop #3 – White pine Provenance trial



Presenter Biography and Abstract

Name: John N King
Affiliation: BCFS, Research Branch - Retired
Position: Research Scientist, Tree Breeder
Responsibilities: Hemlock, Sitka Spruce, White Pine
Academic training: PhD
Previous employment:



Western white pine provenance trial at Ladysmith

Western white pine (*Pinus monticola*) was at one time a major component of BC's forests both in the Interior and here on the Coast. White pine blister rust (*Cronartium ribicola*) is a disease that was introduced from Europe at the turn of the 20th century. Its effects were so devastating that it virtually eliminated western white pine as a commercially viable species in British Columbia. Several species of currants are the primary alternate host for the blister rust disease. The pathogen is passed back and forth between currants and western white pine.

This provenance trial was planted in 1988 and along with other trials in BC and the US Pacific Northwest allows the investigation of natural populations of western white pine and also non-natives such as eastern white pine (*Pinus strobus*) and some of the major-gene resistance trees discovered at the Dorena USDA Research Station in Central Oregon.

Although on last assessment 70 % of trees had blister rust cankers it can be seen that a viable stand of vigorously growing western white pine remains. Current orchard seed of western white pine is significantly more resistant to blister rust cankers (50% less cankering is expected) than this generally unimproved plantation. Current plantations on site such as this would have fewer than 35% cankered trees and we could expect close to 90% overall survival.

Perhaps it is time we revisited white pine and once again consider it in our plantation mixtures.

This provenance trail was planted in 1988 to investigate the performance of different populations of western white pine (*Pinus monticola*) and also includes non-natives such as eastern white pine. We are monitoring this and other such trials in BC and the US Pacific Northwest.

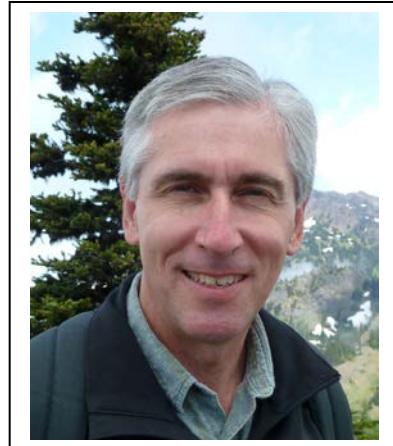
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Although on last assessment 70 % of trees had blister rust cankers it can be seen that a viable stand of vigorously growing western white pine remains. Current orchard seed of western white pine is significantly more resistant to blister rust cankers (50% less cankering is expected) than this unimproved plantation. Current plantations on site such as this would have fewer than 35% cankered trees and we could expect close to 90% overall survival.

White pine can provide a safe, viable timber species with great attributes.

Presenter Biography and Abstract

Name: **Rick Monchak, R.P.F.**
Affiliation: TimberWest Forest Corp.
Position: Operations Forester - Johnstone Straits
Operation
Responsibilities: Silviculture planning
Academic training: BSF from UBC



Rick has been involved with operational silviculture since 1980. He still remembers the carefree days of no paperwork and government paid programs. Previous work locations include South, West and East Vancouver Island and the Mainland Coast from Jervis Inlet to Rivers Inlet.

Rick is a member of both the Coast Region FRPA Implementation Team (CRIT) and the CRIT Silviculture Subcommittee and was recently named Distinguished Forest Professional by the ABCFP.

Topic and/or Title: Pw – What's not to like?!

White pine in coastal BC has had a rough 100 years; first the blister rust and then the MPB. It is no wonder that foresters have not been keen to establish white pine in their plantations and as a result we know very little about it. However, I'm happy to say that in 2013, Pw in coastal BC has a very bright future. Foresters need to embrace white pine for the valued crop tree that it is and begin to gain confidence with it in their plantations. This talk will look at several aspects of Pw including forest health, silvics and G&Y, seedling production, wood properties and markets and end with a discussion on how to get more Pw into sowing requests.

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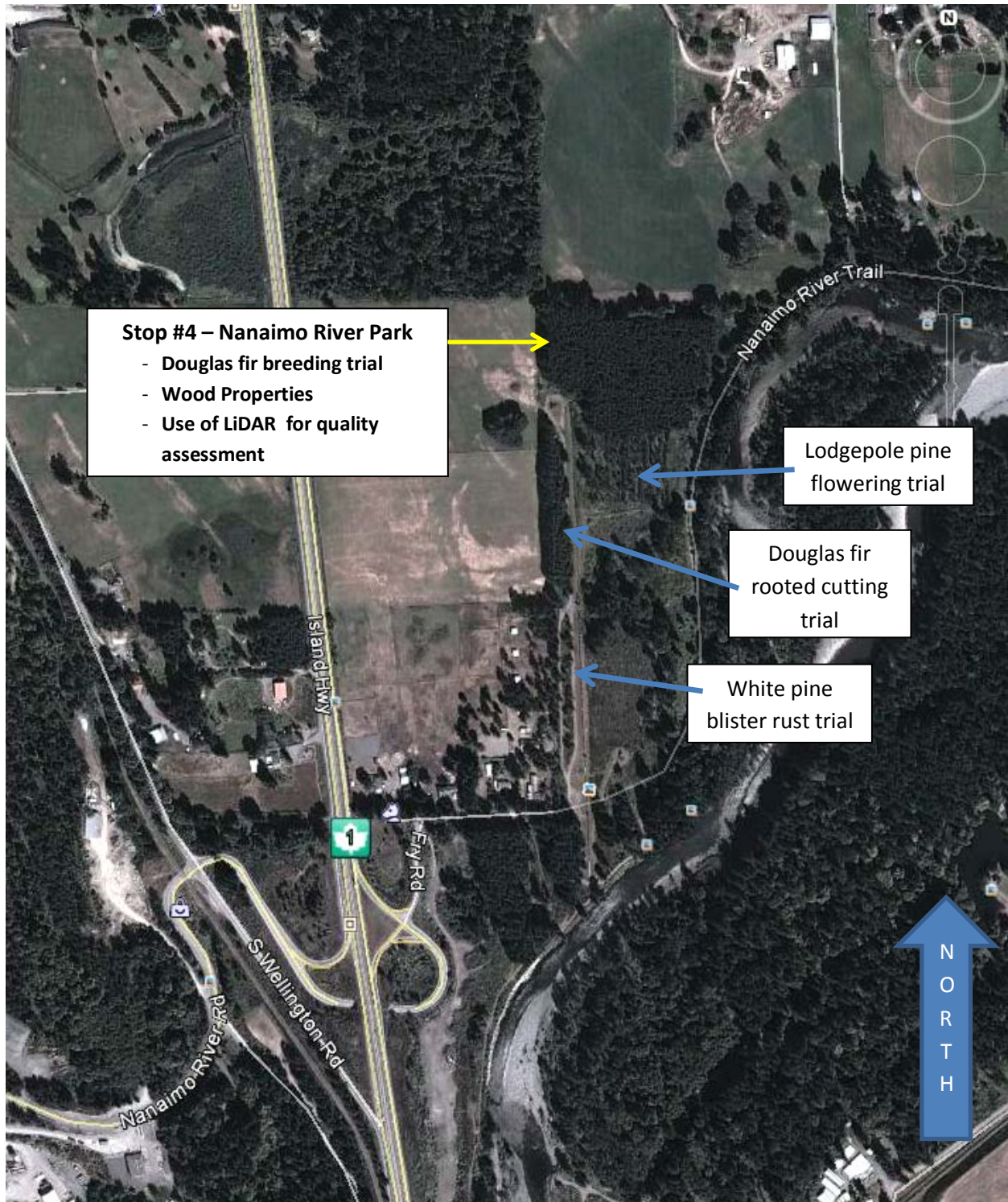
June 19th 2013

Stop #4

Nanaimo River Park

Douglas fir Breeding Trial

CSC Summer Workshop – Day 1 – Stop #4



Research Study of Wood and Lumber Properties in Douglas-fir Progeny Trial at Cassidy Wells-Nanaimo River Regional Park

Purpose: To study wood properties in various families of coastal Douglas-fir. Wood properties include fibre characteristics and mechanical properties of lumber (strength and stiffness). These characteristics affect the value of wood products.

Location: Nanaimo River Regional Park was formerly owned by MacMillan Bloedel Ltd, and in 1979 the BC Forest Service planted 170 families on this site in a replicated test comprising of 2692 trees in total. The same set of families was also planted on 10 other test sites in coastal BC during the same year. The growth of test trees (height, diameter and volume) was evaluated at age 12 when 31 superior trees were selected based on growth performance, juvenile wood density and stem form and branching characteristics in 1990. Some of these selections are now growing in seed orchards to produce seed for reforestation of logged areas in coastal BC. Several others were used to propagate the next generation breeding population.

Methodology: These trees are 36-yr old and are approaching a harvestable size. We are evaluating wood, log and sawn timber properties of three groups of trees: (1) superior selections, (2) intermediate trees, and (3) slower growing trees. A total of 96 trees were selectively harvested and assessed in April 2013. Specifically, we measured log volume, wood density, and additional fibre characteristics relevant to wood strength. We sawn the logs into structural lumber and will test physico-mechanical properties (modulus of elasticity, modulus of rupture). Terrestrial LiDAR data was also collected before trees were harvested.

Anticipated outcomes: We will be able to track how the selected parents have performed between the ages of 12 and 36. A unique aspect of this study is the evaluation of their performance in traits that can only be measured when the trees are mature, such as the amount and strength of sawn lumber.

Participants: This study is spearheaded by the Forest Genetics section of the Tree Improvement Branch of the Ministry of Forests, Lands and Natural Resource Operations, the Canadian Wood Fibre Centre of the Canadian Forest Service and Yellow Point Propagation. Funding comes from MFLNRO and CFS.

Contacts: Don Pigott (Yellow Point Propagation): 250-245-4635

Michael Stoehr (MFLNRO): 250-356-6269

Cosmin Filipescu (CFS/CWFC): 250-298-2552

Brian Saunders (White Raven Innovations Ltd.): 250-802-6115

Day #1, Stop #4 – Cassidy Wells

The area now known as the Nanaimo River Regional Park was formerly owned by Macmillan Bloedel. On the property six shallow wells were developed to supply the Harmac Pulp Mill in 1949. These wells produce slightly less than half the water required, the balance coming from the Nanaimo River itself. The property sits over one of the largest subterranean water bodies on Vancouver Island. The wooden stave line carries 10,000 gallons of water per minute to the Harmac mill over 9 km away.

There were several early planting trials on the property with exotic species including hybrid poplar, but in 1976 the Forest Research section of Macmillan Bloedel was granted permission to use any of the area not needed by the pulp mill. That year the timbered portion on the west side of the river was cleared. The timber was patchy Grand fir-Douglas fir with some powder worm cedar. The soils were extremely variable, from rich loam to pure gravel depending on proximity to the Nanaimo River which was dyked to reduce or eliminate the periodic flood events that occurred in the past.

The area being used for trials was cleared, stumped, root raked and cultivated prior to planting.

Four trials have been planted on the site. In 1978, an early western white pine resistance trial and a Douglas fir seedling /rooted cutting comparison trial were planted. In 1979 EP 708, a Douglas fir genetics trial was planted by the Ministry of Forests. In 1982 a BC range wide Lodgpole pine flowering trial was also planted by the Ministry of Forests.

When MacMillan Bloedel was acquired by Weyerhaeuser, some properties were sold for various reasons. This property was originally sold to another smaller logging company that quickly realized some of the problems or issues with harvesting in the riparian zone on the west side of the river where the majority of the timber was. The property was then purchased by The Land Conservancy who leased the property to the Regional District of Nanaimo for 99 years. Both the TLC and the Regional District have been very supportive of the continuing research on the site.

Western white pine blister rust Trial

White pine blister rust (*Cronartium ribicola*) is a disease that was introduced from Europe at the turn of the 20th century. Its effects were so devastating that it virtually eliminated western white pine as a commercially viable species in British Columbia. These few trees are all that remains of a trial established to select trees that are resistant to the disease. Several species of currents are the primary alternate host for the blister rust disease. The pathogen is passed back and forth between currents and western white pine. This site was chosen for the trial because of the abundance of flowering red current and the objective of the study was to determine if selected trees had resistance to the blister rust disease. This was a small trial, but many larger trials have led to the selection of parent trees that today are providing seed that is resistant to the disease.

Lodgepole pine flowering trial

Lodgepole pine is one of the most widely planted commercial species in British Columbia. One source of seed for reforestation is from seed orchards which specialize in seed production. This trial was established to test the effects of temperature and precipitation on flower production in lodgepole pine to optimize seed production. Included in the trial were trees from as far north as Yukon and as far south as the border with the United States. This site was chosen for its high precipitation. Tests like this are helping us to understand the effects of climate change on forests. This particular plantation has become infested with sequoia pitch moth. The larvae of the moth burrow into the bark causing a large pitch mass to form on the outside.

Production of Genetically Improved Douglas fir Rooted Cuttings For Operational Outplanting

This plantation was established in 1977 to compare the survival, form, and growth of rooted cutting to seedlings of the same improved families of Douglas fir, and hence evaluate the potential of using rooted cuttings for operational planting when seed was in short supply. Although the success for Douglas fir was limited, and eventually became less important as new seed production techniques developed, operational use of rooted cuttings has been highly successful for Yellow cedar.

Presenter Biography and Abstract

Biography:

Name: Don Pigott
Affiliation: Yellow Point Propagation
Position: Principle

Previous employment: Don Pigott worked in a variety of positions during his 13 years in the Forest Research Department at MacMillan Bloedel, where his responsibilities included seed supply for their reforestation program, establishment of their seed orchards, and supervision of their operational tree improvement program.

In 1982 he founded Yellow Point Propagation Ltd., a private silvicultural company providing a variety of services to the forest industry in British Columbia, Alberta, the United States, and other countries.

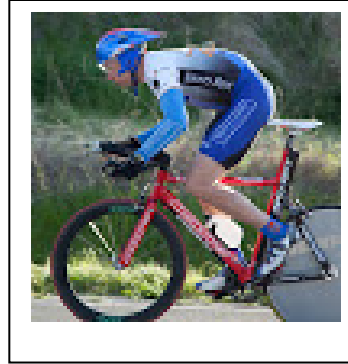
For the past 10 years Yellow Point Propagation has also been working on gene conservation projects with whitebark pine, limber pine, alpine larch and several other species.



Presenter Biography and Abstract

Biography:

Name: Michael Stoehr
Affiliation: Tree Improvement Branch, MFLNRO
Position: Coastal Douglas-fir Breeder
Responsibilities: Breeding, testing, selection
Academic training: BSc(For), MSc(For), PhD(Gen)



Presentation Abstract:

Coastal Douglas-fir EP 708 #42 Cassidy site

Breeding and testing for tree improvement of coastal Douglas-fir started in 1975. The breeding was done in breeding groups of 6 parents, each crossed with each other for a total of 15 full-sib families per breeding group (diallel). Over 8 years of breeding, 62 diallels were completed for a total of 372 (62x6) parents and 930 (62x15) full-sib families tested. Each breeding year was considered a "Series" and in each Series 11 test sites were established for a total of 88 test sites. Each Series had a different number of diallels, ranging from 3 to 10. Cassidy 42 (this site) was in Series 4, planted in 1979, with families from 9 diallels. Other test sites in Series 4 are: Memekay (CR), Squamish, Nesook (Gold R.), Caycuse, Jasper, Oyster, Wakefield (Sechelt), Rose Creek, Bamfield, Pierce Creek (Chilliwack). Each full-sib family was tested with 16 seedlings per site or 176 seedlings across all test sites. Each parent, being part of 5 full-sib families, is represented by 80 trees per site and 880 trees per Series. At age 11, selections were made in general, based on the best trees within the best families (for volume growth) with wood density maintained within a 5% population mean. Stem or form traits, such as ramiforms and sinuosity, were also included in the selection criteria and candidate trees were eliminated based on poor form. Many of these selections are now parents for the next cycle of breeding, testing and subsequent selection.

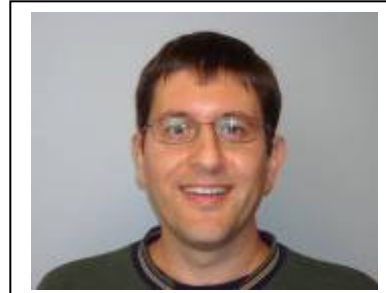
On this site, (Cassidy 42), 31 selections have been made. Eight selections and their full-sibs are part of this study, grouped into a mid-gain and a high-gain category. The mid-gain and high-gain groups have an average breeding value (bv) of 4.5% and 11.2% , respectively. Wood density estimated in 1990, obtained with the Pilodyn, was found to be 370 kg/m³, 350 kg/m³ and 340 kg/m³ for the controls, mid-gain and high-gain families, respectively. The objectives of this wood quality study are to see what near-rotation age wood and lumber characteristics are and how selection for high volume growth affected these traits.

[illegible]

Presenter Biography and Abstract

Biography:

Name: Cosmin Filipescu
Affiliation: Canadian Wood Fibre Centre,
Canadian Forest Service
Position: Research Scientist
Responsibilities: Wood Quality, Modeling, Silviculture
Academic training: BSc (For), PhD
Previous employment: Research, Consulting



Presentation Abstract:

Wood quality in Coastal Forests

Cosmin will present on Day 1 at stop# 2 – Value-added forest products and at stop # 4 – Douglas-fir breeding trial. Cosmin will talk about the importance of wood properties and the need to consider the value of wood products when making management decisions. Recent research results will be presented on wood density, strength and stiffness in Coastal stands. A discussion of relevant factors and implications to free-growing will follow. Cosmin will make a case for an integrated, long-term and systemic approach to the management of Coastal second-growth stands.

Presenter Biography and Abstract

Name: Brian Saunders
Affiliation: White Raven Innovation Ltd.
Position: President /Janitor
Consulting Services: The Use of Tablet Computers for Fieldwork
Ground and Aerial LiDAR
Creation of SNAP! Forms
Academic training: Bachelor of Science in Forestry (UBC)



Biography

Brian has worked in the Forest Industry for a little over 25 years. Six of those years were spent in a sawmill. For most of his career he has worked as a Silvicultural Forester; first for MacMillan Bloedel in Haida Gwaii, then for Weyerhaeuser's South Island Operation and from 2005 to 2012 he worked for Island Timberlands. In 2012 Brian embarked on a career as a consultant. In this role he has been surprised at the demand for services related to the field use of tablet computers. This has included the development of SNAP! forms as an associate of JRP Consulting. He has also ventured into the manufacture of chest packs and related products to facilitate the field use of tablet computers (under the name of "Tablet-EX-Gear). He also represents the TreeMetrics of Cork, Ireland – specializing in the use ground based LiDAR for forest valuation and harvest planning.

Presentation Abstract

Topic: Terrestrial LiDAR as a Tool for Stand Management and Harvest Planning?

Terrestrial LiDAR will become one of the "go to" technologies for forest inventory and harvest planning. Silviculturists will also benefit from this data as it is vastly superior to conventional methods of forest mensuration. Terrestrial LiDAR is valuable tool for planning and managing some aspects of Silviculture – particularly in stands that have achieved crown closure. Fertilization and Commercial Thinning are two activities that will be better managed with this high quality information. One of the most significant benefits is that we can measure the impact of our stand management activities on the growth of the majority of the tree – not just DBH and height. Also, bias introduced by taper equations can be eliminated with measurements of the main stem higher up the tree.

[illegible]

June 19th 2013

Evening Program

**Les Jozsa: Research Scientist Emeritus,
FPInnovations, Forintek. (2010)**

Les retired 11 years ago, but remains active working on special projects dealing with wood quality. His work experience includes research projects investigating the connection between silvicultural treatments such as thinning, fertilization, and pruning and the resultant tree-growth/wood quality. In addition, Les specialized in training and educating students, educators, architects, engineers, foresters and other professionals about wood quality. His extensive varieties of teaching aids are noteworthy, as are his woodcarvings.



IMPACT OF STAND TENDING ON WOOD QUALITY

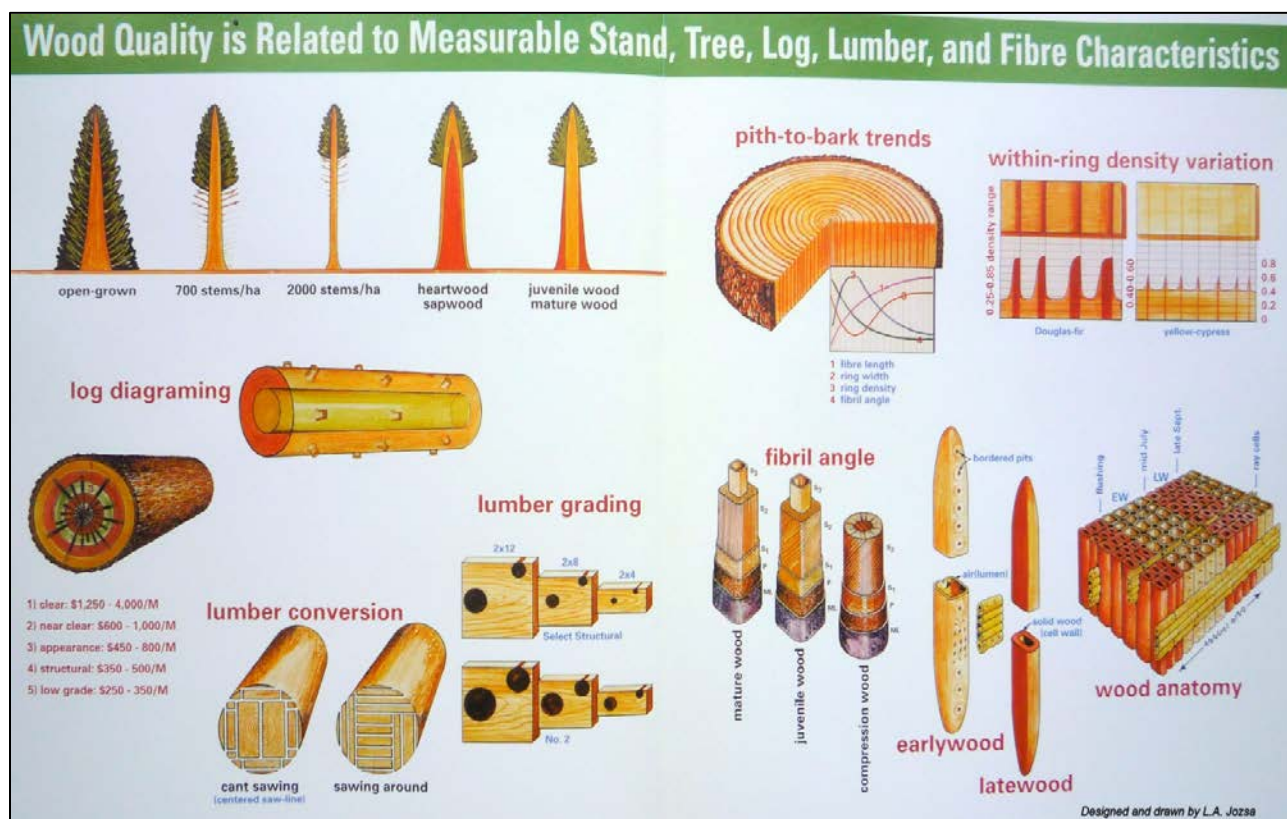
A synopsis of research results at Forintek Canada Corp.

Prepared for the Canadian Silviculture Magazine, June 2002, by Les Jozsa,
Resource Properties Specialist Emeritus

Abstract

In the mid-1980's, Forintek reviewed the state of research on the strength properties of second-growth woods. Although these properties were studied mostly on small, clear specimens of wood, the results clearly showed lower strength and stiffness of juvenile wood, compared to mature wood in Douglas-fir. In-grade testing (utilizing full-size lumber) confirmed these results, and the Douglas-fir Task Force was initiated. Since then, Forintek has conducted research on the impact of stand density (number of stems/ha) on wood quality for several Canadian softwood species, including lodgepole pine, western hemlock, white spruce, western larch, jack pine, balsam fir, and black spruce. These studies looked at the fastest growing trees by diameter class to document potential negative impacts on lumber strength and stiffness, lumber grades and yields, and ultimately product value. The rationale for this research assumed that if decreases in wood quality attributes were not noticeable in the fastest growing trees, then trees grown under average managed stand conditions would not produce inferior quality wood either.

In eastern Canada a similar comprehensive approach is being followed to evaluate silvicultural treatments (e.g., thinning in S-P-F). This strategy includes treatment costs, harvesting and transportation costs, and lumber processing costs in the financial analysis. Total stand value (\$/ha) is then compared with the cost (\$/ha), to calculate the benefit/cost ratio. Completed projects include initial spacing in black spruce, and pre-commercial thinning in balsam fir and jack pine.



Les Jozsa's expertise and knowledge, as a wood technologist, spans a wide perspective, from the macroscopic to the microscopic realm. The above graphic, designed and drawn by the author, could be his business card. His responsibilities included planning, coordinating and conducting research on wood quality attributes, utilizing X-ray densitometry techniques. His resource evaluation projects have dealt with all the major commercial tree species in western Canada, and involved stand selection, tree sampling, laboratory measurements, analysis, and reporting. Log diagramming, lumber conversion, and lumber grading protocols were followed to examine the impact of silvicultural treatments (like spacing, thinning, fertilization and pruning) on wood production and wood quality. Intensive tree sampling techniques provided information on stem size, stem taper, branch size, heartwood-sapwood distribution, and juvenile- mature-wood classification. His three-dimensional analysis of ring width, ring density, fiber length and shrinkage was ground-breaking in Canada. It was made possible through techniques developed by his colleagues at Forintek under his leadership. His other projects have dealt with climate-tree-growth relationships, the acoustical properties of wood, shrinkage and swelling, and lumber drying. Other responsibilities included conducting workshops with professional foresters, wood workers, architects and engineers. He developed an extensive variety of teaching aids which are being used around the world at several universities, dealing with wood technology and wood-structure. He is an expert witness in Forensic Dendrochronology in the Supreme Court of Canada, and he is an avid woodcarver as well.

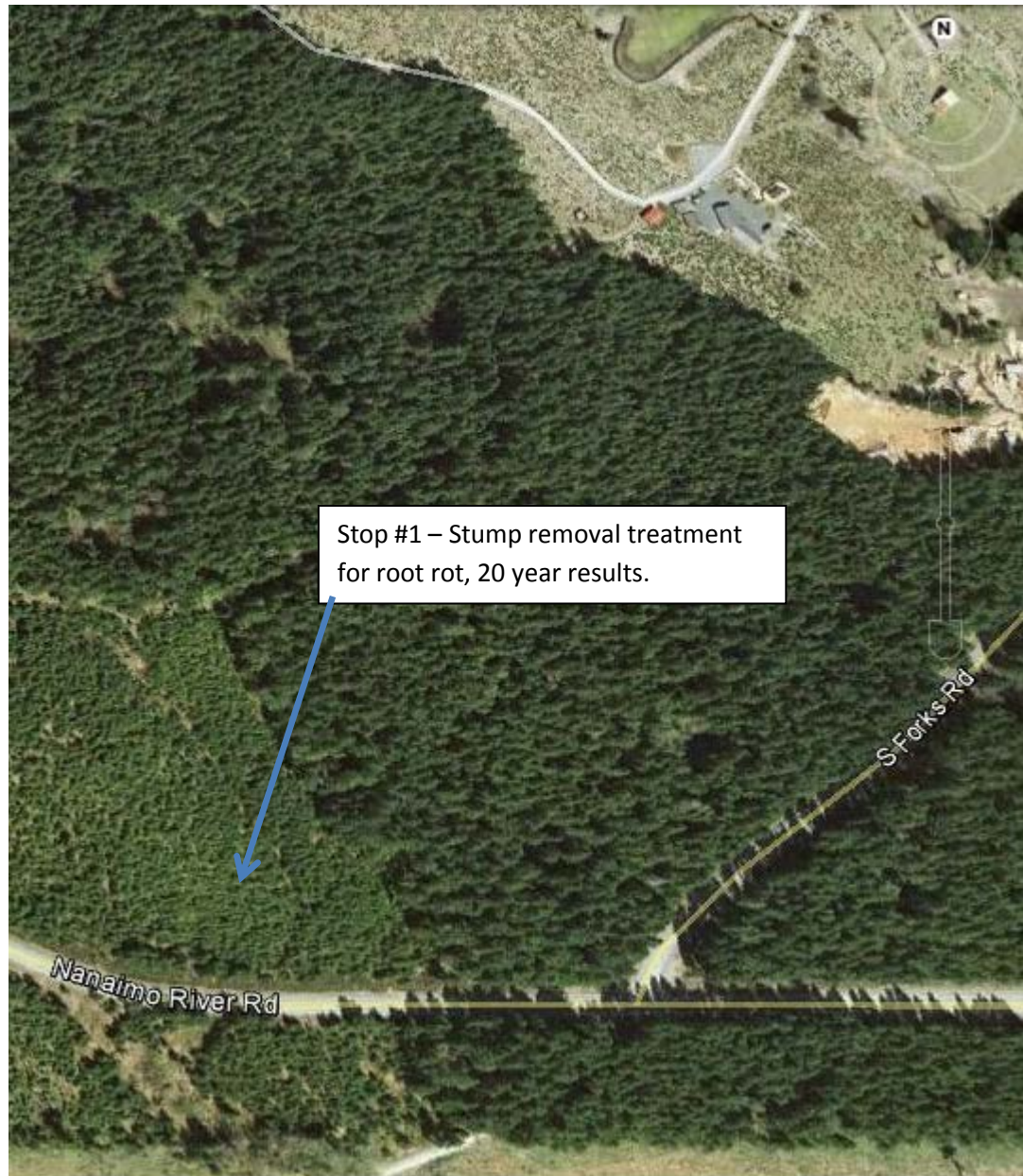
[illegible]

June 20th 2013

Stop #1

***Nanaimo Lakes Road
Root Rot Treatment Site***

CSC Summer Workshop – Day 2 – Stop #1



Presenter Biography and Abstract

Biography:

Name: Stefan Zeglen, R. P. F.
Affiliation: BC MFLNRO
Position: Forest Pathologist
Responsibilities: Dead trees
Academic training: B.Sc.(For.), M. S.
Previous employment:
1994 to present – regional forest pathologist, Nanaimo
1989 to 1994 – regional forest pathologist, Smithers



Presentation Abstract:

Topic and/or Title:

Root Disease and WPBR: One stand 20 years later.

What happens to stands that have been identified as having high levels of root disease and are logged and treated in order to “bring the site back to maximum productivity?” Searching the ancient scrolls, we examine the sordid history behind one such block and using stand monitoring and root disease survey data try to determine how well the treatments worked and where the stand is today in its search for maximum productivity. Discussion will involve treatment options, quality control, prescriptive forestry and the optimism of the times.

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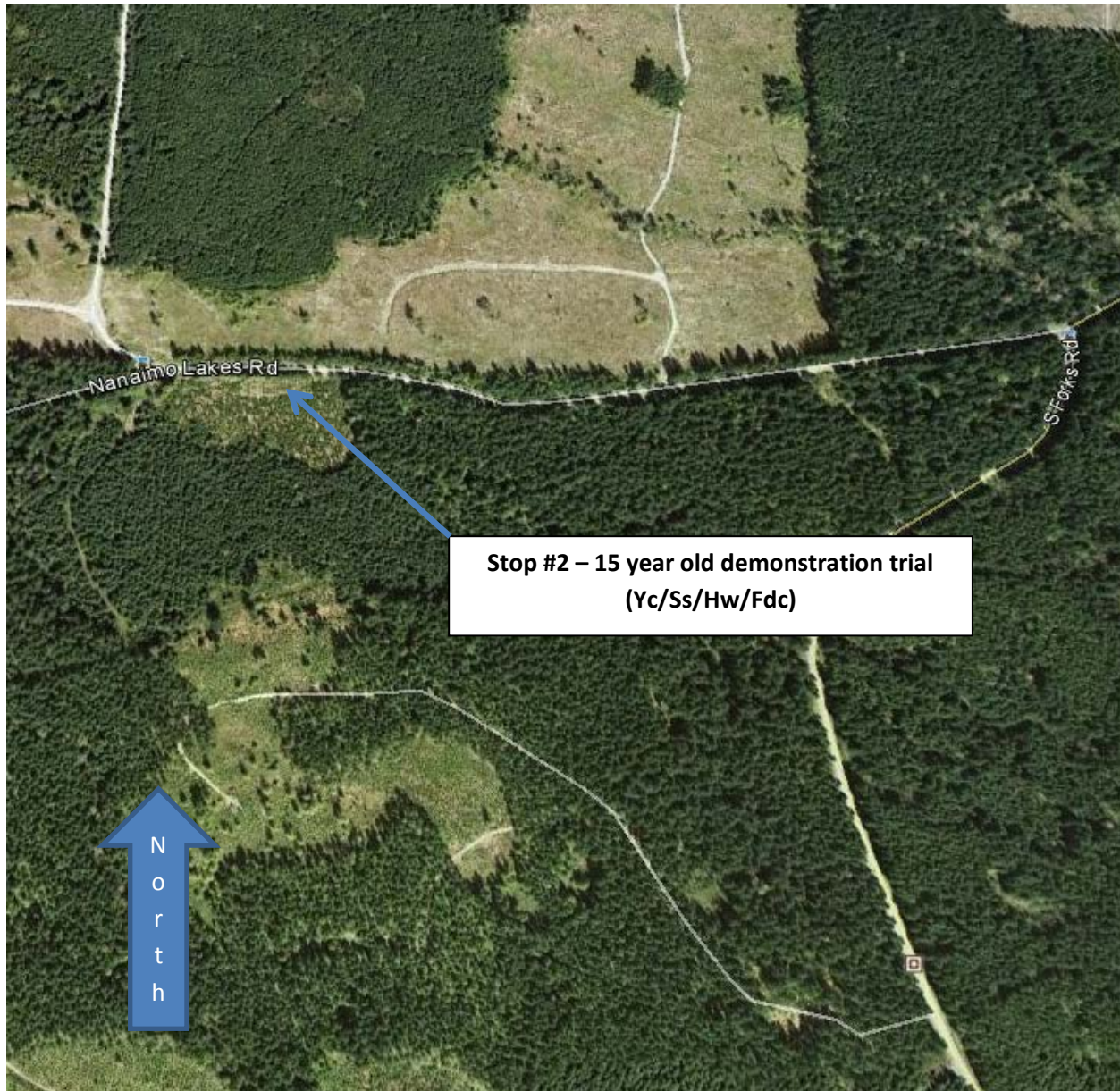
June 20th 2013

Stop #2

Mt. Benson Road

***Tree Improvement
Demonstration Site***

SCS Summer Workshop – Day 2, Stop #2



Presenter Biography and Abstract

Biography:

Name: Charlie Cartwright
Affiliation: MFLNRO, Tree Improvement Branch
Position: Forest Geneticist
Responsibilities: Hembal Genetics / Gene Conservation
Academic training: BSc (UBC), MS (UCB)
Previous employment: Forest Tech, Tree Planting and Lab Tech.



Presentation Abstract:

Regeneration for Resilient Stands

Most forest regions in North America focus their regeneration on a couple species. For the American Pacific North West these are Douglas-fir and western hemlock, for Northern BC the answer is spruce and pine, whereas for us on the BC Coast about three quarters of seedlings planted are redcedar or Douglas-fir. This has the benefit of focusing on product value, but may not be optimal when biological factors are considered. Ecologists espouse species richness for stand resilience and it is questionable as to whether productivity can be maximized with just 2 planting options.

The tree improvement demonstration we are going to view was established in the mid 90s and was intended to compare wild type plants with others selected for improvement in growth or resistance to pests. As well, it showcases the productivity of several species on the same site. Impacts of accelerated climate change are likely to have a de-stabilizing effects on stand development both through direct weather events as well as changes in the populations of pathogens. The level and security of timber supply maybe enhanced through increased species diversity in our growing stock.

Day 2 - Stop #2 - Demonstration Plots

SITE DESCRIPTIONS AND PREPARATION

Locations will, of necessity, be partially dictated by the availability of suitable areas which have been recently logged. It may be necessary to rehabilitate an existing plantation to accommodate the demo.

The sites must be easily accessible, preferably throughout the year, and located within easy reach of the local population centre or District Office. They should be located beside a main road, preferably along an existing tour route or within a demonstration forest. The terrain should be such as to permit easy viewing from the road side and easy maintenance of the site.

Due to seed transfer rules sites should be located in the Maritime Seed Planning Zone and below 700 m in elevation. In order to accommodate 4 species on a small area the site should be ecologically suited to optimize the performance of each species.

Sites must be of good (or medium) quality. They should be homogenous to reduce the amount of variability expressed within and between seed/cutting lots due to environmental factors. Low sites will be avoided due to the time required to demonstrate results. Dry, very wet, root rot and frost prone sites are to be avoided. Any other potential hazards, such as vandalism, should also be considered when selecting the site.

Site preparation will vary depending on the site's condition, but will generally be similar to that for operational planting for the area. They should be prepared in such a manner as to facilitate high planting survival and easy site maintenance. In some cases it may be necessary to remove large debris to allow for the planting of seedlings in straight rows.

The Fdc and Ax will be protected from browse with the erection of fencing (chicken wire) around individual trees.

DESIGN

Site availability may dictate the overall design of the demonstration plantation. Generally, the demo plantation will consist of 4 blocks, each block containing representative seed/cutting lots from the following species: Douglas-fir; Western hemlock; Sitka spruce and Poplar.

Ideally, the 4 blocks should be located side by side adjacent to an existing road. The design is such that it will facilitate easy comparison of the performance and variability between the different seed/cutting lots within each block.

In the future a sign will be erected on the site explaining the objectives of the plantation and a map of the seed/cutting lots established.

Sites will be marked on a 3 x 3 (or 4 x 4) meter grid using wooden or plastic stakes. A stake with an identification label will be placed in the front of each row for identification purposes. This label will list species, seed lot identification, stock type and planting date.

The column's alphabetic character corresponds to the seed or cutting lot group, as listed above for each species. Each block will consist of 6 rows of 6 trees each. Each seed or cutting lot group will be represented by at least two rows. Each row will consist of a single seed or cutting lot. Replication of the group sequence, i.e. ABCABC, is to account for seed or cutting lot and site variation. At 3 m x 3 m spacing for blocks 1, 2 and 3 and 4 m x 4 m for block 4 the total area

required is 0.15 ha. Blocks 1, 2 and 3 are 18m x 18 m. Block 4 is 24 m x 24 m. 78 m of road front will be required for this demo.

The design of the demo will vary according to each site. The orientation of the block will dictate the positioning of the poplar plot, as the poplars will readily have the potential to shade and influence the growth of any adjacent conifers.

| Fdc Block 1 3x3m spacing | | | | | | | | | | Hw Block 2 3x3m spacing | | | | | | | | | | Cy Block 2 3x3m spacing | | | | | | | | | | Se Block 4 4x4m spacing | | | | | | | | | | |
|--------------------------------|--|----|--|----|--|----|--|----|--|-------------------------------|--|---|--|---|--|---|--|---|--|-------------------------------|--|----|--|----|--|----|--|----|--|-------------------------------|--|----|--|----|--|-----|--|----|--|-----|
| A1 | | B1 | | C1 | | A2 | | B2 | | C2 | | D | | E | | D | | E | | E | | N1 | | N2 | | O1 | | O2 | | P1 | | P2 | | 92 | | 100 | | 83 | | 100 |
| X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X |
| X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X |
| X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X |
| X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X |
| X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X |
| X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X |
| X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X |

| Fdc Seedlot | Hw Seedlot |
|---|--|
| A1 101 x 623 Top Cross B1 5000 First Generation C1 69 x 38 Top Cross A2 1334 Wild Stand B2 5000 First Generation C2 409 Wild Stand | E 93 Wild Stand D88 Top Cross E 93 Wild Stand D98 Top Cross E 93 Wild Stand D88 Top Cross |
| YC | Ss Seedlot |
| N1 101 Top Clone N2 106 Top Clone O2 Wild Stand O1 Wild Stand P1 117 Below Average Clone P2 119 Below Average Clone | 92 Non Resistant 100 Weevil Resistant 83 Non Resistant 100 Weevil Resistant 100 Weevil Resistant |

[illegible]

June 20th 2013

Stop #3

Mt. Benson Road

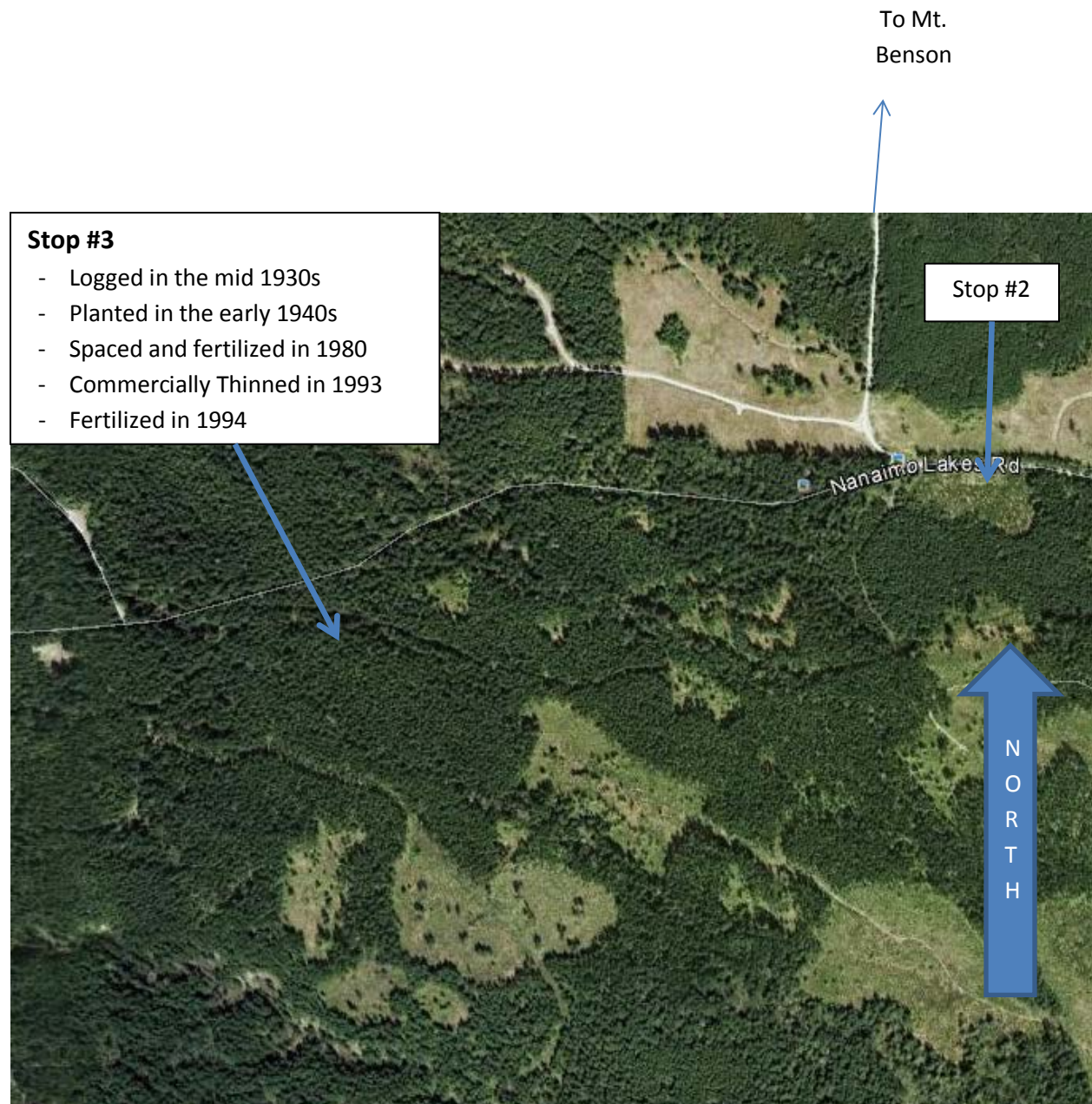
Juvenile Spacing

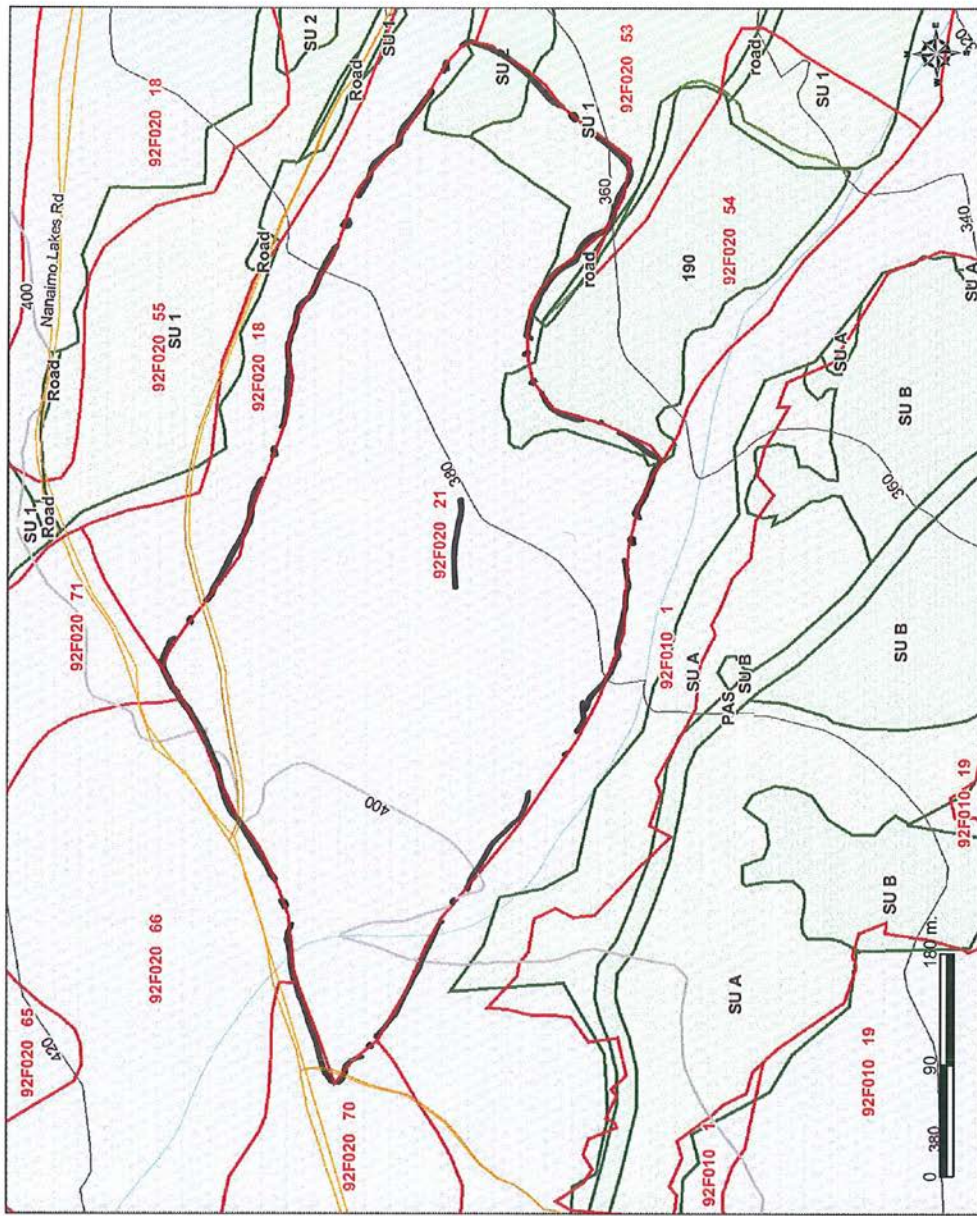
Fertilization

and

Commercial Thinning

CSC – Summer Workshop Day 2 – Stop #3





Legend

- | | |
|---------------------------|---|
| Major Clives | Land and Non Status Trim Road Transportation - Asphalt (BBM) |
| Air Facility | |
| Arrest | |
| Arrest | |
| Assessment/Arrest | |
| Habitat | Transportation - Points (TRM) |
| Habitat | |
| Land Cover Points (1:20K) | |
| Land Cover Lines (1:20K) | |
| Opening | Forest Cover Silviculture |
| Paras | National Parks |
| Paras | National Parks |
| Paras | Cadastre - private/crown (PCF and Survey Permits) |
| Crown Forest | |
| Crown Municipal | |
| Crown Provincial | |
| Free Nations | |
| Private | |
| Unknown | |
| FWA Wetlands | |
| FWA Wetlands | |
| FWA Wetlands | |

Scale: 1: 5,000

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Datum/Projection: NAD83, Albers Equal Area Conic
Units: U.S. FOOT, NAVIGATION, POINTS/INCHES

Created using MapInfo 6.0.0 on: 07/08/13

Key Map of British Columbia



Presenter Biography and Abstract

Biography:

Name: Dean Stewart, R.P.F.

Affiliation: MFLNRO

Position: Senior Licensed C&E Officer prior to this was In silviculture for the South Island Forest District 1991- 2005.

Responsibilities: As the Silviculture Officer was Involved in strategic planning, incremental silviculture, FRBC, SBFEP basic reforestation, and Silviculture Auditing.

Academic training: BScF, UBC 1982.

Previous employment: MB, Canfor, Tahsis Company, 31 years government- over 3 districts and 2 regions.

Presentation Abstract:

Topic and/or Title:

Mt. Benson, Manson Creek Commercial thinning.

In the early 1990's, the Arrowsmith TSA on the East Coast of Vancouver Island contained a large percentage of stands within age class 3, 40-60 years of age. Variable levels of *Phellinus weirii*, (laminated root rot), were found throughout these areas. Starting in 1993 the Small Business Forest Enterprise Program began commercial thinning stands with minor amounts of root rot, and clear cutting or seed tree cutting stands with substantial amounts of root rot. This is the first block that was commercially thinned under that program.

- Logged in the early to mid 1930's. Rail grades were common throughout the area.
- Planted in 1942-1944 by the "Conscientious Objectors".
- Juvenile spaced in 1980 from 2605 stems per hectare (average DBH 22.8 cm, 23 meters in height) to 525 stems per hectare (average DBH 25 cm, 23 meters in height).
- Fertilized in 1980, 435 kg urea per ha, 200 kg nitrogen per ha.
- Commercially thinned in 1993, cutting 219 stems per hectare with an average diameter of 28.6 cm, leaving 260 stems per hectare with an average diameter of 40.5 cm
- Fertilized in 1994, 435 kg urea per ha, 200 kg nitrogen per ha.
- 2013? Take a walk along the old rail grade and see the current stand results.

Day 2 – Stop #3 Mt. Benson, Manson Creek Commercial thinning.

In the early 1990's, the Arrowsmith TSA on the East Coast of Vancouver Island contained a large percentage of stands within age class 3, 40-60 years of age. Variable levels of *Phellinus* *weirii*, laminated root rot, were found throughout these stands. Starting in 1993 the Small Business Forest Enterprise Program began commercial thinning stands with minor amounts of root rot, and clear cutting or seed tree cutting stands with substantial amounts of root rot. This is the first block that was commercially thinned under that program.

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- 2013? Take a walk along the old rail grade and see the current stand results.



Photo courtesy of Ralph Winter, Forest Practices Branch.

A **conscientious objector (CO)** is an "individual who has claimed the right to refuse to perform military service" on the grounds of freedom of thought, conscience, and/or religion. Conscientious objectors are assigned to an alternative civilian service as a substitute for conscription or military service.

During World War II, Canadian conscientious objectors were given the options of noncombatant military service, serving in the medical or dental corps under military control or working in parks and on roads under civilian supervision. Over 95% chose the latter and were placed in Alternative Service camps. Initially the men worked on road building, forestry and firefighting projects. After May 1943, as the labour shortage developed within the nation and another conscriptions crisis burgeoned, men were shifted into agriculture, education and industry.

Source Wikipedia.

Summary of the Major Forestry Project Work May 4, 1942 – March 31, 1944

Reforestation and Nurseries

| | |
|----------------------------|------------|
| Acres planted | 21520 |
| Number of trees planted | 17,006,550 |
| Man-days nursery work | 8395 |
| Bushels of cones collected | 1050 |
| Man-days planting trees | 22,820 |

Source- <http://www.alternativeservice.ca/service/index.htm>

LICENCE NUMBER A42279
CUTTING PERMIT 000
BLOCK NUMBER

P.S.Y.U. 64-0
F.I.Z. B

| USELESS VOLUMES EXCLUDED | | TOTAL MERCHANT AREA | |
|--------------------------|---|---------------------|------------------|
| NO. OF BLOCKS | 1 | NO. OF PLOTS(N/C) | ROADS/LANDINGS - |
| | | 19 | 0 |

COMPUTED 1993- 8-12
OTHER - 516.5

SELECTIVE CUTTING + CUT

| UTILIZATION | FL | C | H | CONIFER | TOTAL |
|-------------|----|---|---|---------|-------|
|-------------|----|---|---|---------|-------|

| COMPILETYPE | 32 | 32 | 32 |
|--------------|------|------|------|
| MINIMUM DBH | 12.0 | 12.0 | 12.0 |
| STUMP HEIGHT | 30.0 | 30.0 | 30.0 |
| TOP DIAMETER | 10.0 | 10.0 | 10.0 |

| VOLUME AND SIZE DATA | | | | | |
|-------------------------|-------|------|------|-------|-----------------------|
| GROSS MERCH VOLUME M3 | 1922. | 26. | 180. | 2128. | 2128. |
| NET MERCH VOLUME M3 | 1845. | 24. | 173. | 2043. | 2043. |
| NET MERCH./HECTARE M3 | 112. | 1. | 10. | 124. | 124m ³ /ha |
| % DISTRIBUTION/HECTARE | 90. | 1. | 8. | 100. | 100. |
| DECAY % GROSS | 0. | 0. | 0. | 0. | 0. |
| WASTE % GROSS | 0. | 0. | 0. | 0. | 0. |
| WASTE(BILLING) % NET | 0. | 0. | 0. | 0. | 0. |
| BREAKAGE % GROSS | 4. | 5. | 4. | 4. | 4. |
| TOTAL CULL(DWB)% GROSS | 4. | 5. | 4. | 4. | 4. |
| STEMS/HA (GREEN & DP) | 181.1 | 17.9 | 19.6 | 218.6 | 218.6 |
| SNAGS/HA (DU) | 19.5 | 0.0 | 14.8 | 34.3 | 34.3 |
| AVG. DBH (GREEN&DP) CM | 29.7 | 16.2 | 26.8 | 28.6 | 28.6 |
| AVG. DBH (SNAGS) CM | 15.5 | 0.0 | 17.8 | 16.5 | 16.5 |
| GROSS MERCH VOL/TREE M3 | 0.64 | 0.09 | 0.56 | 0.59 | 0.59 |
| NET MERCH VOL/TREE M3 | 0.62 | 0.08 | 0.54 | 0.57 | 0.57 |
| AVG. WEIGHT TOTAL HT M | 29.3 | 11.8 | 25.4 | 28.7 | 28.7 |
| AVG. WEIGHT MERCH HT M | 23.7 | 6.1 | 18.6 | 23.0 | 23.0 |
| AVG. 10M LOG NET MER M3 | 0.29 | 0.09 | 0.28 | 0.28 | 0.28 |
| AVG. # OF 10M LOGS/TREE | 2.23 | 1.00 | 2.00 | 2.11 | 2.11 |

CALCULATED GRADE %

| | | | |
|----|-------------|---|-----|
| #1 | PEELER | A | 0. |
| #2 | PEELER | B | 0. |
| #3 | PEELER | C | 0. |
| #1 | LUM/#1 | D | 0. |
| #1 | LUM/#2 | E | 0. |
| #2 | LUM/#1 | F | 0. |
| #2 | LUM/#2 | G | 0. |
| #2 | SAWLOG | H | 0. |
| #3 | SAWLOG | I | 0. |
| #4 | SAWLOG | J | 74. |
| #2 | SAW NOSTAIN | K | 0. |
| #3 | SAW NOSTAIN | L | 0. |
| #4 | SAW NOSTAIN | M | 0. |
| #5 | UTILITY | N | 24. |
| #6 | UTILITY | O | 2. |
| #7 | CHIPPER | P | 0. |

| | |
|-----|-----|
| 0. | 0. |
| 0. | 0. |
| 0. | 0. |
| 0. | 0. |
| 0. | 0. |
| 0. | 0. |
| 0. | 0. |
| 0. | 0. |
| 72. | 72. |
| 0. | 0. |
| 0. | 0. |
| 0. | 0. |
| 24. | 24. |
| 4. | 4. |
| 0. | 0. |

STATISTICAL SUMMARY

| NO. OF MEASURED PLOTS | TYPE OF PLOTS | NO. OF POTENTIAL TREES | COEFF. OF VARIATION |
|-----------------------|---------------|------------------------|---------------------|
| 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 |
| 6 | 6 | 6 | 6 |
| 7 | 7 | 7 | 7 |
| 8 | 8 | 8 | 8 |
| 9 | 9 | 9 | 9 |
| 10 | 10 | 10 | 10 |
| 11 | 11 | 11 | 11 |
| 12 | 12 | 12 | 12 |
| 13 | 13 | 13 | 13 |
| 14 | 14 | 14 | 14 |
| 15 | 15 | 15 | 15 |
| 16 | 16 | 16 | 16 |
| 17 | 17 | 17 | 17 |
| 18 | 18 | 18 | 18 |
| 19 | 19 | 19 | 19 |
| 20 | 20 | 20 | 20 |
| 21 | 21 | 21 | 21 |
| 22 | 22 | 22 | 22 |
| 23 | 23 | 23 | 23 |
| 24 | 24 | 24 | 24 |
| 25 | 25 | 25 | 25 |
| 26 | 26 | 26 | 26 |
| 27 | 27 | 27 | 27 |
| 28 | 28 | 28 | 28 |
| 29 | 29 | 29 | 29 |
| 30 | 30 | 30 | 30 |
| 31 | 31 | 31 | 31 |
| 32 | 32 | 32 | 32 |
| 33 | 33 | 33 | 33 |
| 34 | 34 | 34 | 34 |
| 35 | 35 | 35 | 35 |
| 36 | 36 | 36 | 36 |
| 37 | 37 | 37 | 37 |
| 38 | 38 | 38 | 38 |
| 39 | 39 | 39 | 39 |
| 40 | 40 | 40 | 40 |
| 41 | 41 | 41 | 41 |
| 42 | 42 | 42 | 42 |
| 43 | 43 | 43 | 43 |
| 44 | 44 | 44 | 44 |
| 45 | 45 | 45 | 45 |
| 46 | 46 | 46 | 46 |
| 47 | 47 | 47 | 47 |
| 48 | 48 | 48 | 48 |
| 49 | 49 | 49 | 49 |
| 50 | 50 | 50 | 50 |
| 51 | 51 | 51 | 51 |
| 52 | 52 | 52 | 52 |
| 53 | 53 | 53 | 53 |
| 54 | 54 | 54 | 54 |
| 55 | 55 | 55 | 55 |
| 56 | 56 | 56 | 56 |
| 57 | 57 | 57 | 57 |
| 58 | 58 | 58 | 58 |
| 59 | 59 | 59 | 59 |
| 60 | 60 | 60 | 60 |
| 61 | 61 | 61 | 61 |
| 62 | 62 | 62 | 62 |
| 63 | 63 | 63 | 63 |
| 64 | 64 | 64 | 64 |
| 65 | 65 | 65 | 65 |
| 66 | 66 | 66 | 66 |
| 67 | 67 | 67 | 67 |
| 68 | 68 | 68 | 68 |
| 69 | 69 | 69 | 69 |
| 70 | 70 | 70 | 70 |
| 71 | 71 | 71 | 71 |
| 72 | 72 | 72 | 72 |
| 73 | 73 | 73 | 73 |
| 74 | 74 | 74 | 74 |
| 75 | 75 | 75 | 75 |
| 76 | 76 | 76 | 76 |
| 77 | 77 | 77 | 77 |
| 78 | 78 | 78 | 78 |
| 79 | 79 | 79 | 79 |
| 80 | 80 | 80 | 80 |
| 81 | 81 | 81 | 81 |
| 82 | 82 | 82 | 82 |
| 83 | 83 | 83 | 83 |
| 84 | 84 | 84 | 84 |
| 85 | 85 | 85 | 85 |
| 86 | 86 | 86 | 86 |
| 87 | 87 | 87 | 87 |
| 88 | 88 | 88 | 88 |
| 89 | 89 | 89 | 89 |
| 90 | 90 | 90 | 90 |
| 91 | 91 | 91 | 91 |
| 92 | 92 | 92 | 92 |
| 93 | 93 | 93 | 93 |
| 94 | 94 | 94 | 94 |
| 95 | 95 | 95 | 95 |
| 96 | 96 | 96 | 96 |
| 97 | 97 | 97 | 97 |
| 98 | 98 | 98 | 98 |
| 99 | 99 | 99 | 99 |
| 100 | 100 | 100 | 100 |

92F020 - 05

LICENCE NUMBER A42279
CUTTING PERMIT 000P.S.Y.U. 64-0
F.I.Z. B

NO. OF BLOCKS

USELESS VOLUMES EXCLUDED
1 TOTAL MERCH AREA

COMPUTED 1993- 8-10

16.5

SELECTIVE CUTTING - LEAVE

UTILIZATION F1 C H CONIFER TOTAL

COMPLETION TYPE

| | | | |
|--------------|------|------|------|
| MINIMUM DBH | 32 | 32 | 32 |
| STUMP HEIGHT | 12.0 | 12.0 | 12.0 |
| TOP DIAMETER | 30.0 | 30.0 | 30.0 |
| | 10.0 | 10.0 | 10.0 |

VOLUME AND SIZE DATA

| | | | | | |
|-------------------------|-------|------|------|-------|-------|
| GROSS MERCH VOLUME M3 | 5778. | 108. | 73. | 5959. | 5959. |
| NET MERCH VOLUME M3 | 5547. | 103. | 70. | 5719. | 5719. |
| NET MERCH./HECTARE M3 | 336. | 6. | 4. | 347. | 347. |
| % DISTRIBUTION/HECTARE | 97. | 2. | 1. | 100. | 100. |
| DECAY % GROSS | 0. | 0. | 0. | 0. | 0. |
| WASTE % GROSS | 0. | 0. | 0. | 0. | 0. |
| WASTE(BILLING) % NET | 0. | 0. | 0. | 0. | 0. |
| BREAKAGE % GROSS | 4. | 5. | 4. | 4. | 4. |
| TOTAL CULL(DWB)% GROSS | 4. | 5. | 4. | 4. | 4. |
| STEMS/HA (GREEN & DP) | 234.6 | 22.6 | 2.5 | 259.8 | 259.8 |
| SNAGS/HA (DU) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| AVG. DBH (GREEN&DP) CM | 41.7 | 24.9 | 42.9 | 40.5 | 40.5 |
| AVG. DBH (SNAGS) CM | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| GROSS MERCH VOL/TREE M3 | 1.49 | 0.29 | 1.73 | 1.39 | 1.39 |
| NET MERCH VOL/TREE M3 | 1.43 | 0.27 | 1.66 | 1.33 | 1.33 |
| AVG. WEIGHT TOTAL HT M | 35.0 | 17.0 | 30.8 | 34.6 | 34.6 |
| AVG. WEIGHT MERCH HT M | 30.1 | 12.2 | 25.3 | 29.7 | 29.7 |
| AVG. 10M LOG NET MER M3 | 0.51 | 0.19 | 0.58 | 0.49 | 0.49 |
| AVG. # OF 10M LOGS/TREE | 2.93 | 1.54 | 3.00 | 2.81 | 2.81 |

CALCULATED GRADE %

| | | | | | |
|------------------|-----|-----|-----|-----|-----|
| #1 PEELER A | 0. | 0. | 0. | 0. | 0. |
| #2 PEELER B | 0. | 0. | 0. | 0. | 0. |
| #3 PEELER C | 0. | 0. | 0. | 0. | 0. |
| #1 LUM/#1 PREM D | 0. | 0. | 0. | 0. | 0. |
| #1 LUM/#2 PREM E | 0. | 0. | 0. | 0. | 0. |
| #2 LUM/#1 LUM F | 0. | 0. | 0. | 0. | 0. |
| #2 LUM/#2 LUM G | 0. | 0. | 0. | 0. | 0. |
| #2 SAWLOG H | 0. | 0. | 0. | 0. | 0. |
| #3 SAWLOG I | 12. | 0. | 0. | 12. | 12. |
| #4 SAWLOG J | 73. | 34. | 94. | 72. | 72. |
| #2 SAW NOSTAIN K | 0. | 0. | 0. | 0. | 0. |
| #3 SAW NOSTAIN L | 0. | 0. | 0. | 0. | 0. |
| #4 SAW NOSTAIN M | 0. | 0. | 0. | 0. | 0. |
| #5 UTILITY U | 14. | 57. | 6. | 15. | 15. |
| #6 UTILITY X | 1. | 9. | 0. | 1. | 1. |
| #7 CHIPPER Y | 0. | 0. | 0. | 0. | 0. |

STATISTICAL SUMMARY

| | |
|------------------------|-------|
| NO. OF MEASURED PLOTS | 19 |
| TYPE OF PLOTS | PRISM |
| NO. OF POTENTIAL TREES | 91.0 |
| COEFF. OF VARIATION | 51.2 |
| TWO STANDARD ERRORS | 24.7 |

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June 20th 2013

Stop #4

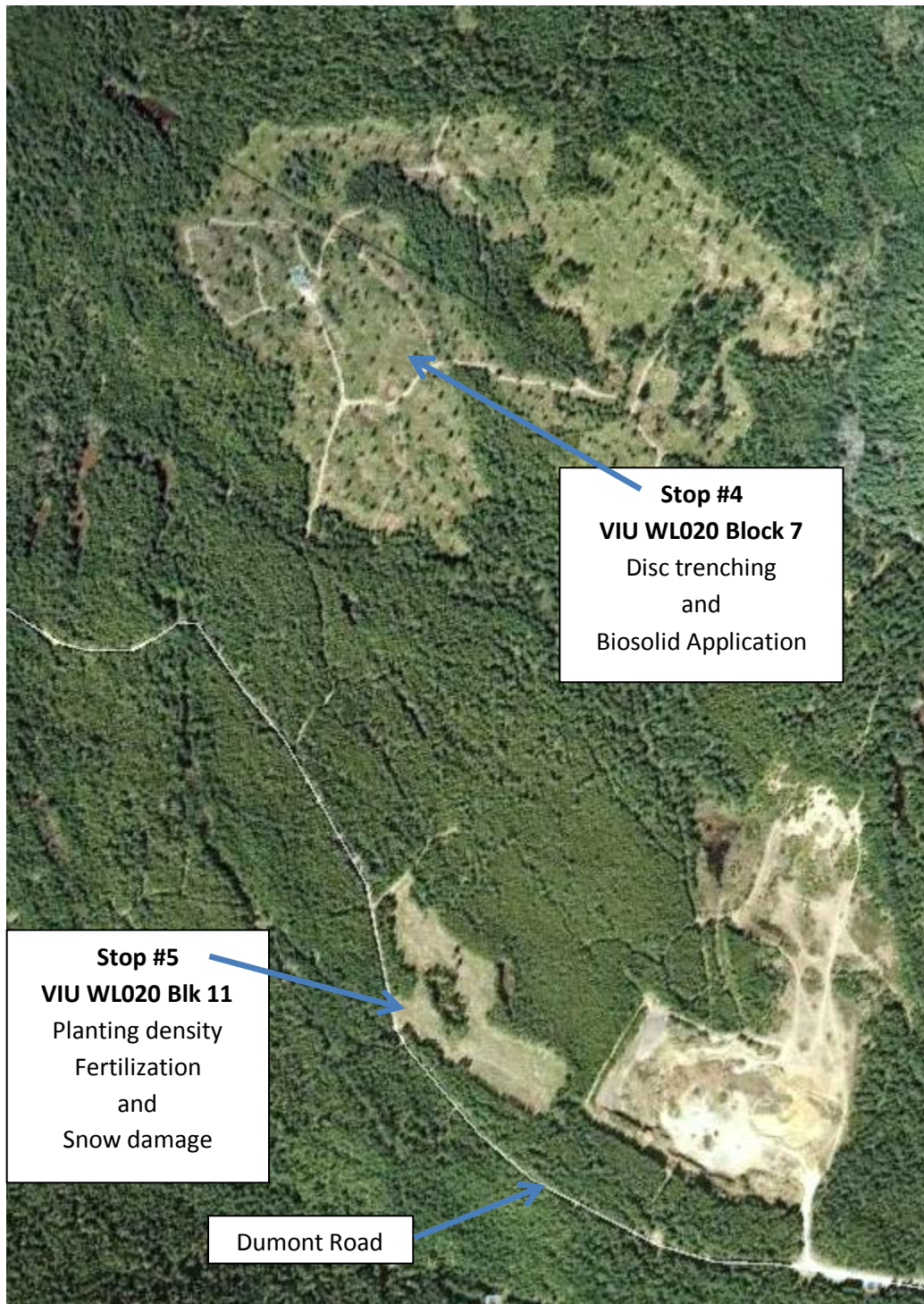
Vancouver Isl. University Forest

Forest Fertilization

With

Biosolids

CSC Summer Workshop – Day 2 Stops 4 and 5



Presenter Biography and Abstract

Biography:

| | |
|-----------------------------|--|
| Name: | Brian Danjou |
| Affiliation: | Brian Danjou Forest Services |
| Position: | Principle |
| Responsibilities: | Operational forest research |
| Academic training: | UBC - 1979 |
| Previous employment: | Brian joined the MoF after graduation and spent the early 1980's conducting independent and co-operative reforestation research, shifting to vegetation management research in the mid to late 1980's. By the early 1990' focus shifted to the initiation of Silviculture Systems Research program with trials established in Boston Bar, Roberts Creek on the Sunshine Coast, Queen Charlotte Islands and west coast of Vancouver Island (Cats Ears Creek). |

Presentation Abstract:

Enhancing Douglas-fir Seedling Growth on Salal-Dominated Sites Using Disc Trenching, Fertilization at Planting and Subsequent Biosolid Application VIU Woodlot 020

Management Issue: Salal can compete with conifer seedlings for both moisture and nutrients. While the presence of salal may have little effect on Douglas-fir survival, on drier and nutrient poor sites competition can have a long-term negative effect on Douglas-fir growth. Older trials have documented site preparation, reducing salal abundance, and fertilization can improve long-term Douglas-fir growth.

Trial Purpose: Demonstrate disc trenching site preparation and fertilization at planting for enhancing early Douglas-fir seedling growth on dry, salal-dominated sites. Trial incorporated the 2003 operational biosolid application conducted around the original trial.

Site Characteristics: Elev. 330 – 370 m; Edatope 2/B Site Series 03- FdHw–Salal Site Index 22 m @50 yr

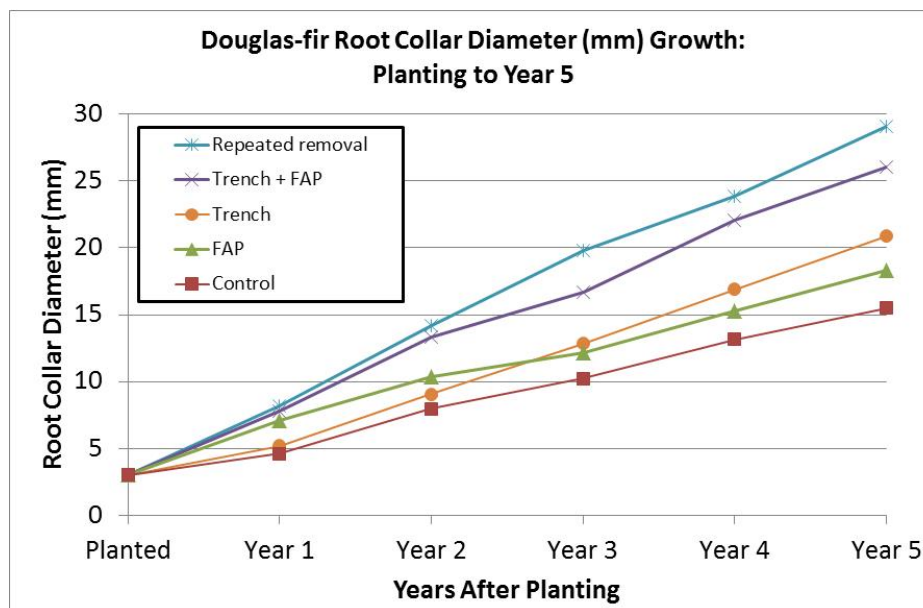
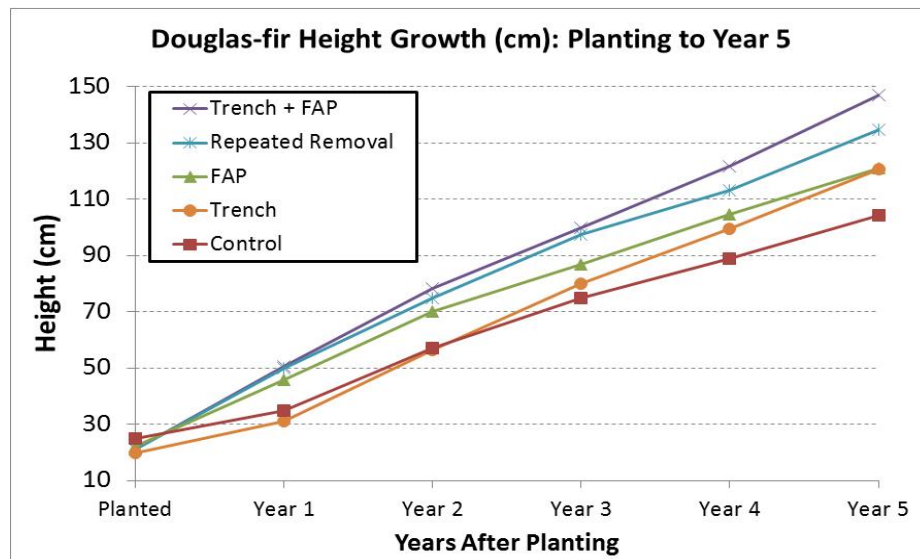
Treatments and costs / ha (1,500 seedlings per ha).

| Treatment | Treatment Description | Total Cost per ha |
|---|--|-------------------|
| Control | Douglas-fir planted (PSB 1+0 415B). Vexar protected. Spring planted in 1998 | \$ 735 |
| Fertilization At Planting (FAP) | Gromax® 2 21-6-2 w/Gel (Dry Site) teabag; 9.0 g wt; 1.9g N; placed in planting hole. | \$ 945 |
| Trench | Parallel non-continuous trenches 2.7 meters apart, 20 cm max. depth (\$200 / ha). Seedlings planted in trench edges | \$ 890 |
| Trench + FAP | Combined treatments described above. This is the operational treatment applied throughout the block. | \$ 1,110 |
| Repeated removal | Experimental treatment to quantify implications of salal-free conditions on Douglas-fir growth. Salal manually removed annually following Trench+FAP treatment. | |
| Red Alder Interplanted into plantation. | Experimental treatment. Evaluate alder for promoting nitrogen status and perhaps accelerate crown closure. Transplanted alder wildings. Abandoned due to low alder survival (< 50%). | |
| Bioslids | Applied at 775 kg N /h a in 2003 and 2007, 6 th and 10 th growing season after planting | |

Results (Planting to Year 5)

- Douglas-fir 1st year survival > 95% in all treatments, except in the FAP (fertilized at planting) treatment where seedling survival declined to 75%. Higher survival in the Trench + FAP treatment (95 %) indicated there was an interaction between site preparation and fertilization. Recommend placing fertilizer beside planting hole.
- 5th-year survival ranged between 75% (FAP treatment) and 95 % (control) and has changed little since year 1.

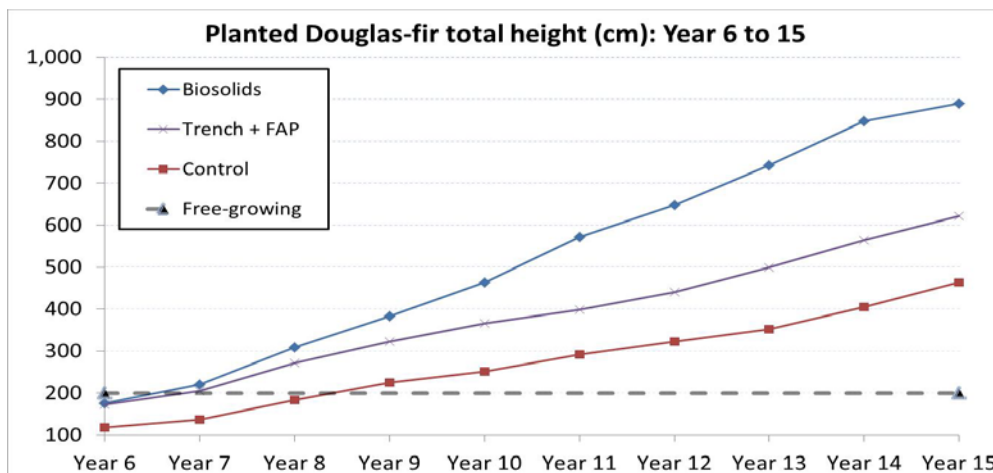
- Highest Douglas-fir height growth was in Trench+FAP treatment while highest RCD growth was in repeated removal treatment, suggesting salal was having greater affect on RCD than height growth.
- FAP promoted Year 1 lammas development (~70%) versus 13% and 28% in control and trench treatment respectively.
- 5th year Douglas-fir foliar N and K were below adequate levels in all treatments.



Results (Year 6 to 15)

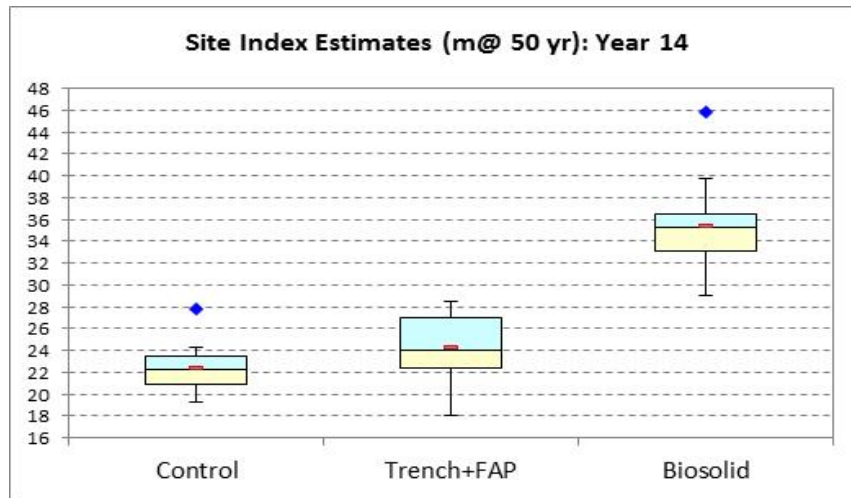
Height Growth

- Biosolids improved Douglas-fir height growth; annual height growth averaged 87 cm between Year 10 and 15. 15th year total height averaged 890 cm and tallest tree was 12.0 m tall.
- Douglas-fir height growth in Trench + FAP treatment averaged 54 cm in the last five years. 15th year total height in Trench+FAP averaged 622 cm, tallest tree 13.2 m. Douglas-fir in the Trenching + FAP treatment reached free-growing height (2.0 m) in seven years,
- In the Control, Douglas-fir height growth averaged 45 cm over the last five years, an increase in the previous 5 year period. 15th year total height averaged 464 cm, tallest tree 9.0 m. Free-growing height reached in 9 years.



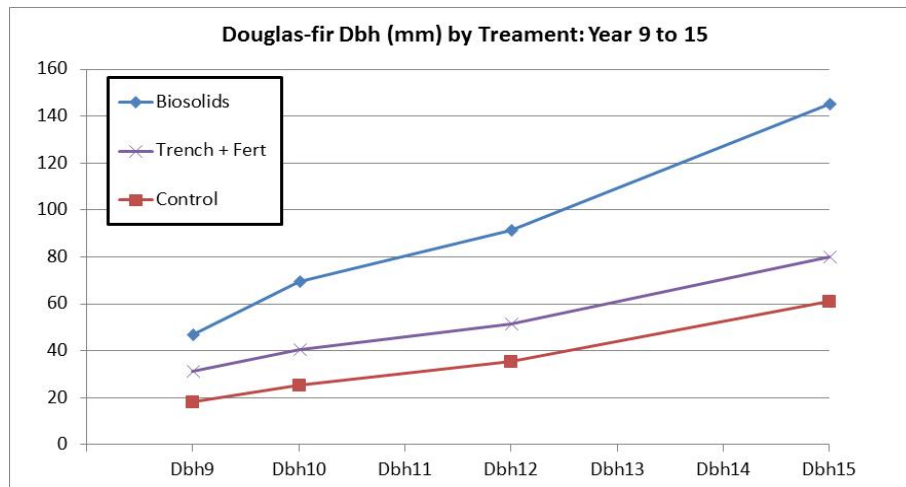
Site Index Estimates

- Site indexes (m @ 50 years) were calculated for individual trees in the Control, Trench+ FAP and Biosolid treatments. Trees selected amongst the middle third of each treatment based on height.
- Site index ranking, from lowest to highest, was 22.5 (control), 24.2 (Trench + FAP) and 35.4 (Biosolid). Considerable variation in all treatments.



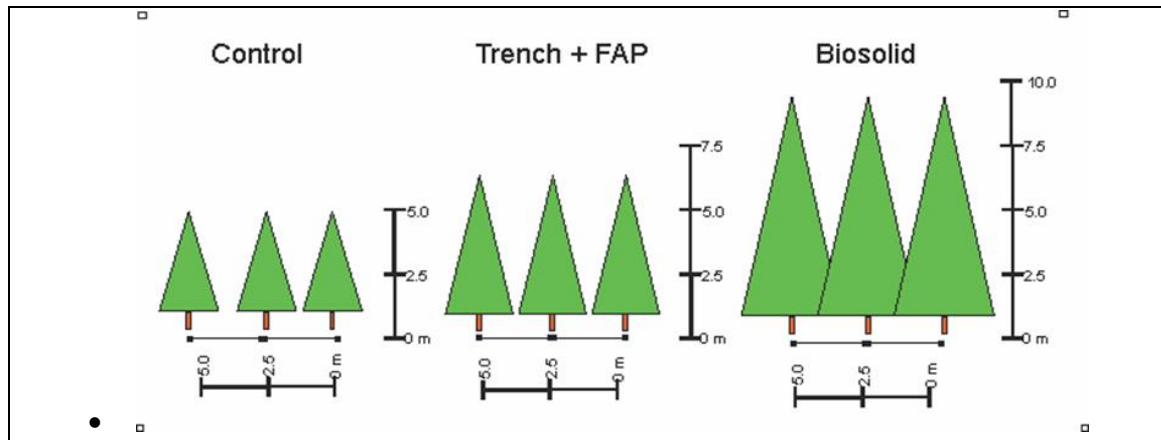
Stem diameter growth.

- Biosolid provided large increase in dbh (diameter at breast height). 15th year dbh averaged 145 mm. Maximum 15th year dbh was 176 mm.
- Average 15th year dbh in Trench+FAP was 80 mm while dbh growth since year 10 averaged 40 mm. Maximum 15th year dbh was 132 mm.
- In the control, 15th year dbh averaged 61 mm and dbh growth 35 mm. Maximum 15th year dbh was 9.0 cm.

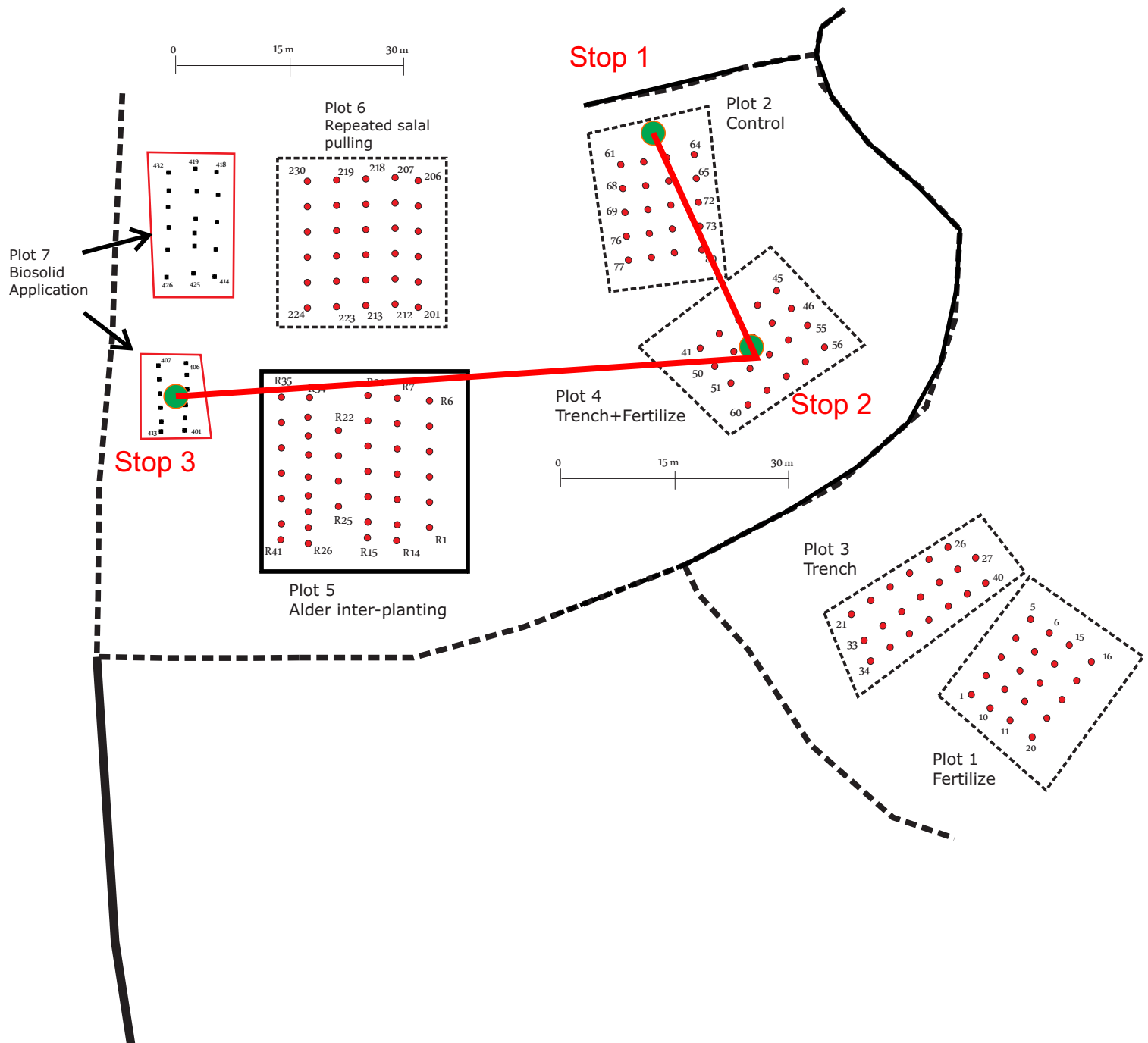


Douglas-fir Crown Diameter.

- For three treatments (Control, Trench+FAP and Biosolid), a diagram was developed, incorporating 14th year tree heights and crown diameters and inter-tree distance of 2.7 m (disc trenches spacing).
- Crown diameter in the Trench+FAP treatment (253 cm) was slightly greater than in the Control (230 cm).
- In the biosolid treatment, crowns are overlapping with crown diameter averaging 374 cm, a 62% increase over the Control, initiating crown closure. With advent of crown closure, lower understory light levels should limit subsequent salal development, a long-term positive factor for Douglas-fir growth.



Malaspina Woodlot Site Preparation / Fertilization at Planting Trial



[illegible]

June 20th 2013

Stop #5

Vancouver Isl. University Forest

Biosolids Applications

And

Plantation Management

Presenter Biography and Abstract

Biography:

Name: Michel Vallee, RPF
Affiliation: Vancouver Isl. University
Position: Faculty – Forestry department
Responsibilities: Silviculture and Soil Science
Academic training: BSc (UBC 1983)
Previous employment: Senior partner – Stave River Trading and Custom Cutting.



Presentation Abstract:

Planning for the Future:

The site before you was harvested in 2001, disc trenched and planted the in the spring of 2002 with Fdc PSB 1+0 425B at 1000SPH. The block was subsequently fertilized once with ~ 80 wet tonnes (~25 to 30 dry) of biosolids at 775 kg N per hectare. Currently there are ~ 750 well-spaced trees per hectare with a total number of trees closer to 5000 per hectare.

Ecological site definition: CWHxm 03/(01)

Elevation: ~350 m

Soils:

- Laomy sand to sandy loam
- Ablation/basal till PM
- Shallow to bedrock (sandstone)
- ~ 65%+ cfc
- Dystric Brunisol

The site is located in a snow belt and, as most of us that live on the south Island know, the snow around here can have quite a high moisture content; that combined with the added foliar area from the fertilization, and possibly weaker wood, caused the condition that we have before us.

So...

- What do we do about it?
- How can we plan for less damage?
- Is the damage severe enough to concern us?
- Can we remedy the situation after the fact?

Composition/Application of Biosolids on VIU Forest

Biosolids Trace Element Analysis (Dry weight basis)

| Constituent ⁽¹⁾ | Greater Nanaimo 6/16/10 ⁽²⁾ | French Creek 6/16/10 ⁽²⁾ | DNC 6/16/10 ⁽²⁾ | OMRR Class A ⁽³⁾ | OMRR Class B ⁽⁴⁾ | Units |
|----------------------------|---|--|-------------------------------|--------------------------------|--------------------------------|-------|
| Arsenic | <0.2 | < 0.2 | < 0.2 | 75 | 75 | ug/g |
| Cadmium | 2.1 | 1.4 | 1.3 | 20 | 20 | ug/g |
| Chromium | 42.6 | 42.3 | 15 | - | 1,060 | ug/g |
| Cobalt | 3.1 | 1.8 | 2.2 | 150 | 150 | ug/g |
| Copper | 989 | 742 | 1840 | - | 2,200 | ug/g |
| Lead | 41.3 | 19.7 | 37.8 | 500 | 500 | ug/g |
| Mercury | 3.11 | 2.05 | 0.569 | 5 | 15 | ug/g |
| Molybdenum | 6.24 | 4.2 | 7.86 | 20 | 20 | ug/g |
| Nickel | 19.8 | 15.6 | 12.1 | 180 | 180 | ug/g |
| Selenium | 4.1 | 2.8 | 5.1 | 14 | 14 | ug/g |
| Zinc | 1160 | 769 | 504 | 1,850 | 1,850 | ug/g |

⁽¹⁾ Reported on a dry weight basis.

⁽²⁾ Indicates sample collection date.

⁽³⁾ Limits specified in Trade Memorandum T-4-93 (September 1997), Standards for Metals in Fertilizers and Supplements as referenced by the OMRR.

⁽⁴⁾ Limits specified in the OMRR for Class B biosolids, Schedule 4, Column 3.

Biosolids Physicochemical and Microbiological Analysis

| Constituent ⁽¹⁾ | Greater Nanaimo 6/16/10 ⁽²⁾ | French Creek 6/16/10 ⁽²⁾ | DNC 6/16/10 ⁽²⁾ | Units |
|----------------------------|---|--|-------------------------------|--------------------|
| Total Solids (%) | 28.5 | 26.7 | 14.1 | % |
| TKN (%) | 4.58 | 4.01 | 7.03 | % |
| Available Phosphorus | 2100 | 1300 | 7800 | ppm |
| Nitrate | <10 | <10 | <10 | mg/kg |
| Ammonia | 2680 | 3460 | 15300 | ppm |
| Available Potassium | 906 | 940 | 3400 | ppm |
| pH | 6.3 | 6.6 | 6.7 | - |
| Electrical Conductivity | 1170 | 1150 | 686 | uS/cm |
| Fecal Coliform | 1,600,00 ⁽³⁾ | 7769 ⁽³⁾ | 2280 ⁽³⁾ | MPN/g ⁴ |

⁽¹⁾ Reported on a dry weight basis.

⁽²⁾ Indicates sample collection date.

- (3) Geometric mean of 7 discrete samples. To meet Class B pathogen limit criteria for fecal coliform, the geometric mean of 7 discrete samples must be < 2,000,000 MPN/g.
- (4) Most Probable Number/gram

2011 Application Rate...Does not vary too much from year to year (calculated for dry tonnes)

Design values used in the calculation of the biosolids application rate reflect the nitrogen demand by the crop trees and minor vegetation. The estimated nitrogen uptake and transformations are found in the table below.

Application Rate Data

| | | | |
|--------------------------|------------|------|----------------|
| Nitrogen Uptake | Trees | 115 | (kg/ha) |
| Nitrogen Uptake | Understory | 40 | (kg/ha) |
| Volatilization | | 30 | % |
| Denitrification | | 10 | % |
| Immobilization | | 175 | (kg/ha) |
| Mineralization Rate | | 30 | % |
| Total Nitrogen Required | | 1038 | (kg/ha) |
| Maximum Application Rate | | 19.6 | (dry t/ha) |
| Application Rate (Bulk) | | 74.5 | wet Tonnes/ha) |

| Soil Background Nutrient Content | |
|---|---------------------------------|
| Nutrients | Concentration (ug/g) |
| Ammonium | 40 |
| Nitrate | 2.0 |
| TKN % | 0.11 |
| Phosphate | 42 |
| Potassium | 152 |
| Arsenic | 8.6 |
| Cadmium | .15 |
| Chromium | 58.4 |
| Cobalt | 25.1 |
| Copper | 59 |
| Lead | 7.3 |
| Mercury | 0.05 |
| Molybdenum | 1 |
| Nickel | 46.6 |
| Selenium | 0.3 |
| Zinc | 93 |
| pH | 5.4 |

TKN =Total Kjeldahl nitrogen (OM N and ammonia N

[illegible]

Workshop Delegates

| First Name | Last Name | Organization | Email |
|------------|-------------|------------------------------|--|
| Jerry | Benner | Benner Forestry Ltd. | jerry@bennerforestry.ca |
| Keith | Bird | MFLNRO | keith.bird@gov.bc.ca |
| Tom | Bown | CWFC NRCan | tborn@nrcan.gc.ca |
| Taisa | Brown | WFP | tlbrown@westernforest.com |
| Kevin | Brown | KR Brown and Associates | treenutrition@gmail.com |
| Charlie | Cartwright | MFLNRO | Charlie.Cartwright@gov.bc.ca |
| Lee | Charleson | MFLNRO | Lee.Charleson@gov.bc.ca |
| Catherine | Charman | MFLNRO | Catherine.Charman@gov.bc.ca |
| Marilyn | Curtis | PRT Growing Services Ltd. | marilyn.curtis@prt.com |
| Paul | Dagg | HFN Forestry LP | gimpdagg@shaw.ca |
| Brian | D'Anjou | Brian D'Anjou consulting | bdnewlife@gmail.com |
| Ernie | De Geus | MFLNRO | ernie.degeus@gov.bc.ca |
| Louise | de Montigny | MFLNRO | Louise.deMontigny@gov.bc.ca |
| Shaotang | Deng | MFLNRO | Shaotang.Deng@gov.bc.ca |
| Diane | Douglas | | dldoug2@gmail.com |
| Iola | Elder | Sylvan Vale Nursery Ltd. | info@svnltd.com |
| Ron | Elder | R.J.F. Elder Forestry Cons. | ron.elder2@gmail.com |
| Cassandra | Ennis | MFLNRO | cassandra.ennis@gov.bc.ca |
| Andres | Enrich | TimberWest | enricha@timberwest.com |
| Cosmin | Filipescu | NRCan | Cosmin.Filipescu@NRCan.gc.ca |
| Blake | Fougere | MFLNRO | blake.fougere@gov.bc.ca |
| Laura | Gilbert | ProFor Consulting Ltd | laura.gilbert@shaw.ca |
| Dave | Goldie | MFLNRO | Dave.Goldie@gov.bc.ca |
| Marissa | Hallaway | Western Forest Products | mhallaway@westernforest.com |
| Jimmie | Hodgson | Island Timberlands LP | kmilholm@islandtimberlands.com |
| Graham | Hues | WFP | GHues@westernforest.com |
| Less | Jozsa | FPI-ret | ljoza@shaw.ca |
| John | King | MFLNRO | king.forgen@gmail.com |
| Ross | Koppelaar | Canadian Wood Fibre Centre | ross.koppelaar@nrcan.gc.ca |
| Ed | Korpela | MFLNRO | ed.j.korpela@gov.bc.ca |
| Jodie | Krakowski | MFLNRO | jodie.krakowski@gov.bc.ca |
| Megan | Laing | MFLNRO | megan.laing@gov.bc.ca |
| Chris | Laing | Results Based Forest Mgmt | chrislaing@shaw.ca |
| Lynn | Laliberte | North Cowichan | laliberte@shaw.ca |
| Cameron | Linklater | ProFor Consulting Ltd. | linklater.c@shaw.ca |
| Shirley | Mah | MFLNRO | Shirley.Mah@gov.bc.ca |
| Brian | Marcus | Western Forest Products | bmarcus@westernforest.com |
| Lisa | Meyer | MFLNRO | lisa.meyer@gov.bc.ca |
| Kevin | Mintz | WFP | kmintz@westernforest.com |
| David | Mogensen | Western Forest Products Inc. | dmogensen@westernforest.com |
| Rick | Monchak | TimberWest | monchakr@timberwest.com |

| | | | |
|----------|-----------|------------------------------|--|
| Ropd | Negrave | MFLNRO | roderick.negrave@gov.bc.ca |
| Don | Pigott | Yellow Point Propagation | ypprop@shaw.ca |
| James | Proteau | MFLNRO | james.proteau@gov.bc.ca |
| Marie | Robertson | Capital Regional District | mrobertson@crd.bc.ca |
| Nigel | Ross | Westfor Resources Ltd | blr@uniserve.com |
| Chris | Runnals | MFLNRO | chris.runnals@gov.bc.ca |
| Enrique | Sanchez | MFLNRO | Enrique.Sanchez@gov.bc.ca |
| Brian | Saunders | White Raven Innovations Ltd. | briansaunders.wri@gmail.com |
| Dean | Stewart | MFLNRO | Dean.Stewart@gov.bc.ca |
| Michael | Stoehr | MFLNRO | michael.stoehr@gov.bc.ca |
| Jack | Sweeten | MFLNRO | Jack.Sweeten@gov.bc.ca |
| Kevin | Telfer | MFLNRO | kevin.telfer@gov.bc.ca |
| Ellery | Tetz | MFLNRO | ellery.tetz@gov.bc.ca |
| Matthew | Tjepkema | Western Forest Products | MTjepkema@Westernforest.com |
| Michel | Vallee | Vancouver Island University | Michel.Vallee@viu.ca |
| Andy | Waines | MFLNRO | Andy.Waines@gov.bc.ca |
| Dave | Weaver | MFLNRO | David.Weaver@gov.bc.ca |
| Jacob | Wedman | Sylvan Vale Nursery | info@svnltd.com |
| Richard | Whittall | F. Warren and Associates | rich_whittall@shaw.ca |
| Craig | Wickland | MFLNRO | craig.wickland@gov.bc.ca |
| Marise | Wickman | Vancouver Island University | Marise.Wickman@viu.ca |
| Bevin | Wigmore | Arbutus Grove Nursery | bwigmore@arbutusgrove.com |
| Del | Williams | Forest Practices Board | Vijay.Hundle@gov.bc.ca |
| CHANG-YI | XIE | MFLNRO | CHANG-YI.XIE@GOV.BC.CA |
| Stefan | Zeglen | MFLNRO | stefan.zeglen@gov.bc.ca |