Forest Genetics Council of BC

Summary of seed and seed orchard need analysis for Seed Planning Units impacted by Mountain Pine Beetle

the "STRAW DOG[1]"

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December 11, 2006

[1] A "straw-dog proposal" is a simple draft proposal intended to generate discussion of its disadvantages, and to provoke the generation of new and better proposals (Wikipedia). The origin of this phrase is thought to be a straw man set up for the purpose of attacking it for combat practice.

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1. Purpose

Mountain pine beetle (MPB) has caused changes to logging rates and patterns. This has in turn changed seed-use in many parts of the interior, and in some areas has resulted in substantial increases in planting. These increases will require an adequate seed supply. Also, the use of select (orchard) seed has the potential to contribute to the mitigation of harvest declines over the next few decades. The production of select seed in support of reforestation efforts is a concern of the Forest Genetics Council of BC (FGC).

This report was prepared for the FGC to help inform their decisions and recommendations regarding possible seed orchard developments that are supported partly or wholly with Forest Investment Account Tree Improvement Program funds. Information may also provide guidance on cone and seed collections to licensees and BC Timber Sales (BCTS).

This report does not address seed availability and needs in class B seed planning zones, or in areas that do not have opportunities for seed orchard developments (i.e. no breeding program and select material available). An analysis of lodgepole pine seed availability in class B seed zones was completed by the Ministry of Forests and is available at the following website: http://www.for.gov.bc.ca/hti/pinebeetle/index.htm. Note, however, that this analysis is also relevant to class B seed zones.

2. Overview

The issue:

Two primary issues drive the need to consider incremental seed orchard developments:

1. Seed requirements for planting areas impacted by MPB.
2. Mitigation, through the use of faster-growing genotypes, of forecast near-term harvest declines in many interior management units impacted by MPB.

Content of report

Results are summarized from discussions with seed users (industry, BCTS, MoFR), Interior TAC input, and analyses on planting and seed needs in mountain pine beetle (MPB) impacted seed planning units (SPU[2]). Uncertainty and risk are considered, and risk analysis is used to support recommendations. Needs vary widely by SPU due to very different levels of availability of select (orchard) seed and orchard production expectations. Recommendations are made by SPU.

3. Information sources:

1. Twelve-year historic seed use data from the Seed Planning and Registration System (SPAR) were used to show trends, and year to year variation. Species plans of the FGC use average seed-use from the previous 5-year period for planning purposes.
2. Discussions with staff from industry, MoFR (regional, headquarters, FFT), and BC Timber Sales. Discussions also took place at the fall 2006 Interior TAC meeting. Conference calls were held with FFT and stakeholders from the central interior.

[2] Seed Planning Units refer to a species within a seed zone and elevation band (i.e. Pli Prince George zone, elevation 700-1400m). An SPU represents an operational unit for breeding, seed orchards and seed need planning. SPUs are not unique to licensees, and many licensees use seed within an SPU.

3. A sensitivity-analysis model that aids in the evaluation of seed-use patterns under a variety of assumptions, including orchard development options, AAC shifts, species-choice changes, climate change, and historic-use patterns.
4. Orchard seed production forecasts from FGC species plans (in FGC Business Plan).
5. Existing seed inventories.

4. Uncertainty is high:

Seed-need forecasts are unreliable due to:

- Timber supply availability and changing industry logging plans (such as broad operating trends to different geographic areas, different elevations, etc.).
- Market opportunities and mill needs (changing products and mill types).
- Health issues (like MPB) that significantly change wood availability and harvest patterns.
- Silvicultural trends that cause shifts in species preference, regeneration systems, etc.
- Economic (and accounting) factors that drive industry to plant or leave areas for natural regeneration.
- Crown land policy changes that impact logging and reforestation patterns.
- Publicly-funded programs (FRDA, FRBC, FFT) that encourage or support planting for specific time periods.

For each SPU, the result is a seed-use pattern that varies a great deal from one year to the next. Past attempts to accurately forecast seed needs have had limited success.

In addition to variation from one year to the next, seed-use patterns vary a great deal among SPU. The result is high uncertainty. This analysis provides information on trends, current situations, and options for action, but it must be recognized that this effort to forecast future seed use is UNLIKELY TO HAVE MORE ACCURACY THAN PREVIOUS ATTEMPTS by others. This analysis, however, considers all sources of seed and the specific impact additional seed orchards might have on seed supply and use. Also, the accompanying model allows sensitivity analyses to examine "what-if" questions regarding orchard developments.

5. Risk is low:

Fortunately, seed stores well, and for many SPU, uncertainty may be moderated by developing a multi-year seed supply.

Risk can be broken down to three categories:

1. Insufficient seed available to meet reforestation needs.
2. Opportunity costs associated with using wild seed when select seed is, or could have been available.
3. Risk of burning capital on seed orchards that provide no value.

Risk #1 is the greatest risk, as costs associated with not meeting reforestation needs greatly exceed costs associated with risks #2 and #3. However, as wild seed is available or collectable

for most SPU, risks #2 and #3 are well worth consideration. In general, this analysis seeks to eliminate risk #1 over the longer term, while reasonably avoiding risks 2 and 3.

6. Key information on which to base orchard expansion decisions:

- Forecast seed needs over about 25 years.
- The availability of other seed (from existing orchards or wild seed) that is currently in seed inventories, will be produced, or could be collected.
- The percentage of total seed supply a new orchard(s) could provide between 2007 and 2030.
- Costs associated with new orchards

It is assumed that any new seed orchards will use the best available genetic material, and contribute to the mitigation of near-term harvest declines to at least the degree of existing seed orchards. Detailed analyses of actual impacts on harvest declines are beyond the scope of this report.

7. Analysis methods:

The following information was compiled and forecast for each SPU of concern:

1. long-term seed-need estimates (to 2030)
2. seed orchard production forecasts (existing seed orchards)
3. existing seed inventories (class A, B+, and B)
4. production forecasts for hypothetical new seed orchards

Percentage of total seed supply

An estimate of total seed supply and demand to 2030 may be viewed graphically. Figure 1 shows a hypothetical seed need curve, estimated supply from existing seed orchards (derived from FGC Species Plans), and supply from hypothetical new seed orchards.

The areas enclosed by the various curves represent the total seed use from existing orchard supply, new orchards, and "other sources" (Figure 2). Other sources may be seed in storage (including class A), wild seed (class B or B+). In this analysis, the areas shown in Figure 2 are represented as a percentage of the total seed use to 2030, and reported for each SPU (Table 1).

The primary uncertainty in the analysis illustrated in Figures 1 and 2 is associated with the seed need forecast. Historic seed orchard production curves, while subject to error and year-to-year variation, have a reasonable historic basis.

Figure 1. Seed needs and orchard supply for a hypothetical seed planning unit. Similar data are developed for each SPU of interest (see Appendix 2).

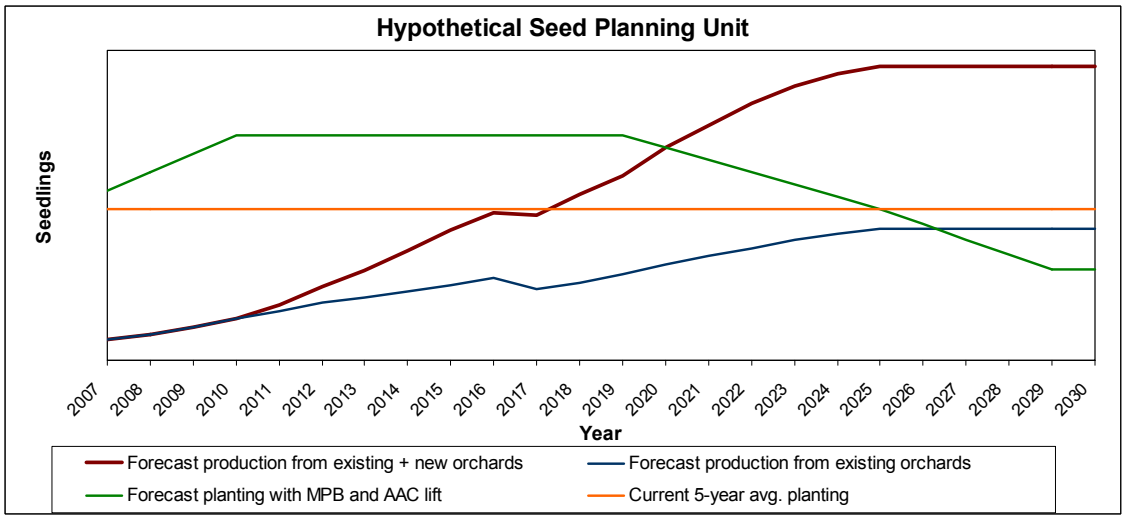
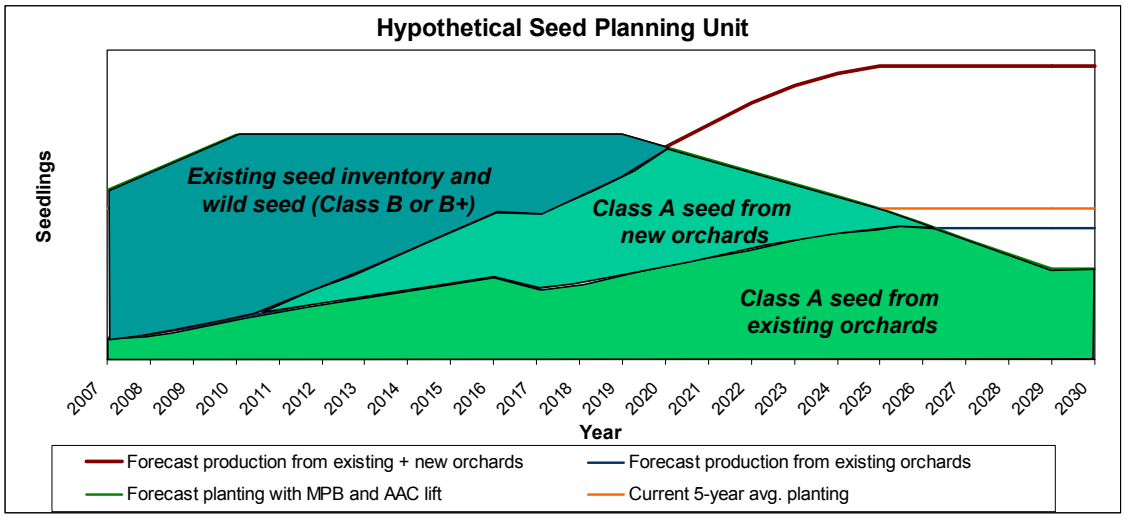


Figure 2. Seed sources for a hypothetical seed planning unit. Areas represent the total supply of seed anticipated from each source. In this chart, the "Existing seed inventory and wild seed" section may include new seed collections from wild stands (B) and superior provenances (B+), as well as all seed currently in inventory (classes A, B+, and B).



Estimating seed needs to 2030

Seed need estimates were made with guidance from the following information:

- Average 2002-2006 sowing average.
- 12-year variability and trends (1995 to 2006).

- Information on AAC lifts by management unit in each SPU.
- Local knowledge from industry, MoFR, and BCTS staff.
- Species-preference trends (i.e. more mixed planting, changes in mixes).

Seed inventory and availability

For all SPU, some amount of seed is in storage at the Provincial Seed Centre. The amount of seed, however varies among SPU, and changes due to withdrawals for seedling orders and additions from cone collections. In addition, seed in storage is owned by a forest company, the Ministry of Forests, BC Timber Sales Ltd., or a seed company. As a result, seed inventories change rapidly, and are not necessarily representative of availability. For example, there may be many years of seed in storage for a SPU, but if the owner keeps it in reserve for their own operations, a shortage may exist for a different user with a need in the same SPU.

It is reasonable to assume that where multiple years of seed exist in inventory, this seed will be used and users will make agreements for purchase or trade. At some level of inventory, seed owners will be willing to release some of their inventory for sale. Based on discussions with industry and BCTS seed owners, the number of years supply they prefer to hold in reserve varies from about 7 years for spruce, larch, and Douglas-fir, to about 15 years for lodgepole pine. Where the total inventory exceeds these thresholds, there is more flexibility and willingness among owners of the seed to sell, and the inventory will tend to fill the needs of all seed users. When inventories are below these thresholds, flexibility will drop, and increasingly, more situations will arise where seed shortages will arise for some seed users.

In this analysis, seed inventories are estimated as the number of years supply using the following criteria:

- Class A, B+ and B seed inventories are grouped (no attempt to separate by Genetic Worth[3]).
- Seed ownership is not considered.
- SPAR sowing factor assumptions are used (individual nurseries and seedling buyers may choose to use different sowing factors).

Current seed inventory is reported in this analysis as years supply using estimated future planting levels under the assumption that forecast production from existing seed orchards will get used first. In other words, the seed inventory would only be applied to the two upper areas on the graph in Figure 2. This statistic can only be a general guide, due to seed ownership issues that will result in some users having lots of seed while others may run out.

Adding to seed inventory from sources other than new seed orchards

Seed may be added to inventory through future collections from existing seed orchards, and from wild stands (class B and B+). Production from existing seed orchards is predictable over long periods, although year-to-year production may vary widely. Opportunities for wild stand collections may be limited in some cases; particularly for lodgepole pine in areas where MPB has killed virtually all mature stands. For other species, it is generally assumed that

[3] Genetic Worth = GW. There was no attempt made to differentiate seed inventories by GW, as this information is not directly relevant to the analysis. It can be assumed that seed from any new orchards will have higher GW than seed from existing orchards (unless they are poorly placed and subject to high levels of non-orchard pollen).

opportunities will exist. It is worth noting that operational people have very significant concerns that lodgepole pine seed will not be available from wild stands in many areas for some time to come (15+ years), and that we may be forced to consider seed collections from plantations.

Analysis presentation format

Data from the analysis are presented in the graphical format shown in Figure 1 for all SPU of concern. Spruce and most larch SPUs are not shown, as seed supply from existing orchards is not an issue. In addition, the percentage of total forecast seed needs to 2030 met by the following sources (areas illustrated in Figure 2) are summarized in Table 1:

- Production from existing orchards (forecast production only).
- Seed in inventory or new wild stand collections (this may include class A seed already in inventory, but for the species of most concern – Fdi and Pli – class A inventories are negligible).
- Seed needs met by hypothetical new orchards.

8. Results

Table 1 shows results of this analysis for each seed planning unit of interest. Note that only SPU with an associated breeding program are considered. While seed needs may exist in SPU not listed here, there is either no genetic gain available within the time frame of the analysis, or the SPU has not been part of FGC planning to date, and species plans are not developed.

Appendix 1 provides detailed descriptions of the information in each column of Table 1, including assumptions of importance.

Data for existing inventories, production assumptions for existing seed orchards, and historic 5-year seed use are relatively fixed. The column containing "*Orchard expansion* (# *ramets)*" shows a recommended expansion. As discussed above, the "*% seed from new orchards*" is the estimated contribution of the recommended orchard expansion to total seed use in the period 2007 to 2030. This is based on historic production figures, and on assumptions of seed need.

Results by SPU are shown graphically in Appendix 2.

Table 1: Preliminary summary of SPU data and recommendations for incremental seed orchard developments. Column headings are explained in Appendix 1.

Seed Planning Unit information									Estimates			Recommendations			% of total seed supply between 2007 and 2030			
SPU #	Spp.	Zone	Elev. (m)	# orch. ramets currently planned	# ramets currently in orch.	5-yr. Avg. planting (million)	Climate change caused SPU shift[4]	Years seed in storage incl. Class A forecast	% max increase in planting	year of peak planting	year planting begins to decline	Orchard expansion (# ramets)	Manage-ment intensity	Adminis-trative option(s)	Existing seed orchards	Proposed new seed orchards	Current inventory (A, B, B+) and new wild collections	Comments
21	Fdi	Ne Low	400-1000	2187	2158	2.4	151%	>24	20%	2009	ongoing	500	Moderate	MoFR interest	81%	2%	17%	Increased use of Fdi expected. No contingency or roguing ability with current orchard size. Cl. chng. may increase zone size
22	Fdi	Ne High	1000-1600	3350	1525	3.4	108%	7	20%	2009	ongoing	0			77%	0%	23%	Sufficient capacity in existing orchard
37	Fdi	QL Low	700-1200	1119	1313	0.5	35%	>24	0%	na	na	0			98%	0%	2%	Sufficient capacity in existing orchards
39	Fdi	EK	700-1400	750	468	1.0	70%	>24	20%	2009	ongoing	400	Intensive	MoFR interest	52%	18%	30%	Expand existing orchard at Bailey if space available
41	Fdi	PG Low	700-1000	1296	1285	2.6	-63%	9	20%	2007	2015	600	intensive	SelectSeed	49%	21%	29%	Insufficient capacity to meet needs. A new orchard will provide security of supply. CT orchard could supply all of PGC overlap zone.Not feasible to expand existing orchard.
43	Fdi	CT Low	600-1200	962	962	0.9	44%	>24	20%	2007	ongoing	0			99%	0%	1%	Sufficient capacity in existing orchard
13	Lw	Ne Low	500-1200	1583	1583	3.0	140%	>24	25%	2009	ongoing	0			99%	0%	1%	Sufficient capacity in existing orchard
34	Lw	EK	800 - 1500	1301	1301	2.0	39%	>24	25%	2009	ongoing	0			100%	0%	0%	Sufficient capacity in existing orchard
50	Lw	NE high	1200-1800	400	410	1.3	96%	>24	20%	2009	ongoing	50	Intensive	Private interest	75%	0%	25%	Small expansion to existing orchard under development may be warranted.
7	Pli	Ne Low	700-1400	3972	3849	3.6	198%	>24	30%	2010	2023	0			100%	0%	0%	Current orchard capacity sufficient. Zone expansion due to climate change may justify future expansion.
10	Pli	TO low	700-1400	7165	6814	15.0	79%	15	20%	2009	2022	4000	Moderate	MoFR/ SelectSeed?	57%	15%	28%	Current orchard capacity probably insufficient. Additional extensively managed low-cost orchard warranted.
12	Pli	PG Low	700-1200	14570	14324	36.5	49%	>24	15%	2007	2021	10000	Mod./Inten.	MoFR/VSOC /SelectSeed?	54%	13%	33%	Currently planned orchard expansions (rust-resistant SO) are expected to be adequate. SelectSeed role uncertain.
16	Pli	TO High	1400-1600	4156	4131	5.9	-27%	>24	15%	2009	2022	1000	Moderate	SelectSeed	74%	4%	22%	Current orchard capacity probably insufficient. Additional extensively managed low-cost orchard warranted.
17	Pli	BV Low	700-1200	14155	14558	16.4	8%	>24	10%	2007	2020	0			92%	0%	8%	Current orchard capacity sufficient.
18	Pli	CP Low	700-1100	10242	9509	6.2	-16%	>24	20%	2010	ongoing	0			100%	0%	0%	Current orchard capacity sufficient.
20	Pli	Ne High	>1400 m	2500	0	2.9	60%	>24	15%	2010	2023	0			55%	0%	45%	MoFR planning a to establish a new orchard.
32	Pli	EK Low	800-1500	1551	2377	2.8	94%	>24	15%	2010	2023	0			73%	0%	27%	Current orchard capacity sufficient.
15	Pw	KQ Low	500-1400	2823	2656	0.9	144%		30%	2010	2023	0			100%	0%	0%	Current orchard capacity sufficient.
4	Sx	NE mid	1000 - 1500	2065	2230	4.4	143%	>24	15%	2010	2023	0			100%	0%	0%	Current orchard capacity sufficient.
5	Sx	NE high	1500-1900	2490	2553	5.3	88%	>24	15%	2010	2023	0			100%	0%	0%	Current orchard capacity sufficient.
14	Sx	PG Low	600-1200	7840	7039	27.9	-35%	>24	20%	2007	2023	0			100%	0%	0%	Current orchard capacity sufficient.
25	Sx	EK Low	750-1700	425	425	2.0	50%	>24	15%	2010	2023	0			100%	0%	0%	Current orchard capacity sufficient.
28	Sx	TO High	1300-1900	1057	1584	3.5	-37%		10%	2010	2023	0			100%	0%	0%	Curretnt orchard capacity sufficient if Tolko continues to manage orchard 303
30	Sx	TO Low	700-1300	454	961	1.4	22%		15%	2010	2023	0			100%	0%	0%	Curretnt orchard capacity sufficient if Tolko continues to manage orchard 303
35	Sx	BV Low	500-1200	2630	2317	9.7	150%	>24	15%	2007	2021	0			100%	0%	0%	Current orchard capacity sufficient.
40	Sx	PR Low	650-1200	4064	3623	5.4	20%	>24	0%	2010	2023	0			90%	0%	10%	Current orchard capacity sufficient.
42	Sx	PG High	1200-1500	1957	1829	2.3	-10%	>24	15%	2007	2023	0			100%	0%	0%	Current orchard capacity sufficient.
44	Sx	NE low	1-1000	900	819	1.1	197%	>24	20%	2010	ongoing	0			90%	0%	10%	Current orchard capacity sufficient.

[4] Climate change impacts on SPU size were provided by the UBC Centre for Forest Gene Conservation, and are based on moderate and generally accepted assumptions of future climatic conditions.

9. Administrative options for orchard capital investments

Both public and private capital supports seed orchards investments in British Columbia. The FGC has worked to develop a provincial seed supply system that is efficient and will provide a reliable long-term supply of seed for Crown lands. FGC business plans set targets for total orchard capacity within each SPU, and where private capital or MoFR Tree Improvement Branch internal funds are not forthcoming to establish needed seed orchard developments, the FGC has recommended the use of public (FIA[5]) capital through SelectSeed Co. Ltd. This structure provides for an investment structure, and return on capital as seed sales accelerate.

MoFR investments in seed orchards either predate the current seed market situation (established during the era when the Crown paid for seed used for reforestation on public lands), or are designed to support the needs of their primary client, BC Timber Sales Ltd. New investments in MoFR orchards have generally been consistent with FGC business plans with respect to forecast needs.

The development of new seed orchards has the potential to negatively impact the long-term business interests of existing private, MoFR, and SelectSeed seed orchards. This could occur where new developments create a future over-supply of seed, resulting in a loss of market share and revenue for current suppliers. Recommendations to use public FIA funds for orchard developments that could have a negative financial impact on existing operations, should be avoided.

Given the uncertainty associated with future seed needs and markets, the FGC should give consideration to the administrative mechanism used for capital expenditures on new orchards. The following administrative options exist, or may exist, for the use of FIA funds for capital expenditures:

1. Make no orchard capital expenditures.
2. Direct orchard capital expenditures through SelectSeed Company Ltd. using a competitive bid process (status quo). This is a mechanism for multi-year funding and eventual return on capital employed. Governance and contractual systems are in place.
3. Use the existing Operational Tree Improvement Program (OTIP) call for proposal process. This is an annual funding structure with no mechanism for obtaining a return on capital employed.
4. Direct capital expenditures to Ministry of Forests orchard operations.

To date, FIA (and FRBC before FIA) funds for orchard capital developments have only been spent through SelectSeed Company Ltd. This mechanism has allowed Council control of developments to be undertaken and provided a transparent business planning process for approvals and reporting. In addition, there is provision for return of capital to Council.

It is recommended that any FIA funds allocated to seed orchard developments be done only through SelectSeed Company Ltd. However, before SelectSeed is assigned any new seed orchard developments, private interests and the MoFR Tree Improvement Branch should be given the opportunity to state their interest in establishing the orchard using their own funds.

[5] Forest Investment Account

Only if these groups decline, should Council recommend establishment of the orchard to the SelectSeed Board of Directors.

The appropriate mechanism will vary with the mix of orchards and needs for each SPU. Based on information received to date, the likely administrative option is listed in Table 1.

10. Technical options for orchard capital investments

Seed orchard development options will vary by species and SPU, and include the following:

1. Expansions of existing orchards where space is available.
2. New, intensively managed site(s) with permanent or semi-permanent staff (status quo for most BC orchards).
3. Intensively managed site with contract or part-time staff (current situation for some SelectSeed orchards).
4. Moderate management intensity. Establishment of ramets on appropriate sites with minimal management between establishment and crop management. Ongoing adjustment to management intensity may be made as needed to balance costs and seed needs. Contract management.

11. Seed orchard expansion recommendations by SPU:

SPU 21 Fdi Nelson 400-1000m:

Rationale

Long-term orchard seed supply is expected to barely meet demand or to fall short. There is no flexibility for orchard rouging and improvement. Available genetic gains are high (GW 29 and higher), increasing the value of Fdi seed in this zone for mitigation of mid-term harvest declines. Fdi planting is expected to remain high, as foresters prefer it on many sites. Climate change could expand the appropriate climate envelope for these genotypes, increasing demand.

Risk

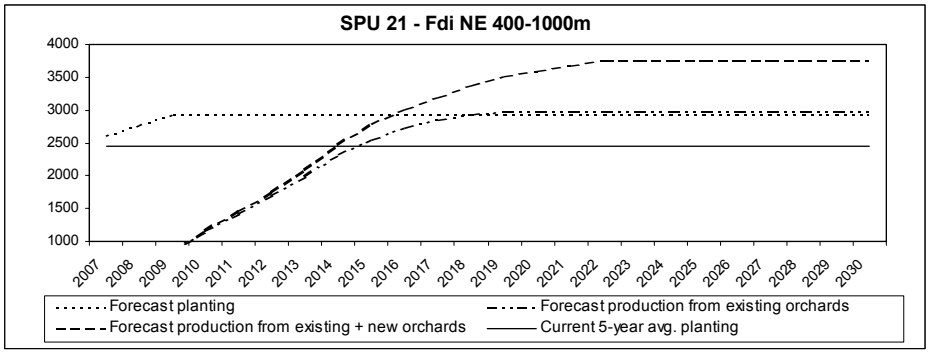
If no orchard expansion is put in place, risk #1 (no seed) is low, as current class B inventory is expected to last for >24 years with forecast orchard production. Risk #2 (mitigation of harvest declines) is high, due to high GW and the timber-inventory age-class structure (Wang and Listar[6]). Also, without expansion, increasing GW potential will be difficult as the forecast orchard supply will be barely able to meet demand. Risk #3 (burning capital) is moderate, as stable demand is expected, but the existing orchard may be capable of meeting demand.

Recommendation

500 ramet orchard on a site away from the current seed orchard to increase supply security. Moderate management (low intensity approach to get ramets established at minimum cost).

[6] Wang, E. and I. Listar. 2000. Impact of the current and planned seed orchard program on timber supply in the Arrow TSA. FGC report. 27pp.

Evaluate needed management intensity as seed demand and supply develop. The MoFR has expressed interest in establishing this orchard at the Kalamalka site.



SPU 39 Fdi East Kootenay 700-1400m

Rationale

Long-term orchard supply is expected to fall short of demand. There is no flexibility for orchard rouging and improvement. Available genetic gains are high (GW 20 and higher), increasing the value of Fdi seed in this zone for mitigation of mid-term harvest declines. Fdi planting is expected to remain high, as foresters prefer it on many sites.

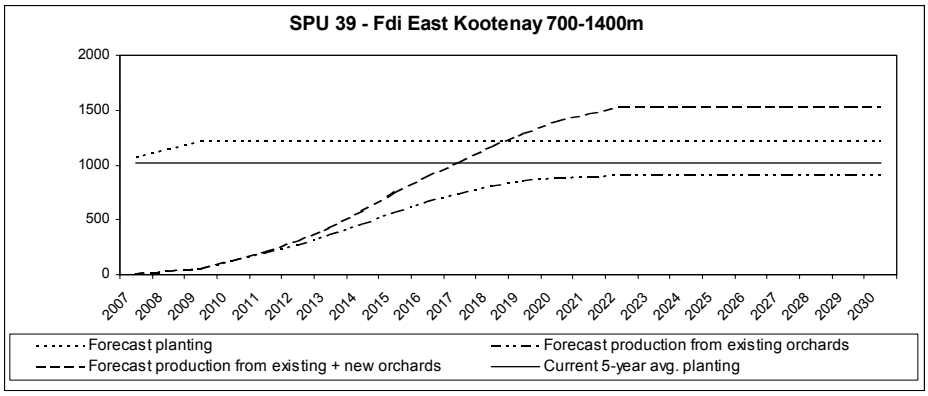
Risk

If no orchard expansion is put in place, risk #1 (no seed) is moderate, as current class B inventory is expected to last for only about 7 years. However, wild seed collections will likely be possible within this time frame. Risk #2 (mitigation of harvest declines) is high due to high GW and the timber-inventory age-class structure (Wang and Listar[7]). Also, without expansion, increasing GW potential will be difficult as the forecast orchard supply will be barely able to meet demand. Risk #3 (burning capital) is moderate, as stable demand is expected, but the existing orchard may be capable of meeting this demand.

Recommendation

400 ramet expansion of the seed orchard currently under establishment at the MoFR Bailey site. Management consistent with current site management is recommended. The MoFR has expressed interest in this expansion.

[7] Wang, E. and I. Listar. 2001. Impact of the current and planned seed orchard program on timber supply in the Golden TSA. FGC report. 38pp.



SPU 41 Fdi Prince George 700-1200m

Rationale

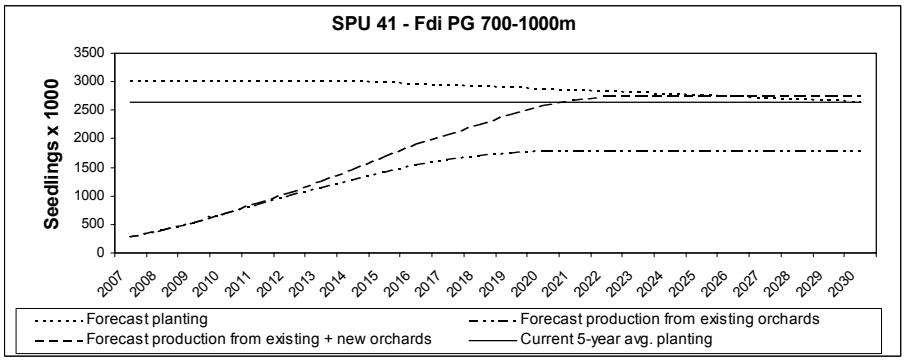
Long-term orchard supply is expected to fall short of demand. There is no flexibility for orchard rouging and improvement. Available genetic gains are high (GW 29 and higher), increasing the value of Fdi seed in this zone for mitigation of mid-term harvest declines. Fdi planting is expected to remain high, as foresters use it in mixes and on specific sites.

Risk

If no orchard expansion is put in place, risk #1 (no seed) is moderate, as current class B inventory is expected to last for only about 9 years. However, wild seed collections will likely be possible within this time frame. Risk #2 (mitigation of harvest declines) is high, due to high GW and extensive MPB-caused mortality in the seed zone. Also, without expansion, increasing GW potential will be difficult as the forecast orchard supply will be barely able to meet demand. Risk #3 (burning capital) is moderate, as stable demand is expected, but the existing orchard is beginning to produce well, and may be capable of meeting this demand.

Recommendation

500 to 600 ramet orchard on a site away from the current seed orchard to increase supply security. Moderate to intensive management. Evaluate needed management intensity as seed demand and supply develop. Interest in this orchard has not been expressed by the MoFR or private parties, therefore, it is recommended that SelectSeed undertake this orchard expansion.



SPU 50 Lw Nelson 1200-1800m

Rationale

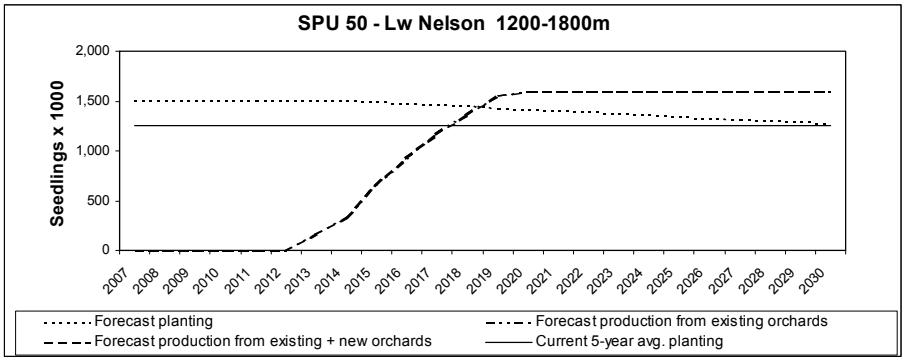
Long-term orchard supply is expected to meet demand, but without the 30% buffer normally built in to allow orchard rouging and build up of high GW inventory. Thus, there is no flexibility for orchard rouging and improvement. Available genetic gains are expected to be high, but breeding values are not yet available. Demand for larch planting is expected to remain high, as foresters use it in mixes and on specific sites.

Risk

If no orchard expansion is put in place, risk #1 (no seed) is low, as the existing class B inventory is expected to last for >24 years. Risk #2 (mitigation of harvest declines) is high, due to high GW and timber-inventory age-class structure (Wang and Listar[8]). Also, without expansion, increasing GW potential will be difficult as the forecast orchard supply will be barely able to meet demand. Risk #3 (burning capital) is moderate, as stable demand is expected. Also, the existing orchard is in an early phase of development, with land available for a small (50 ramet) expansion.

Recommendation

Expand the existing seed orchard by about 50 ramets to ensure future demands are met. The current orchard owner (B. Kasdorf) has expressed interest in this small expansion at his own cost.



SPU 10 Pli Thompson Okanagan 700-1400m

Rationale

Long-term orchard supply is expected to fall short of demand. In addition, Pli orchards are not meeting seed-production expectations to date. There is no flexibility for orchard rouging and improvement. Available genetic gains are expected moderate.

Risk

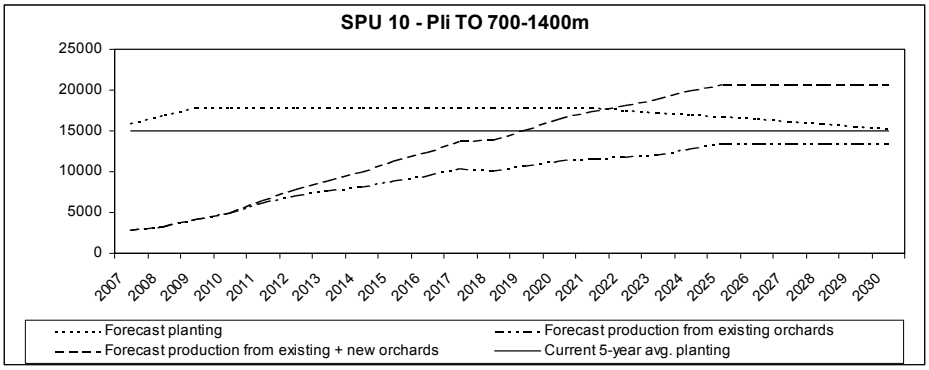
If no orchard expansion is put in place, risk #1 (no seed) is moderate, as the existing class B inventory is expected to last about 13 years. Risk #2 (mitigation of harvest declines) is moderate to high, due to moderate GW and an expected decline in timber availability in the next few decades. Also, without expansion, increasing GW potential will be difficult as the forecast orchard supply will be unable to meet full demand. Risk #3 (burning capital) is

[8] Wang, E. and I. Listar. 2000. Impact of the current and planned seed orchard program on timber supply in the Arrow TSA. FGC report. 27pp.

moderate to low, as stable demand is expected, and existing orchards appear to be insufficient for forecast demand.

Recommendation

4000 ramet orchard expansion on a site away from the current seed orchards to increase supply security. Moderate management (low intensity approach to get ramets established at minimum cost). Evaluate needed management intensity as seed demand and supply develop. The MoFR has expressed interest in establishing 2000 ramets of this expansion at the Skimikin site. I recommend keeping the full expansion as a single orchard for efficiency, and that the MoFR establish the full 4000 ramets. A second option is for SelectSeed to develop the additional 2000 ramet orchard.



SPU 12 Pli Prince George 700-1200m

Rationale

Long-term orchard supply is expected to fall short of demand. There is no flexibility for orchard rouging and improvement. Demand for seed is expected to remain high for several more years (although not at the level of 2006 sowing), and eventually decline below the current 5-year average usage.

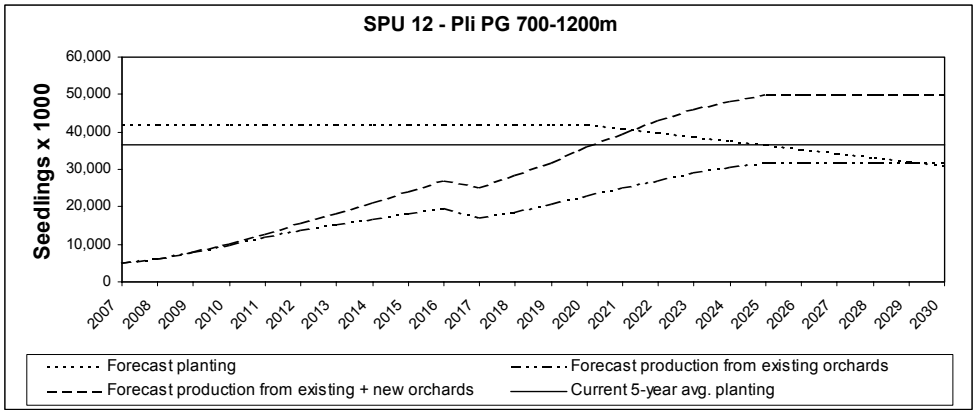
Risk

If no orchard expansion is put in place, risk #1 (no seed) is moderate, as current class B seed inventories are fairly high. However, concern exists among licencees and BCTS that shortage will develop for some users. Availability of wild seed is expected to be low. Risk #2 (mitigation of harvest declines) is moderate to high, due to moderate GW and an expected decline in timber availability in the next few decades with MPB-caused mortality. Without expansion, increasing GW potential will be difficult as the forecast orchard supply will be unable to meet full demand. Risk #3 (burning capital) is moderate to low, as the current orchards are insufficient for forecast demand.

Recommendation

10,000 ramet orchard expansion. Vernon Seed Orchard Company has expressed interest in establishing a 5,000 ramet rust-resistant orchard on a new site (to be found), in collaboration with SelectSeed. The Ministry of Forests and Range is also interested in establishing a 5,000 ramet orchard at Skimikin. This latter proposal is under discussion, as the Pli breeder is

concerned about inappropriate pollen contamination for this orchard at the Skimikin site. An alternative would be for SelectSeed to collaborate with VSOC to establish a full 10,000 ramet, low management intensity and low-cost orchard on a new site.



SPU 16 Pli Thompson Okanagan 1400-1600m

Rationale

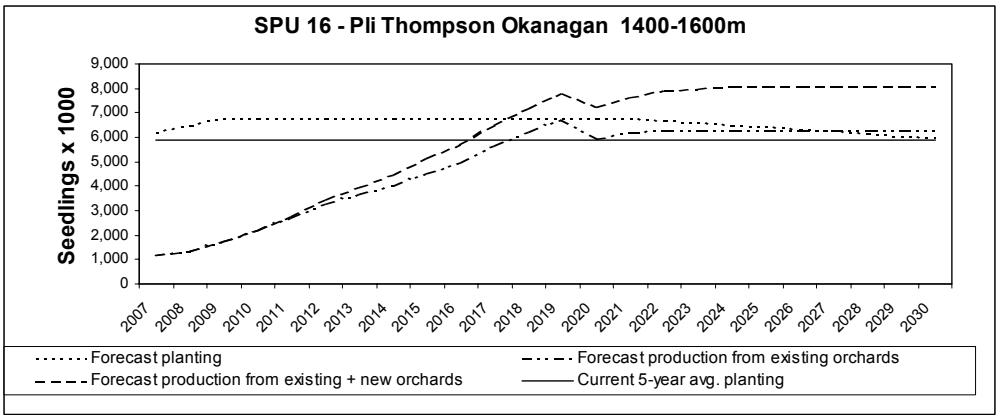
Long-term orchard supply is expected to just meet demand, but without the 30% buffer normally built in to allow orchard rouging and the build up of high GW inventory. In addition, Pli orchards are not meeting seed-production expectations to date. As a result, there is no flexibility for orchard rouging and improvement. Available genetic gains are expected to be high, but breeding values are not yet available. Demand for seed is expected to remain high.

Risk

If no orchard expansion is put in place, risk #1 (no seed) is moderate to low, as the existing class B inventory is expected to last 24+ years. Risk #2 (mitigation of harvest declines) is moderate to high, due to moderate GW and an expected decline in timber availability in the next few decades. Also, without expansion, increasing GW potential will be difficult as the forecast orchard supply will be unable to meet full demand. Risk #3 (burning capital) is moderate to low, as stable demand is expected.

Recommendation

1000 ramet orchard expansion on a site away from the current seed orchards to increase supply security. Moderate management (low intensity approach to get ramets established at minimum cost). Evaluate needed management intensity as seed demand and supply develop. Interest in this orchard has not been expressed by the MoFR or private parties, therefore, it is recommended that SelectSeed undertake this orchard expansion.



Acknowledgements

Members of the Interior Technical Advisory Committtee, MoFR staff from the Northern and Southern Interior Regions, and many industry foresters are thanked for their input, wise guidance, and critique of this analysis. In particular, I would like to thank Dave Kolotelo of the MoFR Tree Seed Centre, Vince Day (Canadian Forest Products), Guy Burdikin (West Fraser Timber), Bob Johnson (Tolko), Scott King (Lousiana Pacific), Dave Basaraba (Tembec), Mike Madill (MoFR Southern Interior Region), Anna Monetta (MoFR Northern Interior Region), and Al McDonald (BCTS Ltd.), and, of course, Mike Carlson (MoFR and ITAC Chair).

Appendix 1: Table 1 header descriptions

Columns 1 – 4 **SPU:** Seed planning unit; Species, zone, elevation

Column 5 **# orchard ramets currently planned.:** the number of ramets currently planned for orchard development. Data from species plans

Column 6 **# ramets currently in orch.:** the total number of orchard ramets currently established. This does not address ramet age, but the analyses considers orchard production forecasts over time in determining other information in the table.

Column 7 **5-year average planting (million):** 5-year average sowing requests from SPAR for the sowing years 2002 to 2006.

Column 8 **Climate-change causes SPU shift:** Climate change impacts on SPU size were provided by the UBC Centre for Forest Gene Conservation, and are based on moderate and generally accepted assumptions of future climatic conditions. These are forecasts from climate modeling, and do not necessarily reflect future policy changes that may result in adjustments to SPU boundaries or seed transfer.

Column 9 **Years seed in storage with Class A forecasts:** The estimated number of years that the total existing seed inventory at the Provincial Seed Centre, for the SPU, would last if forecast production from existing orchards is used first. In question form; if existing orchards produce as forecast, and if seed use proceeds as forecast, how long will current seed inventories last?

Column 10 **% maximum increase in planting:** Estimated percent increase in planting over the current 2002-2006 average due to MPB or other uses (FFT).

Column 11 **Year of peak planting:** Year in which planting maximizes (note that it is know that demand will spike up and down, but these are estimates of when the "smoothed" curve will maximize).

Column 12 **Year planting begins to decline:** Estimated year in which planting is likely to begin to decline of "normal" levels or below.

Column 13 **Orchard expansion (# of ramets):** Recommended number of ramets of orchard expansion

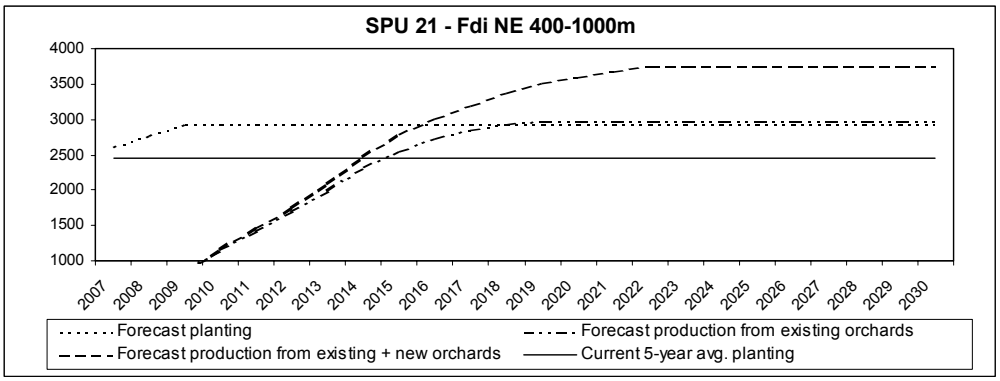
Column 14 **Management intensity:** Recommended seed orchard management intensity. In some cases, there is very high uncertainty associated with new orchard establishment, and substantial orchard capacity already in place. Moderate management intensity is suggested for some developments to keep costs down while keeping options available to increase intensity if necessary.

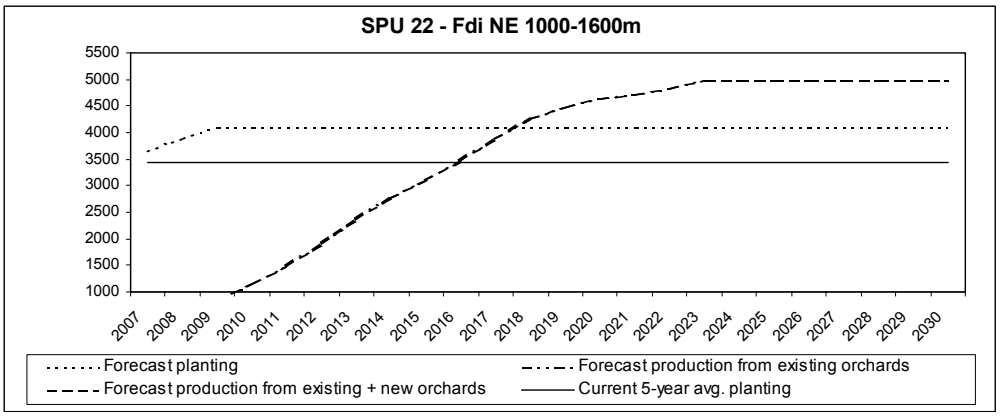
Column 15 **Administrative option(s):** Discussed in Section 10

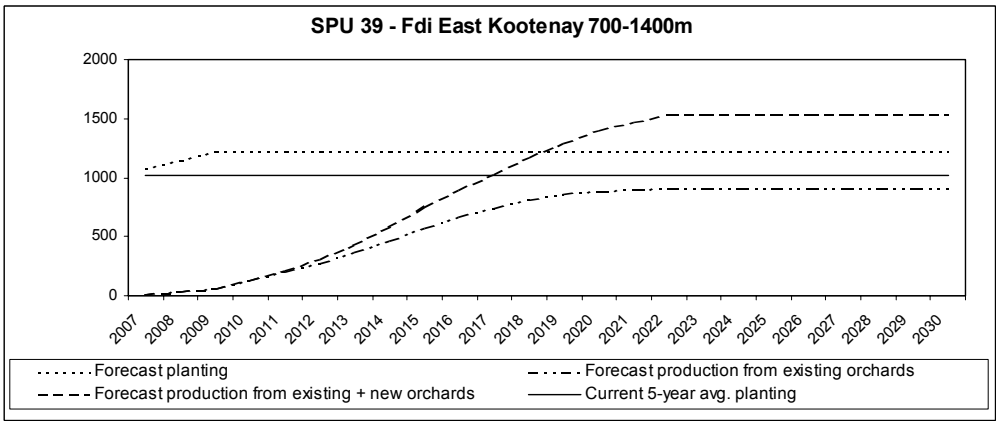
Columns 16-18 **% of total seed supply between 2007 and 2030; Existing seed orchards, Proposed new seed orchards, Current inventory:** Estimates of the total amount seed that would be used to meet forecast planting. Estimates use planting forecasts and seed production forecasts to determine the areas shown Figure 2 over the time period.

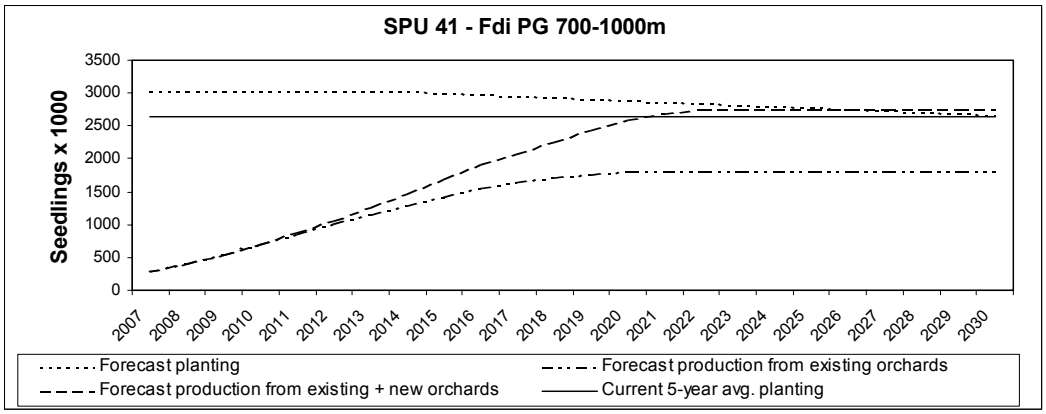
Appendix 2: Graphical forecasts by SPU

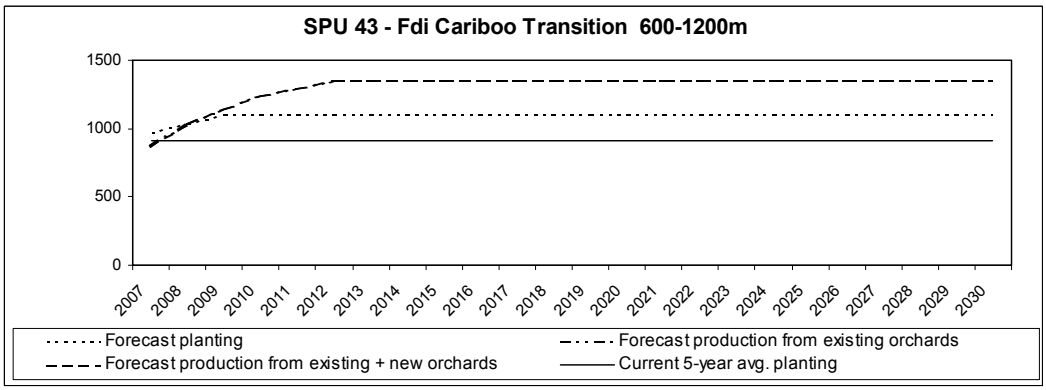
Graphs showing forecast seed demand and supply under the analysis assumptions and orchard development recommendations shown in Table 1. Figures 1 and 2 above explain the format of the graphs. Note that the Y axis represents Seedlings x 1000. Interior spruce and some larch SPUs are not shown, as orchard expansion is clearly not warranted.

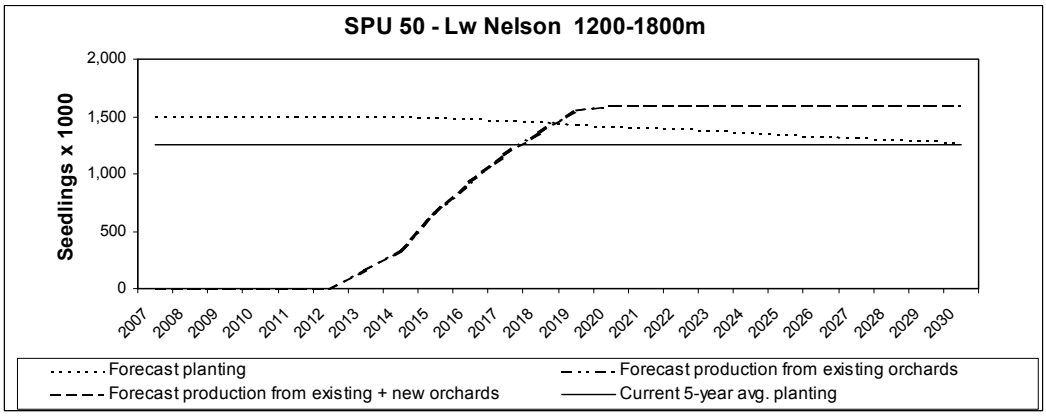


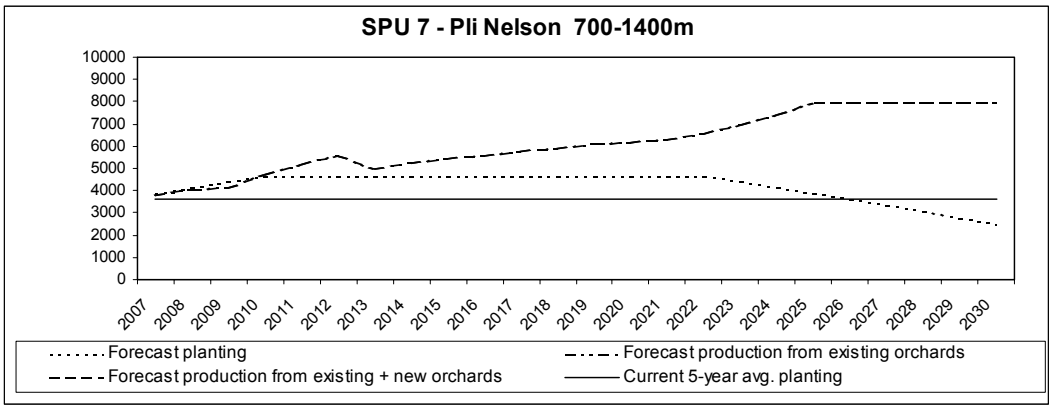


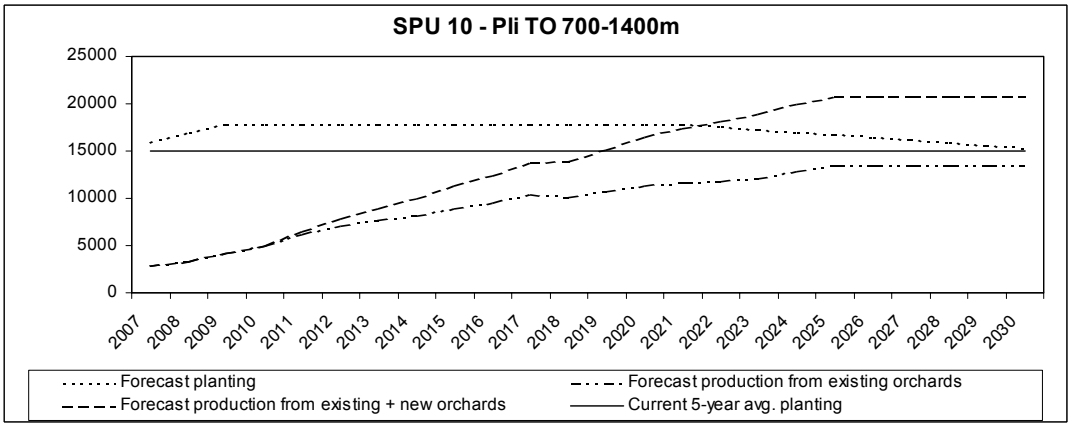


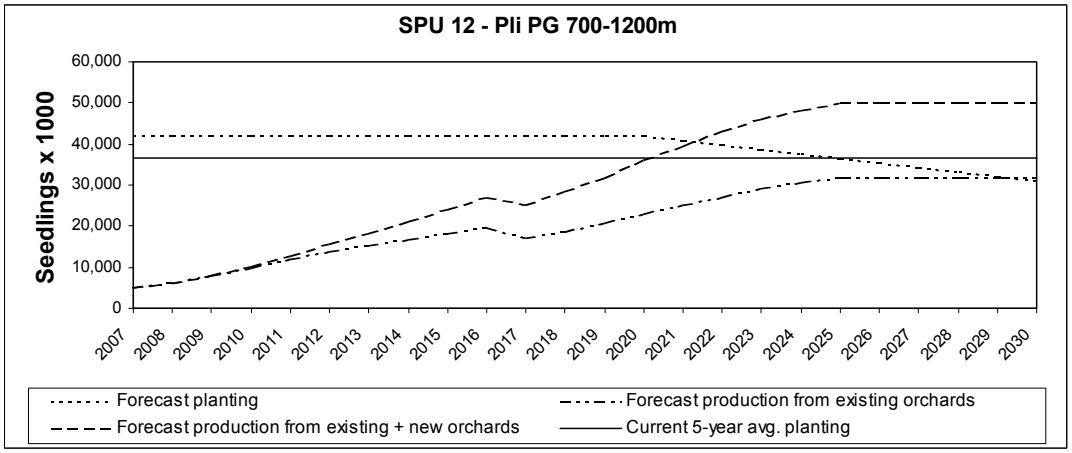

SPU 41 - Fdi PG 700-1000m
Seedlings x 1000
3500
3000
2500
2000
1500
1000
500
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Forecast planting
Forecast production from existing orchards
Forecast production from existing + new orchards
Current 5-year avg. planting

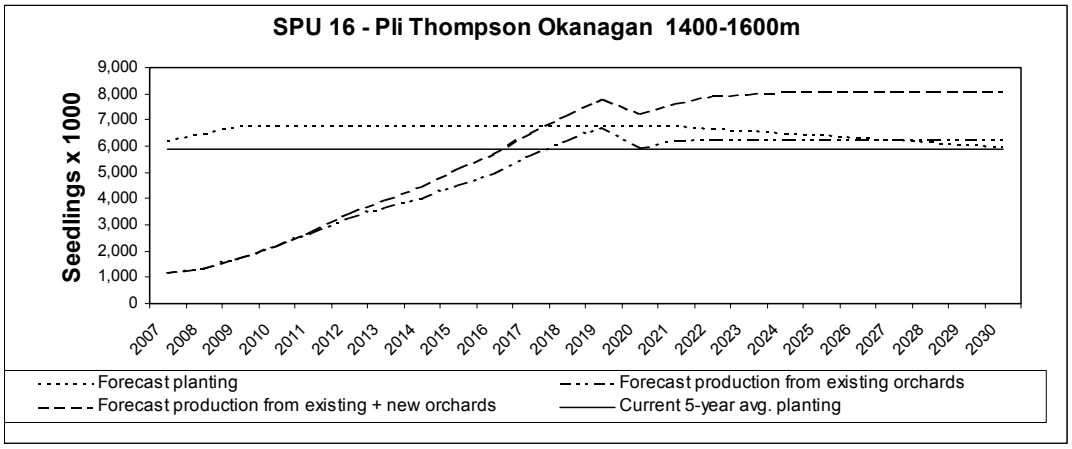

SPU 43 - Fdi Cariboo Transition 600-1200m
1500
1000
500
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Forecast planting
Forecast production from existing orchards
Forecast production from existing + new orchards
Current 5-year avg. planting

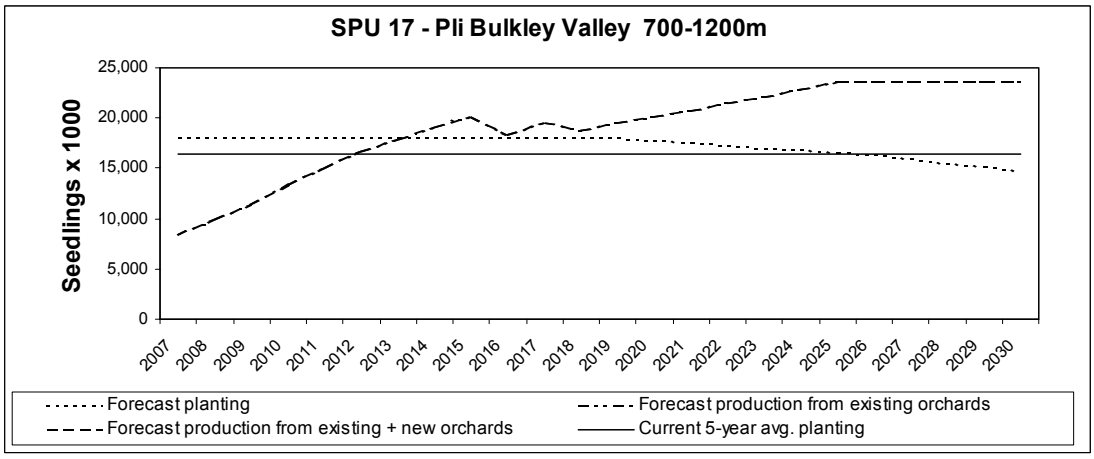

SPU 50 - Lw Nelson 1200-1800m
Seedlings x 1000
2,000
1,500
1,000
500
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Forecast planting
Forecast production from existing orchards
Forecast production from existing + new orchards
Current 5-year avg. planting

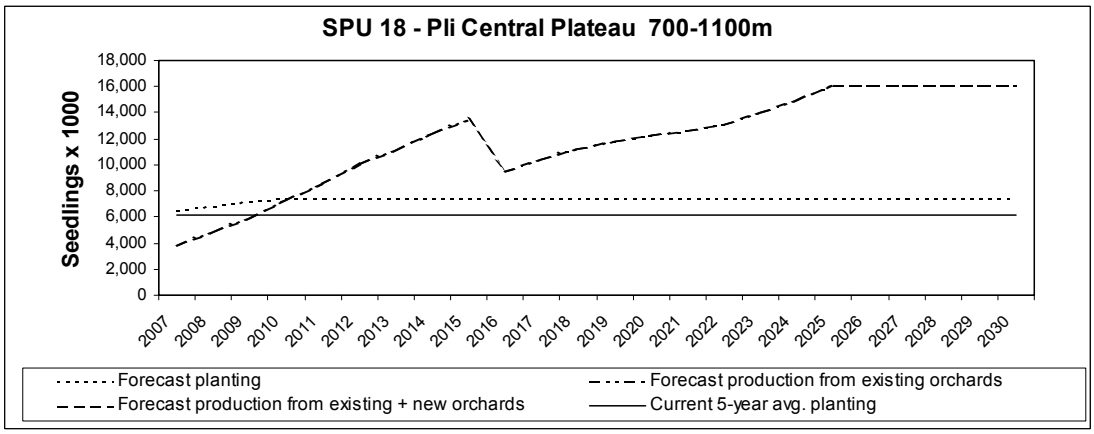

SPU 7 - Pli Nelson 700-1400m
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Forecast planting
Forecast production from existing orchards
Forecast production from existing + new orchards
Current 5-year avg. planting

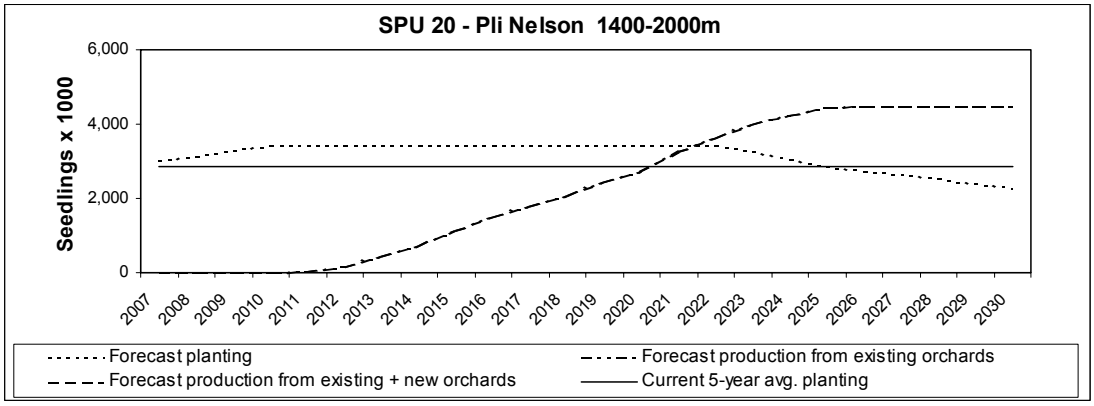

SPU 10 - Pli TO 700-1400m
25000
20000
15000
10000
5000
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Forecast planting
Forecast production from existing orchards
Forecast production from existing + new orchards
Current 5-year avg. planting

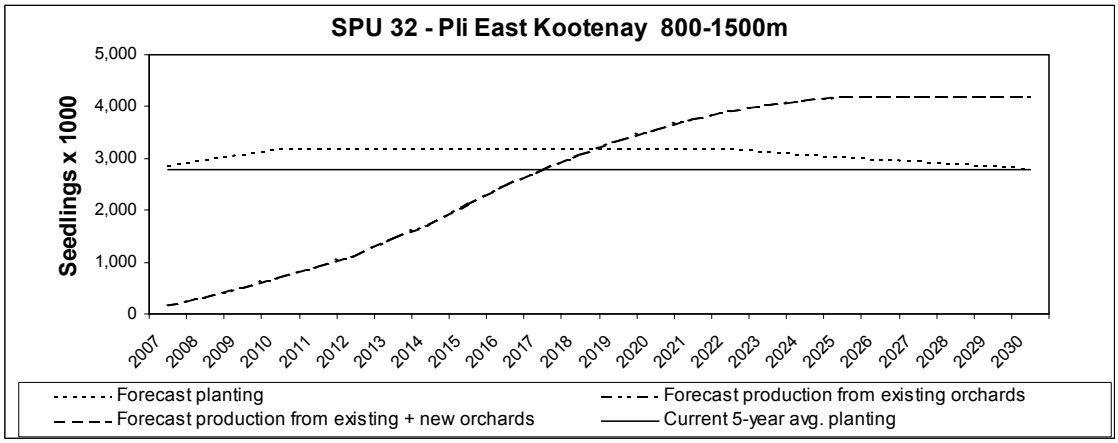

SPU 12 - Pli PG 700-1200m
Seedlings x 1000
60,000
50,000
40,000
30,000
20,000
10,000
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Forecast planting
Forecast production from existing orchards
Forecast production from existing + new orchards
Current 5-year avg. planting


SPU 16 - Pli Thompson Okanagan 1400-1600m
Seedlings x 1000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Forecast planting
Forecast production from existing orchards
Forecast production from existing + new orchards
Current 5-year avg. planting


SPU 17 - Pli Bulkley Valley 700-1200m
Seedlings x 1000
25,000
20,000
15,000
10,000
5,000
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Forecast planting
Forecast production from existing orchards
Forecast production from existing + new orchards
Current 5-year avg. planting


SPU 18 - Pli Central Plateau 700-1100m
Seedlings x 1000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Forecast planting
Forecast production from existing orchards
Forecast production from existing + new orchards
Current 5-year avg. planting


SPU 20 - Pli Nelson 1400-2000m
Seedlings x 1000
6,000
4,000
2,000
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Forecast planting
Forecast production from existing orchards
Forecast production from existing + new orchards
Current 5-year avg. planting


SPU 32 - Pli East Kootenay 800-1500m
Seedlings x 1000
5,000
4,000
3,000
2,000
1,000
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Forecast planting
Forecast production from existing orchards
Forecast production from existing + new orchards
Current 5-year avg. planting