Mitigating timber supply impacts through strategic Forest Fertilization

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Objectives

To review forest fertilization

- background
- stand level outcomes
- forest level outcomes
- program for FIA/FFT
- Communication and future directions

Background

- MPB mortality and salvage is disrupting forest age class distributions and creating severe mid-term timber supply problems in many mgmt units
- Every tree to be harvested in the next 20-60 years is in the ground now
- Fertilization is a proven method for increasing harvest volume and accelerating the operability of established stands (this is real wood, not digital !)

Background

- Fertilization can be used strategically to mitigate “pinch points” in the timber supply
- Many jurisdictions in similar latitudes (e.g., Sweden, Finland) have used fertilization effectively to improve timber supply
- Analysis of a number of TSAs and TFLs indicates positive opportunities for fertilization to improve timber supply shortfalls

Fertilization Response

- The ministry has done 25 years of fertilizer research in the interior and has published scientific information for several species, sites, and ages
- Work has been done in close cooperation with universities, industry, and others leading to good support for operational fertilization
- Fertilizer response potential of interior lodgepole pine is well documented and local fertilizer response information for other species (Fdi, Sx) is available
- Local response data for Fdi and Sx can be supplemented with data from other jurisdictions

Interior spruce fertilization research

- 14 screening trials (SBS, ICH, ESSF)
- 9 area-based "conventional" trials (SBS, ICH, ESSF)
  - 19 to 34 years
  - SI 24-29 m @ 50 years
- 3 area-based "maximum productivity" trials (SBS)
  - 9 to 13 years

Summary (Rob Brockley, February, 2006)

Interior spruce

- best responses (20-25 m^3/ha or 30-40% over 9 years) are associated with low foliar N (< 1.1%) and SI < 20
- smallest growth responses are associated with highest SI (> 23)
- little evidence of improved growth when S is combined with N in fertilizer prescriptions
- B deficiencies (< 10 ppm) may limit growth response to N and NS fertilization on some SBS sites
- planted spruce is apparently very well suited to “high input” silviculture

Economics

- When done on the right sites and for the right objectives fertilization of stands can return
  - 15 m^3/ha of additional volume within 10 years
  - shorten technical rotations by 3-4 years
  - 3-12% mid-term timber supply impacts
  - 2-5 % internal rates of return
  - 0.15 pdays/ha employment in fertilization
  - 2.77 direct and indirect jobs per 1000 m3 produced

Analysis of a spruce plantation fertilized at age 50 compared to untreated. A volume response at age 70 of 16 cubic metres.

YIELD TABLES

Untreated		Treated	
Age	m^3/ha	Age	m^3/ha
0	0	0	0
5	0	5	0
10	0	10	0
15	0	15	0
20	0	20	0
25	2	25	2
30	22	30	22
35	68	35	68
40	122	40	122
45	178	45	178
50	235	50	235
55	284	55	291
60	331	60	346
65	379	65	395
70	430	70	446
75	469	75	484
80	502	80	518
85	525	85	541
90	546	90	562
95	563	95	579
100	578	100	594

INCREMENTAL TREATMENT COST ASSUMPTIONS

	Calendar Year	Cost ($/ha)
Fertilization	2005	300

FINANCIAL INDICES (Incremental Costs and

	Treated Stand Physical Rotation	Treated Stand Financial Rotation
IRR	5.93%	7.98%
NPV 2%	$635	$635
NPV 3%	$398	$473
NPV 4%	$222	$448
B/C 2%	3.12	3.12
B/C 3%	2.33	2.58
B/C 4%	1.74	2.49

	Untreated	Treated
cMAI	6.3	6.5

HARVEST COST ASSUMPTIONS

	Physical Rotation		Financial Rotation (3%)	
	Untreated	Treated	Untreated	Treated
Rotation Age	80	80	70	70
Fixed Harvest Costs ($/ha)	1,613	1,613	1,613	1,613
Tree-To-Truck Costs ($/ha)	6,704	6,873	5,893	6,080
Haul Costs ($/ha)	2,452	2,529	2,099	2,178
Milling Cost ($/ha)	19,200	19,939	16,038	16,736
Harvest Revenue ($/ha)	58,777	61,351	48,366	50,634

Analysis of a spruce plantation fertilized at age 35 compared to untreated. A volume response at age 70 of 17 cubic metres.

YIELD TABLES

Untreated		Treated	
Age	m^3/ha	Age	m^3/ha
0	0	0	0
5	0	5	0
10	0	10	0
15	0	15	0
20	0	20	0
25	2	25	2
30	22	30	22
35	68	35	68
40	122	40	130
45	178	45	194
50	235	50	252
55	284	55	300
60	331	60	347
65	379	65	396
70	430	70	447
75	469	75	485
80	502	80	519
85	525	85	542
90	546	90	563
95	563	95	580
100	578	100	595

INCREMENTAL TREATMENT COST ASSUMPTIONS

	Calendar Year	Cost ($/ha)
Fertilization	2005	300

FINANCIAL INDICES (Incremental Costs and

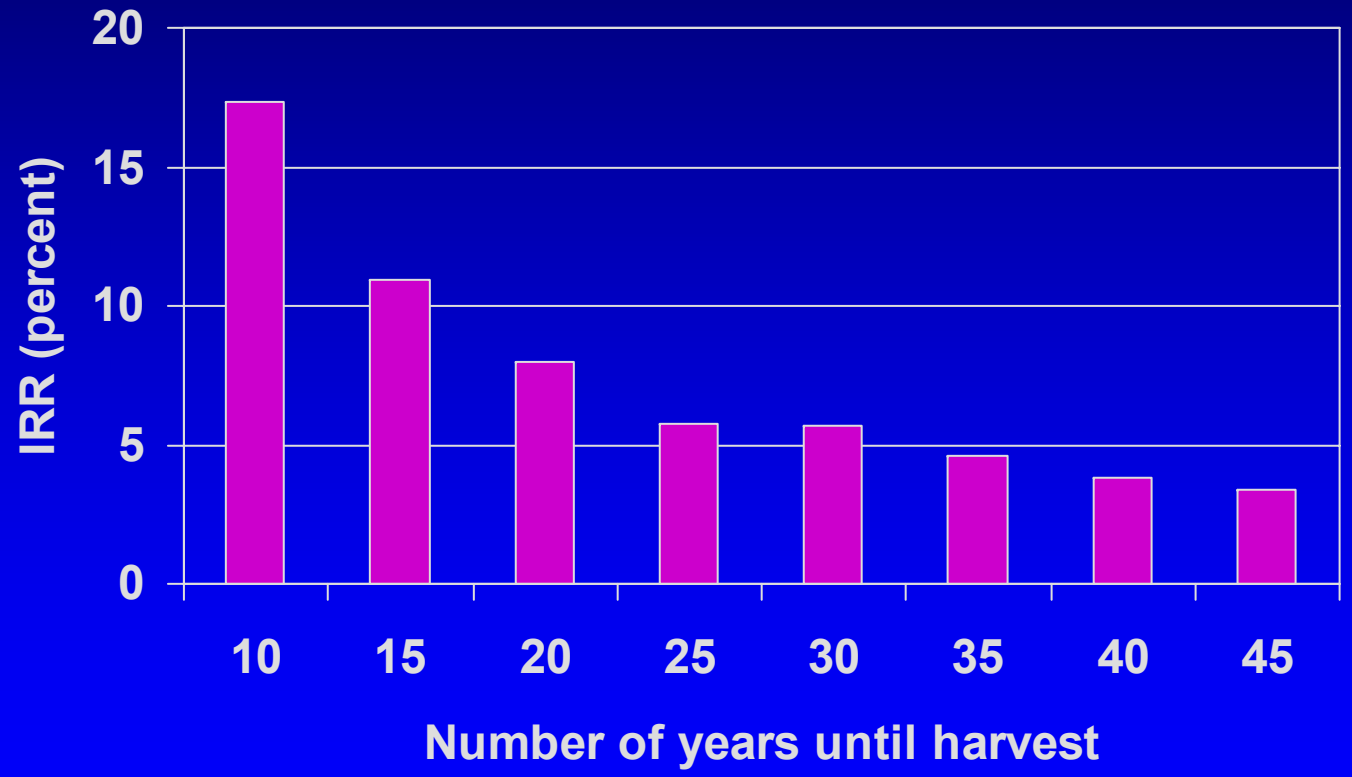
	Treated Stand Physical Rotation	Treated Stand Financial Rotation
IRR	4.04%	4.63%
NPV 2%	$431	$431
NPV 3%	$171	$221
NPV 4%	$5	$137
B/C 2%	2.44	2.44
B/C 3%	1.57	1.74
B/C 4%	1.02	1.46

	Untreated	Treated
cMAI	6.3	6.5

HARVEST COST ASSUMPTIONS

	Physical Rotation		Financial Rotation (3%)	
	Untreated	Treated	Untreated	Treated
Rotation Age	80	80	70	70
Fixed Harvest Costs ($/ha)	1,613	1,613	1,613	1,613
Tree-To-Truck Costs ($/ha)	6,704	6,883	5,893	6,090
Haul Costs ($/ha)	2,452	2,533	2,099	2,182
Milling Cost ($/ha)	19,200	19,979	16,038	16,770
Harvest Revenue ($/ha)	58,777	61,487	48,366	50,747

The Internal Rate of Return for fertilization is dependant on time to harvest

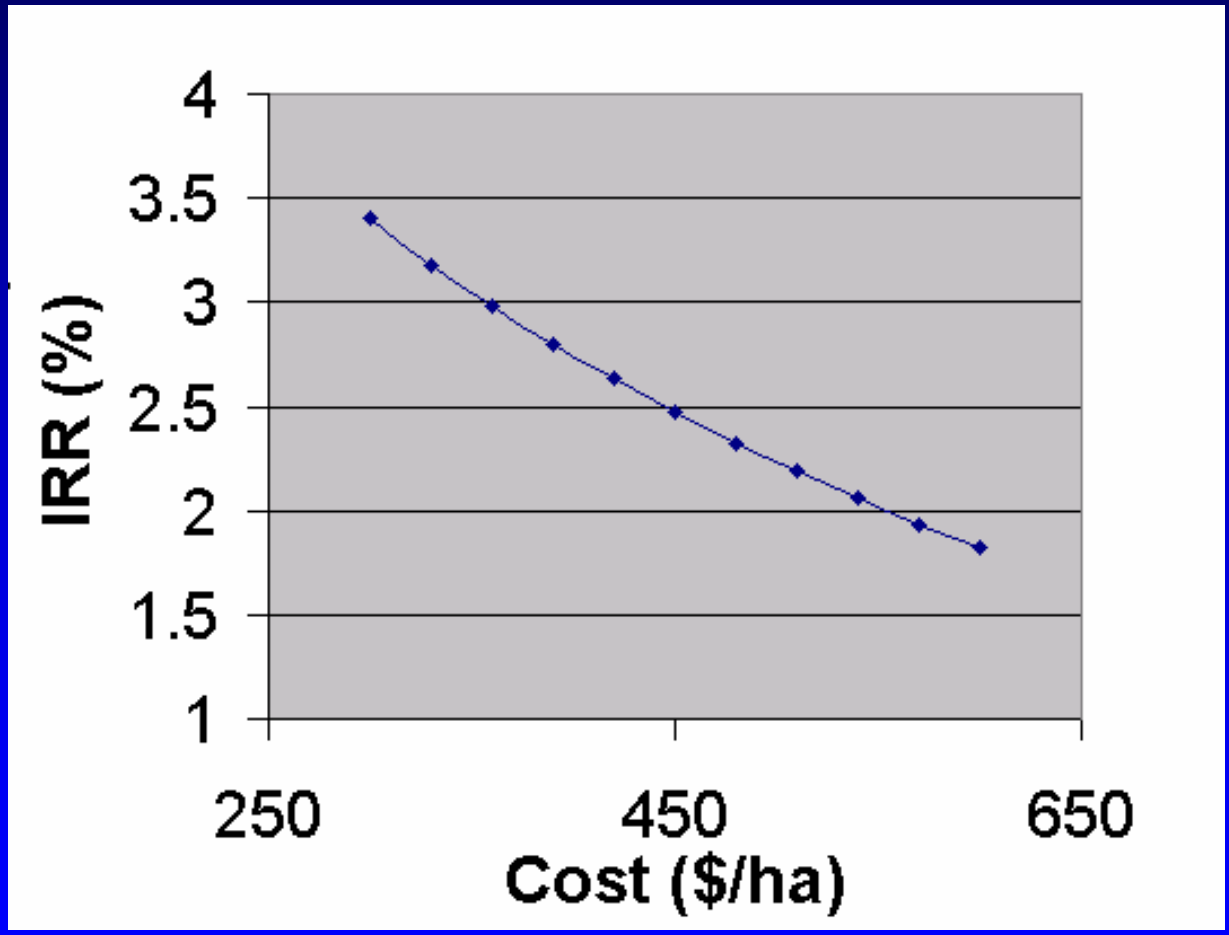


5% IRR can be achieved if time to harvest is less than 35 years -

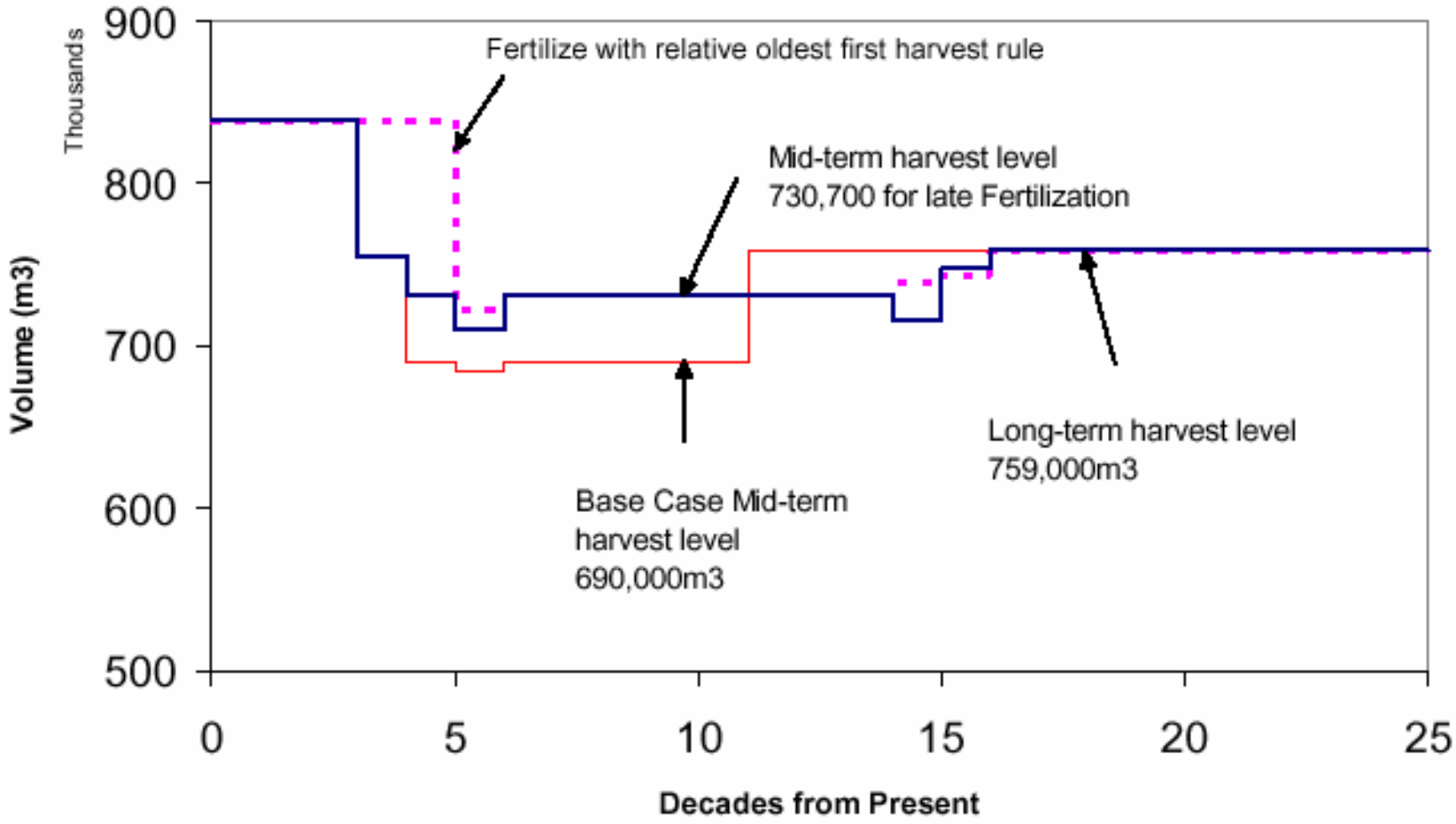
30 to 40 year Govt bond rates are at 4.73%

Spruce plantations - 100 km - SI 19.6

IRR if fertilized at age 25, harvested at age 70 with 15 cubic metre response



Allowable cut effect -
sustain harvest levels longer and 5.9 % increase in the midterm



Cranbrook TSA

Forest level analysis - TFL 52

Table 1: Summary of Silviculture Scenario Results.

Scenario	Total Harvest Volume (m^3)	Total Harvest Revenue ($ 1,000s)	Total Silviculture Cost ($ 1,000s)	Total Net Revenue ($ 1,000s)	NPV Net Revenue ($ 1,000s)	NPV Net Revenue Rank
Base Case	**124,553,994**	**6,956,846**	**704,788**	**6,252,058**	**1,150,343**	**n/a**
% Difference from the Base Case						
Fertilization II	5.250	5.098	4.540	2.275	6.524	1
Basic Silviculture	-1.532	5.686	-25.987	8.285	3.351	2
Alternate Density – 1200 sph	-2.052	8.803	-23.590	11.421	2.695	3
Fertilization I	2.078	3.046	0.134	2.280	1.878	4
CT-Fert II	2.175	4.702	-2.375	4.586	1.574	5

TFL 52 silviculture strategy

At the forest level, fertilization proves to be one of the most beneficial individual treatment regimes in terms of both volume production and financial return. This is primarily due to an increase in the amount of volume available for harvest at a time when available volume is limited, approximately 20 to 60 years in the future.

TFL 52 silviculture strategy

Intensive silviculture treatments shown to be more beneficial in mitigating the short-term timber supply problem are fertilization, A-seed planting, and commercial thinning.

Specifically, the *Preferred Silviculture Strategy* demonstrates that increases in the harvest level by 11% in the short-term and 5% in the long-term are sustainable when the prescribed incremental silviculture treatments are applied. Results also demonstrate that in some cases silviculture investment may not produce a positive financial return, indicating the importance of strategic silviculture investment planning.

Other factors that have been analysed in comprehensive silv strategies

- Log quality profiles
- changes in harvest
- net revenue impacts
- stumpage
- direct and indirect jobs
- income tax generated
- wildlife habitat
- biodiversity

Year	Activity Cost ($)							Employment		Change in Harvest	Revenue ($)			Net Present Value	
	Records	Class A Seed	Rehab	Space /Fertilize	Pre-harvest fertilize	Spacing	Clumpy planting	Direct Jobs Created	Indirect Jobs		income taxes, direct and	Stumpage saved	Net Revenue	Factor	Future Income Streams
2031	100000	105000	200000	350000	0	150000	60000	11.55	23.1	0	$277,200	0	-687,800	0.302	-$207,638
2032	100000	105000	200000	350000	0	150000	60000	11.55	23.1	0	$277,200	0	-687,800	0.291	-$200,010
2033	100000	105000	0	35000	0	150000	60000	5.505	11.01	128,645	$132,120	3,859,350	3,541,470	0.280	$992,017
2034	100000	105000	0	35000	0	150000	60000	5.505	11.01	128,645	$132,120	3,859,350	3,541,470	0.270	$955,574
2035	100000	105000	0	35000	0	150000	60000	5.505	11.01	128,645	$132,120	3,859,350	3,541,470	0.260	$920,470
2036	100000	105000	0	35000	0	150000	60000	5.505	11.01	128,645	$132,120	3,859,350	3,541,470	0.250	$886,655
2037	100000	105000	0	35000	0	150000	60000	5.505	11.01	128,645	$132,120	3,859,350	3,541,470	0.241	$854,082
2038	100000	105000	0	35000	0	150000	60000	5.505	11.01	128,645	$132,120	3,859,350	3,541,470	0.232	$822,706
2039	100000	105000	0	35000	0	150000	60000	5.505	11.01	128,645	$132,120	3,859,350	3,541,470	0.224	$792,483
2040	100000	105000	0	35000	0	150000	60000	5.505	11.01	128,645	$132,120	3,859,350	3,541,470	0.216	$763,370

100 mile strategy

6.0 Opportunities to Address TSA Issues

Prior to the district workshop, background information was used to identify the following silvicultural strategies as having potential to address timber and habitat issues at the TSA level. Each of these potential strategies was discussed during the workshop to clarify or refine them and/or add new strategies. Each strategy was assigned an effective opportunity area based on data and local knowledge. The impact on Timber Supply, Quality and Habitat were estimated and each strategy was given a ranking of High, Medium or Low in addressing the three targets summarized in Table 7.

Table 7. Summary of potential silviculture strategies to address TSA issues.

Strategy	Opportunity in Next 5 yrs (ha)	Timber Supply Effects			Quality	Habitat	Cost/ha ($)	Rank
		Short	Mid	Long				
TS1a-b. Late rotation fertilization (40-80yrs old) non Pl	17,000	++	++		+	+/-	400	H
TS1c-d. Late rotation fertilization (81+yrs old) non Pl	44,000	+	+		+	+/-	400	H*
TS2. Young stand fertilization (non Pl)	9000		+++		+	++	400	H

100 mile strategy

6.1 Potential Strategies to Improve Timber Supply

The following table (Table 8) provides detail regarding potential timber supply strategies. It reflects discussions within the workshop and is meant to add clarity around the strategy and how it was ranked.

Table 8. Timber Supply Strategies

Strategy	Workshop Comments / Discussion	Anticipated Benefits	Timing of Benefit
TS1a-b Late rotation fertilization of near mature Fd and Sx stands (wetbelt stands 40-80yrs old)	These stands will be candidates for harvesting near the front end of the trough. The intent is to add volume to these stands to reduce the depth of the front end of the trough. Focus is Fd stands first as it has a greater response than Sx. Moisture limited sites (drybelt) should be avoided. Priority = High (one of the few opportunities to influence the front end of the trough)	Fd -17m^3/ha per application.[8] Sx -11 m^3/ha per application. Benefit realized over 10 yr period.	Short to Midterm
TS1c-d Late rotation fertilization of older Fd and Sx stands (wetbelt stands 81-140yrs old)	These stands will be candidates for harvesting near the front end of the trough. The intent is to add volume to these stands to reduce the depth of the front end of the trough. Moisture limited sites (drybelt) should be avoided. Priority = High as a trial. Response is less certain as data is limited on treating older stands; therefore a trial is suggested for stands at the younger end of the range.	No North American data but response could be similar to younger stand benefits described above.	Short to Midterm
TS2 Young stand fertilization (Fd and Sx)	These stands will be candidates for harvesting in the mid-back end of the trough. The intent is to add volume to these stands more quickly through several fertilizations at 10 yr intervals. This will make these stands available sooner or have more volume at time of harvest. Moisture limited sites (drybelt) should be avoided. Priority = High. The intent is to focus on Fd first and Sx as a trial, some concerns around terminal weevil. *Once the risks associated with MPB are reduced, treatment of younger Pl stands will become a high priority with very large potential benefits.*	Fd - 17m^3/ha per application. Sx - 11 m^3/ha per application. Benefit realized over 10 yr period.	Back end of Midterm

Industry comments in FIA submissions

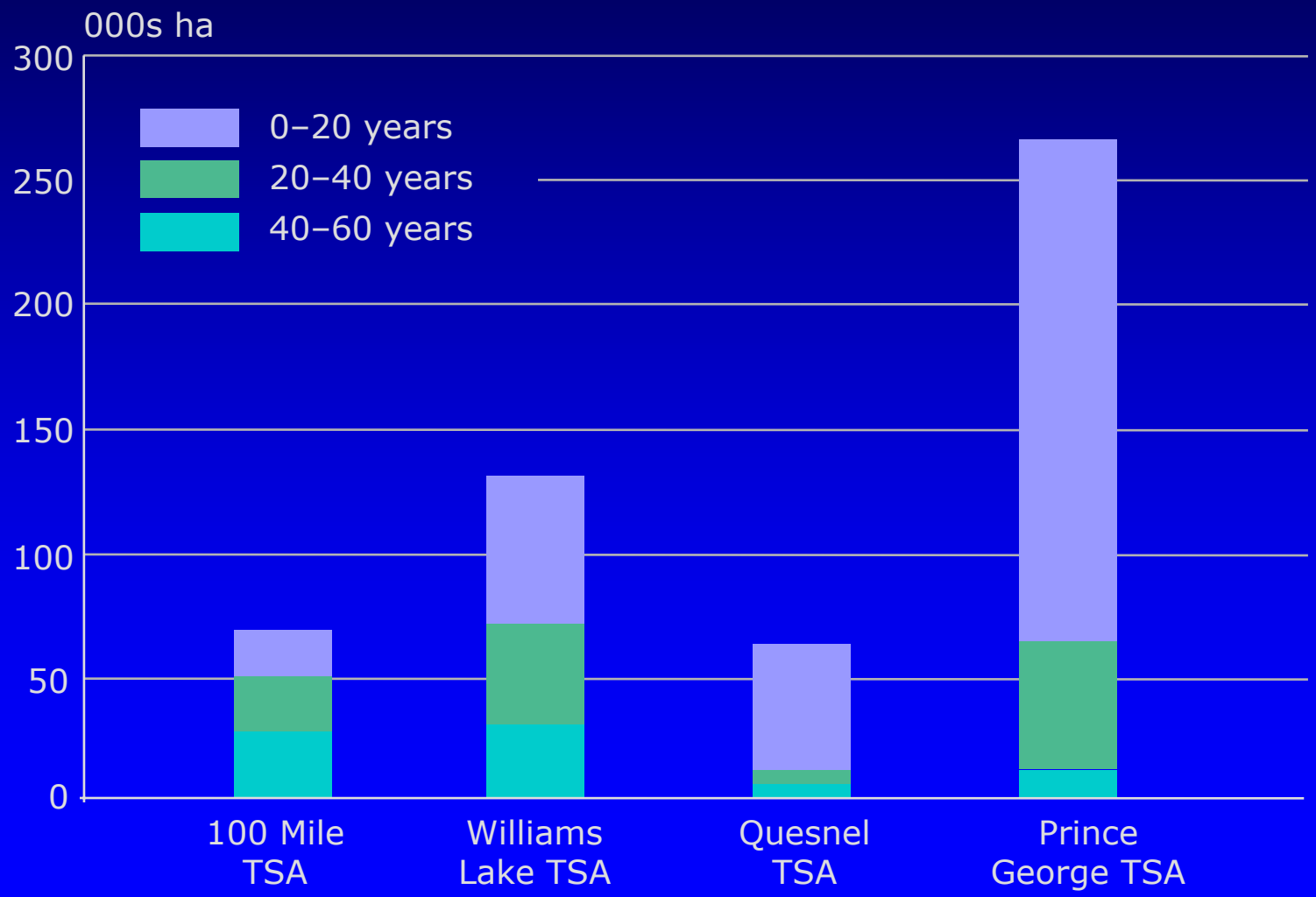
- Fertilization will “Increase wood volume and utilization. This will increase product output and reduce recovery costs. Also, reduce rotation age”
- "Fertilization is a silviculture treatment that can be effectively used to increase the merchantable yield and value of established forests"
- “Operational Fertilization programs have been recognized as a high priority for the future timber supply issues through the TSA silviculture analysis”

Risks that must be managed

- Water
  - protect through fertilizer free zones
- Watershed impacts
  - limit applications in sensitive watersheds
- Insects
  - limit fertilization to fir and spruce till epidemic runs it course
  - avoid areas with forest health issues

Regional Opportunities for Fertilization

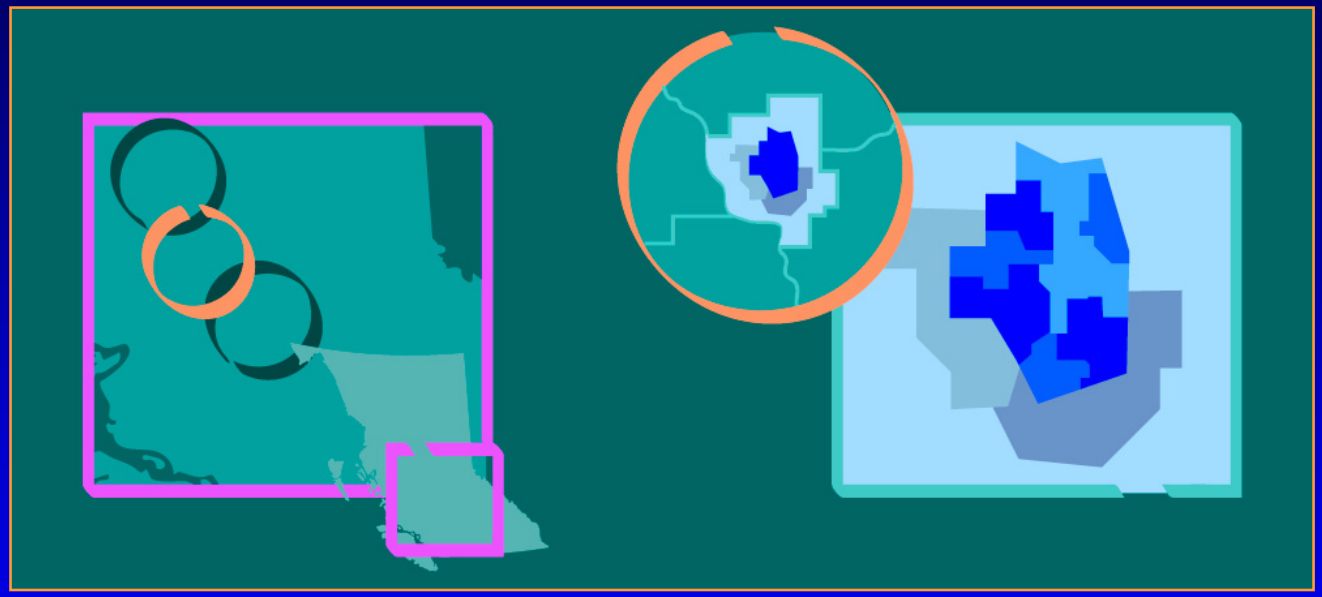
Fd- and S-leading stands ages 0–60 years



FFT Fertilization Program
Goals, objectives

- Mitigate timber supply shortfalls that will occur in 20 to 70 years
  - add merchantable volume to 15- to 70-year old stands (make operable sooner, redistribute timber availability)
  - reduce depth and duration of timber supply shortfall
- Help reduce community/regional economic impacts from MPB
  - provide short- and mid-term employment
  - invest in timber assets on public forest land
- Complement other strategic investments in timber supply mitigation efforts

Fertilization Program
Strategic approach



- BC Interior
- Areas facing major timber supply impacts from MPB, wildfire

Projected TSA level impact of 80% pine mortality on mid-term timber supply (Districts for PG TSA).

District	Mid-term Impact
Quesnel	45%
Vanderhoof	45%
Williams Lake	41%
Lakes	40%
Merritt	40%
100 Mile House	34%
Lillooet	30%
Morice	29%
Prince George	24%
Cranbrook	23%
Kamloops	20%
Kootenay Lake	20%
Mackenzie	20%
Invermere	19%
Boundary	18%
Fort St. James	15%
Okanagan	15%
Dawson Creek	13%
Bulkley	10%
Robson Valley	9%

Tactical approach

- Within key units, initially focus on spruce, Douglas-fir stands
- Identify sites for treatment in 15- to 70 year old stands
- Treat large, contiguous blocks of eligible stands
- Focus on stands close to roads and rail lines

Delivery

- Quality and efficient fertilization requires specialized and experienced crews
- To achieve good coordination, efficiencies and economies of scale, consider using a limited number of contracts and contractors for this program.
- On the priority TSAs and TFLs, tactical Planning to be lead by the licensees and or consultants.
- Review of proposed tactical plans and treatment sites with licensee TSA groups.
- Review plans with MOE to identify any issues.
- Discuss how coordinated aerial fertilizer contracts can be let through licensees this year

Delivery

- Implementation supervision by experienced and specialized fertilizer operations contractors working for licensees.
- Quality control and evaluation by specialized contractors working for licensees.
- Accomplishment reports to be submitted to MOF by all contractors
- PWC to carry out audits and role up summary reports
- monitoring

Monitoring

Need to do monitoring of

- treatment response
- costs
- forest health issues
- non-timber issues
- whether results are consistent with expectations

General annual work shedule		
Work area	***Responsibility***	***Completion Date***
Review strategic opportunities	FPB, Regions and Districts and licensees	Nov to Dec
Site selection, Foliar analysis of key sites	Licensees	Oct to Nov
Strategic Planning	FPB, Regions and Districts and licensees	January
Detailed Budgeting	FPB, Regions and Districts and licensees	February
Site review and selection	Licensees	May June
Review with MOF	Licensees	July
Review with other agencies	Licensees	July
Review with First Nations	Licensees	July
Contract development	Licensees	July
Award of fertilizer contract	Licensees	July
Fertilizer operations	Application contractors	October and/or March
Quality control	Licensees	Ongoing, annual report, 31 March
Reporting of accomplishments	Licensees – preferably delegate to application contractor, input to RESULTS	Within 30 days of operations
Audits of work done	PWC	March 31st

Communications

- Brochure – *Forest Fertilization in BC* four pages with background, why, how, who and where.
- Type 1 & 2 silviculture strategies.
- Web site.
- Lakes is dealing with local concerns, the approach will be used as a template in other management units.
- Presentations such as this.

Forest Fertilization Strategy

- A large program is required in order to have a significant impact on timber supply. A two million cubic metre response will require treatment of about 128 000 hectares with an estimated cost of $45 million.
- Initially the focus will be on healthy spruce and Douglas-fir stands.
- Any fertilization of lodgepole pine will be delayed until the MPB epidemic has run its course.

Proposed annual budget and areas to be treated

- $ 3.2 million this fiscal
- $8 million in 2007/2008
- $8 million in 2008/2009
- $10 million in 2009/2010
- $12 million in 2010/2011

- 19,000 hectares ($3 million fertilizer purchased)
- 23,000 hectares
- 23,000 hectares
- 29,000 hectares
- 34,000 hectares

2006/07 Fertilizer Program

Management Unit	area (ha)
Lakes	350
Prince George	8650
TFL 53 (Dunkley)	2000
TFL 52 (WF)	3000
Quesnel TSA	1000
Williams Lake	2000
100 Mile	2000
Total	**19000**

Summary

- Fertilization is a proven method for increasing merchantable volume and accelerating the operability of established stands
- analyses indicate that fertilization has positive impacts when done on the right sites for the right reasons
- FFT will strategically fund large scale fertilization
- Fertilization should be considered as part of a suite of activities that are planned to mitigate mid term timber supply impacts and contribute to community stability
- ***Every tree to be harvested in the next 20-60 years is in the ground today. If we want to leave a positive contribution for future generations, we need to do the right things…now***

THANK YOU!

- For your time and interest
- to Industry and MOFR for silv strategy information
- Rob Brockley
- Mel Scott
- Cortex Consultants
- Al Hunter
- Ron Gladiuk