Introduction to Climate Based Seed Transfer

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Nanaimo, Vernon, Castlegar, Prince George
Wild stand Cone Collection Workshops

Margot Spence, RPF
Tree Seed Policy Officer

Susan Zedel, PAg
Seed Resource Specialist

Forest Improvement and Research Management Branch

What is Climate Based Seed Transfer (CBST)?

"Climate Based Seed Transfer (CBST) refers to a seed transfer system based on climate, for the purposes of adapting to and mitigating the impacts of climate change."

How does CBST compare with BC's most recent approach to seed transfer (geographically based seed transfer)?

GBST

- A geographically-based methodology using, longitude, latitude, elevation and biogeoclimatic zone,

CBST

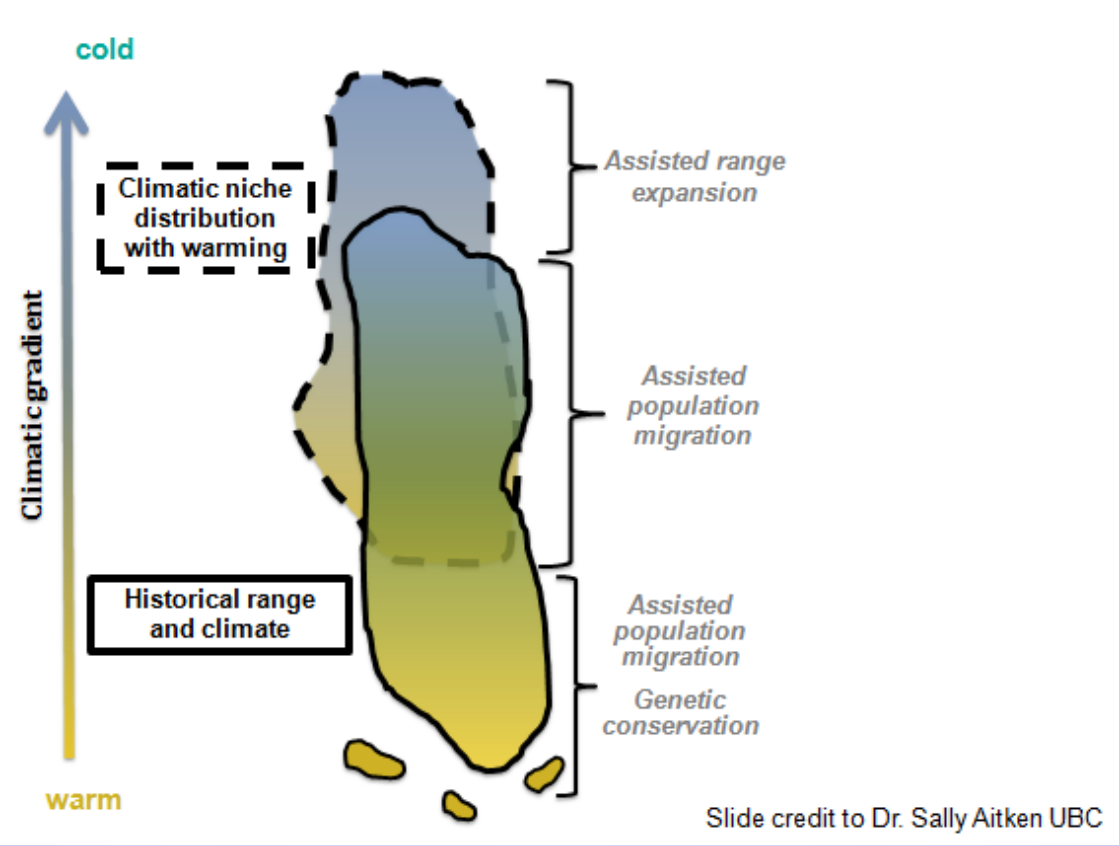
- A climate-based methodology that matches the climate of the seed source with the current and (near) future climate of a planting site.
- Based on new and emerging climate and forest genetic science.
- Includes "assisted migration."

Both systems are science based and supported by data from provenance trials

"Assisted Migration"

(1) is a climate change adaptation strategy;

(2) is the intentional movement of tree seed, from areas they grow naturally, to planting sites that are climatically suitable for their growth at the present time and in the near future.



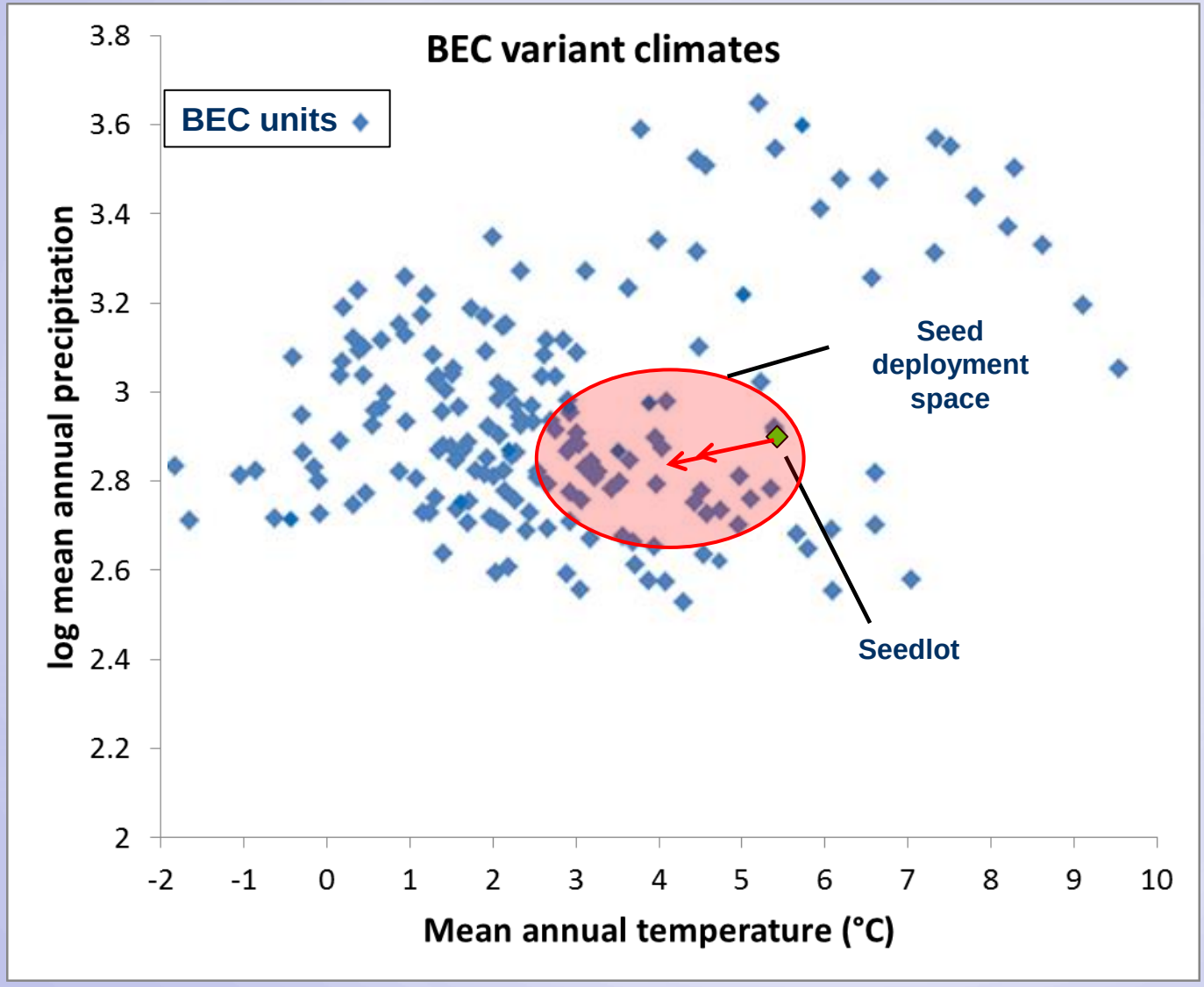
CBST Science Foundation

- Based on climate and forest genetic (provenance) data
- Climate represented by **BEC variants**
- CBST accounts for both past (adaptation lag ~70years) and future climate change (15yrs coast; 20yrs interior)
  = Climate migration distance is to the first quarter rotation

Baseline data sets

- BEC10
- ClimateBC
- Transfer functions
- Minimum genetic and species suitability thresholds
- Expert opinion

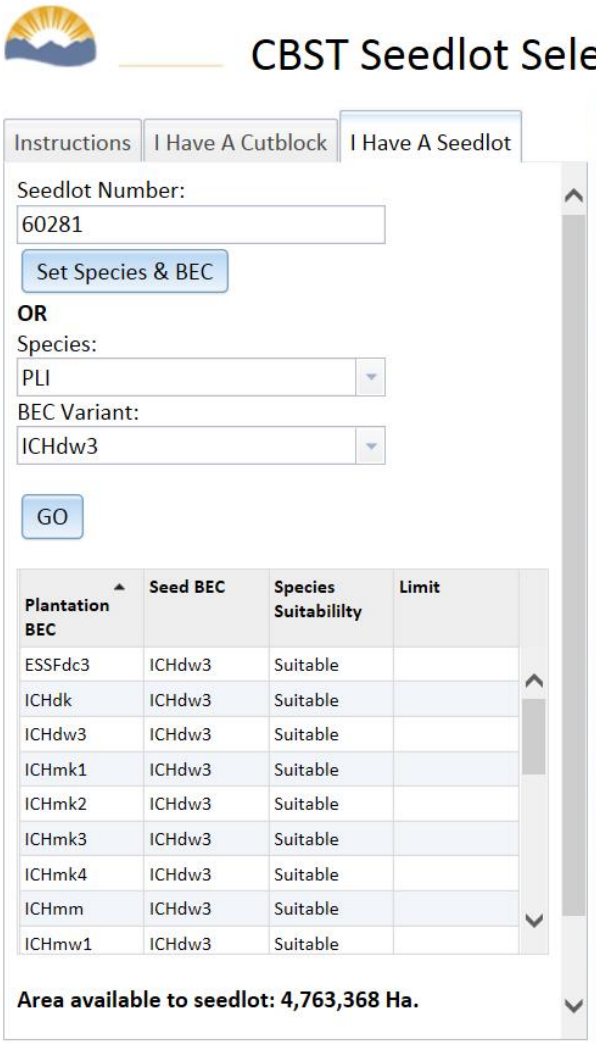
For more information, see Technical Report 099: "*A Proposed Climate-based Seed Transfer System for British Columbia*" by G O'Neill, T Wang, N Ukrainetz, L Charleson, L McAuley, A Yanchuk and S Zedel. (2017)

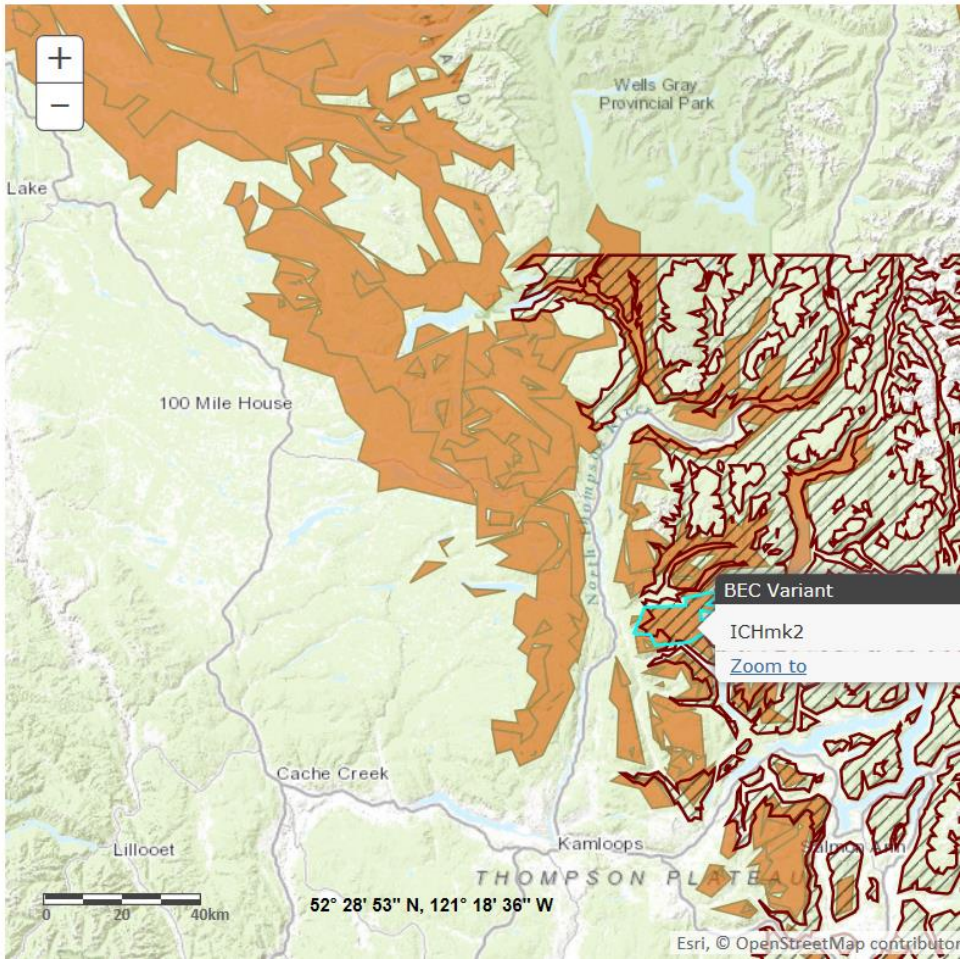


Migrating the climate space

(BEC variants represent climate space)

Example of Shift to a Seedlot Area of Use





The CBST seed deployment area (i.e. CBST Area of Use) comprises the **orange** areas marked on the map. The current seed deployment area (or Area of Use) is marked in the **brick red** colour.

The **CBST Seedlot Selection Tool** enabled mapping of shifts in seed deployment and procurement areas under CBST

/Vegetative Lot for CBST

Search | Lot Info | Requests | Reports | Services | Maintenance | TSC | Registration | Admin

Lot Type: Both Active/Expired: Active Only *
Species: FDI *
Latitude: Longitude Default BEC
BEC Zone: ICH * BEC Subzone: mw * Variant: 2 SeedMap

No. of Seedlings (000's):
Specific Lot(s):
Crown/Private: Registered: Yes
Owner Agency:
Cutting Quantity: Production Year: 2018
Seed Quantity:
Go

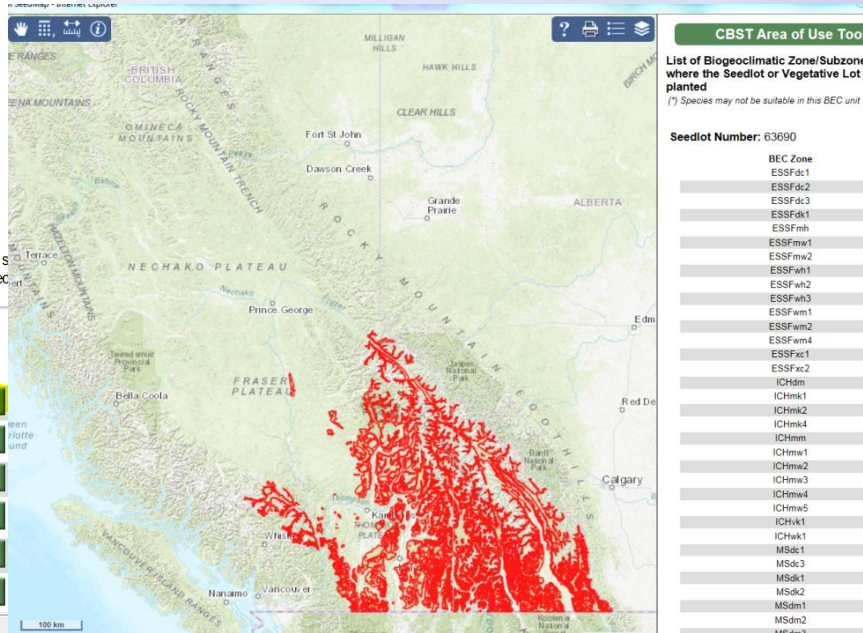
Display: (•) Trees ( ) Quantity (grams/cuttings) Refresh Print
(•) Orchard No./Location ( ) Lat/Long

Seedlot Quantity is displayed in grams; Vegetative lot Quantity is displayed in No. of Cuttings (in thousands)

167 row s returnec

Lot No.	Genetic Class & Worth	Germ. %	C/P	Agency	BEC	Orchard No. / Location	Coll. / Prod. Year	Reserve Trees (000's)	Surplus Trees (000's)		
63690	A G+34	96	C	BCTS 00	ICHmw 2	324 - BAILEY	2016	121.3	0	DT	CBST
63690	A G+34	96	C	MOF 20	ICHmw 2	324 - BAILEY	2016	0	38.3	DT	CBST
63586	A G+34	89	C	BCTS 00	ICHmw 2	324 - BAILEY	2015	34.5	0	DT	CBST
63586	A G+34	89	P	TOLKO 01	ICHmw 2	324 - BAILEY	2015	1.6	0	DT	CBST
63535	A G+34	84	C	BCTS 00	ICHmw 2	324 - BAILEY	2014	0	3.5	DT	CBST
63377	A G+33	82	C	BCTS 00	ICHmw 2	324 - BAILEY	2012	0	3.1	DT	CBST

Functionality and data now incorporated into **SPAR** – training to begin in August, for 2019 Seedling Requests



Chief Forester's Standards for Seed Use

Amendments of April 5, 2018 come into effect August 6, 2018[1]

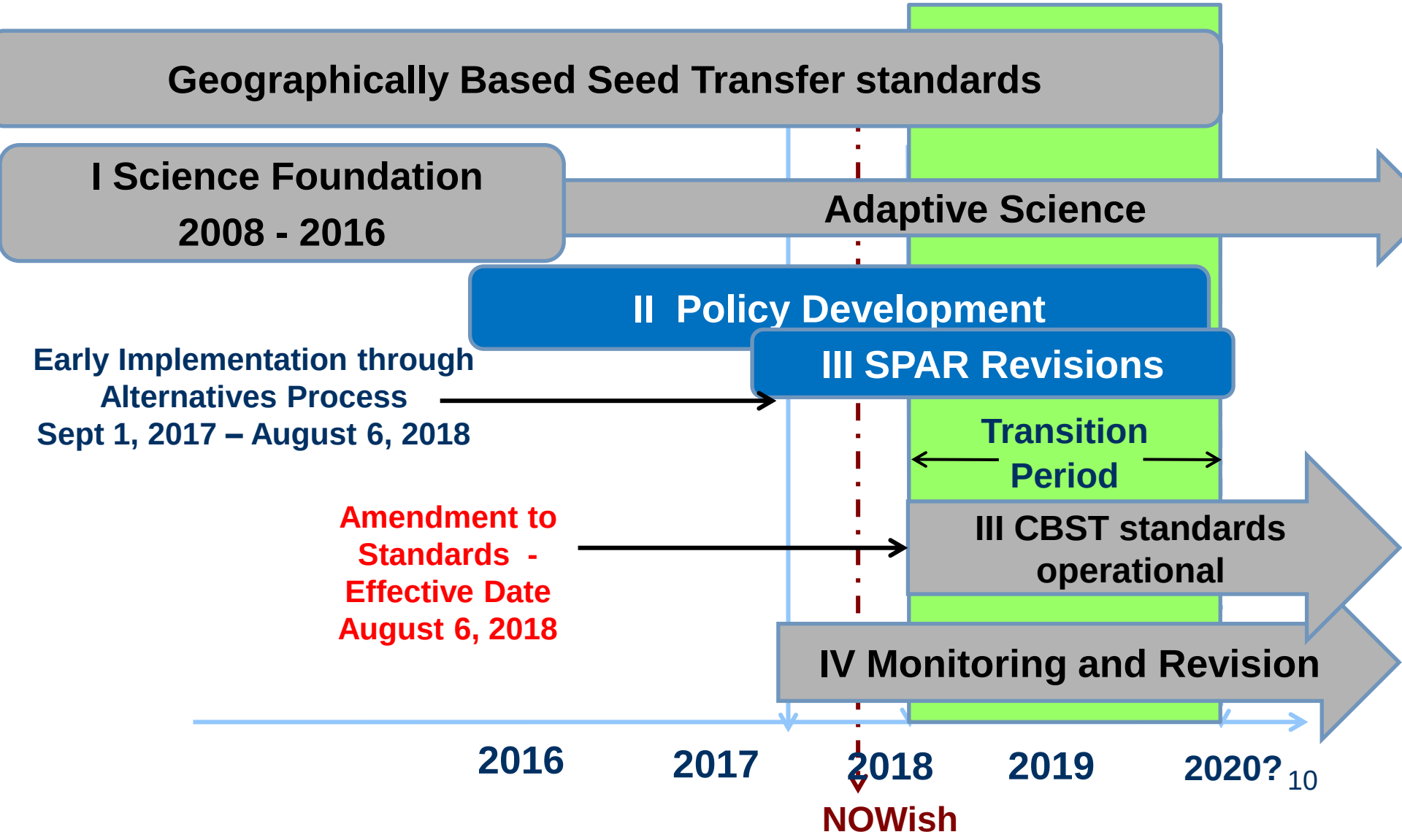
Introduction of:

- Option to use CBST standards, continue with Geographically Based Seed Transfer standards (GBST) or use a mix of both
- New cone collection requirements that align with CBST
- Other minor amendments to update reference and administrative provisions

https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/tree-seed/legislation-standards/chief-forester-s-standards-for-seed-use

[1]Notice period may be waived

CBST Policy Timeline



The Transition Period

- Time to learn the new CBST system – the GBST standards will be removed as an option at end of transition period
- Opportunity to use up seed that may not be useable under CBST
- Current thinking is a 2 year transition
  - subject to broader stakeholder consultation and results of the impact assessment and gap analysis

Strategic Use of Policy Options in Transition Period

If the goal is to maximize productivity of a site, use policy options is this order of priority:

1. Use CBST seed transfer and Class A seed with the highest Genetic Gain
2. Use Current transfer standards with Class A seed with the highest Genetic gain
3. Use CBST seed transfer and Class B seed
4. Use Current transfer standards and Class B seed

If none of these policy options have seed availability – consult with FIRM.

Risks related to Introduction of CBST

- Doing nothing about climate change is high risk
  - Losses from increased wildfire and pests
  - Loss of productivity through maladaptation
- Using CBST mitigates the impacts of climate change and reduces risk
  - We are currently planting into sites that are too warm for the seed
  - With CBST, we will be planting into sites that are slightly colder (in anticipation of ongoing climate change)
  - CBST takes a conservative approach - focusing more on catching up with climate change to date, rather than projecting too far into the future

Revised Cone Collection Standards

- New requirements come into effect August 6, 2018 **with no transition period.**
- Seed now required to be collected from a single BEC variant (and seed collection area to be mapped in SPAR).

Why new collection standards?

- To maintain identity of seed source for future transfer limits
- To create a “CBST area of use” (based on BEC variants)
- To reduce the likelihood of increasing inventories that can not be used after the CBST transition period.

Revised Cone Collection Standards

- No change to requirement to collect from a minimum of 10 trees and area with a maximum 8 km radius.
- No longer need to consider elevation.*
- May collect from one or more seed planning zones - **unless** you wish to maintain the option to use GBST in the transition period, then collect from a single BEC unit **and** the same natural stand seed planning zone.
- Applications for seed registration (on SPAR) reviewed and approved by the TSC before August 6, 2018 will be processed under the current standards. Received on or after Aug 6, will be processed under the new standards.

**See Cone Collection and Climate Based Seed Transfer Information Bulletin - May 2018*

CBST Impact Assessment and Gap Analysis

- To what degree does CBST impact seed use, investments, and assets, including impacts to:
  - Seed Users
  - Seed Owners; and
  - Seed Producers?
- How are CBST impacts characterized compared to previous deployability of a seed lot (losses, gains)?
- What are the opportunities (e.g. new seed sources moving in)?
- Where are the gaps in CBST coverage? What are the opportunities to fill them (in short and long term)?
- What do we do about “orphans”? Seedlots with no where to plant, or BEC variants with no seed source?

Gap Analysis – Cw Historical Planting

e/seed planted (annual 5-year average - 2012-2017)

Species

BA
CW
FDC
FDI
HW
LW
PLI
PW

Sum of SUM_NUMBER_PLANTED	Column Labels			
	CWMLOW1 {128}	CWMLOW2 {155, 190}	CWMLOW3 {993, 198, 140, 152, 186, 184}	Grand
	CWHvh1	CWHvh3	CWHvm1	Total
Row Labels				
CDFmm	22		3,438	3,460
CWHdm	26,172		480,529	506,701
CWHds1	5,416		14,328	19,744
CWHmm1	480		93,436	93,916
CWHmm2	312		9,957	10,269
CWHms1			13,805	13,805
CWHvh1	150,572	4,608	886,059	1,041,240
CWHvh2	8,582	37,580	309,161	355,323
CWHvh3	0	2,094	0	2,094
CWHvm1	148,136	14,673	2,396,722	2,559,531
CWHvm2	31,226	9,597	695,937	736,760
CWHwh1	0	146,892		146,892
CWHwh2		0	0	0
CWHws2			32	32
CWHxm1	4,987		80,960	85,947
CWHxm2	7,868		280,219	288,087
Grand Total	**383,773**	**215,444**	**5,264,584**	**5,863,800**

ntory (Plant) | Surplus_Deficit (Plant) | Inventory (Area) | Surplus_Deficit (Area)

Historical Planting (trees) of Class A seed - by BEC variant based on an annual Five Year Average Source: RESULTS

Gap Analysis – Cw Class A Inventory in SPAR

potion of suitable gross area

Species

BA
CW
FDC
FDI
HW
LW
PLI
PW

Sum of Available * Area	Column Labels			
Row Labels	CWMLOW1 {128} CWHvh1	CWMLOW2 {155, 190} CWHvh3	CWMLOW3 {993, 198, 140, 152, 186, 184} CWHvm1	Grand Total
CDFmm	0		0	0
CWHdm	0		1,227,359	1227359.319
CWHds1	0		0	0
CWHmm1			501,179	501179.0448
CWHmm2	0		746,731	746730.5561
CWHms1			0	0
CWHvh1	1,141,282	0	2,286,757	3428038.828
CWHvh2	2,933,563	833,557	5,877,901	9645020.868
CWHvh3	577,221	164,015	1,156,563	1897799.344
CWHvm1	4,187,872	0	8,391,126	12578997.93
CWHvm2	0	0	5,912,578	5912577.814
CWHwh1	478,262	135,896		614157.8041
CWHwh2		19,032	134,206	153238.4953
CWHws2			0	0
CWHxm1	0		0	0
CWHxm2	0		0	0
Grand Total	9,318,200	1,152,500	26,234,400	36,705,100

Inventory is based on seed currently in the bank (potential trees) - proportioned to BEC variants (based on the proportion of each BEC var to the gross seed deployment area (CBST AOU) for the Sp BECvar combination Source: SPAR

Cells highlighted by green dots = CBST AOU

Gap Analysis – Cw Surplus and Deficits (CBST)

Total Surplus/Deficit =	30,858,320	Source BEC ↓	8,935,027	937,056	20,986,237	
cies	Deploy BEC →	Sum of A*A Difference	Column Labels			
	Surplus/Deficit	Row Labels	CWMLOW1 {128} CWHvh1	CWMLOW2 {155, 190} CWHvh3	CWMLOW3 {993, 198, 140, 152, 186, 184} CWHvm1	Grand Total
	(3,460)	CDFmm	-22		-3,438	-3,460
	720,658	CWHdm	-26,172		746,831	720,658
	(19,744)	CWHds1	-5,416		-14,328	-19,744
	421,838	CWHmm1			421,838	421,838
	736,461	CWHmm2	-312		736,773	736,461
	(13,805)	CWHms1			-13,805	-13,805
	2,386,799	CWHvh1	990,710	-4,608	1,400,697	2,386,799
	9,289,698	CWHvh2	2,924,981	795,977	5,568,740	9,289,698
	1,895,705	CWHvh3	577,221	161,921	1,156,563	1,895,705
	10,019,467	CWHvm1	4,039,736	-14,673	5,994,404	10,019,467
(2,856)	5,175,818	CWHvm2	-31,226	-9,597	5,216,641	5,175,818
	467,266	CWHwh1	478,262	-10,996		467,266
	153,238	CWHwh2		19,032	134,206	153,238
	(32)	CWHws2			-32	-32
	(85,947)	CWHxm1	-4,987		-80,960	-85,947
	(285,641)	CWHxm2	-7,748		-277,893	-285,641
		Grand Total	8,935,027	937,056	20,986,237	30,858,320

Surplus-Deficit (trees) is based on SPAR Inventory minus Historical Planting by BEC variant Source: GIS-based spatial overlay

Green cells = Surplus

Red cells = Deficit

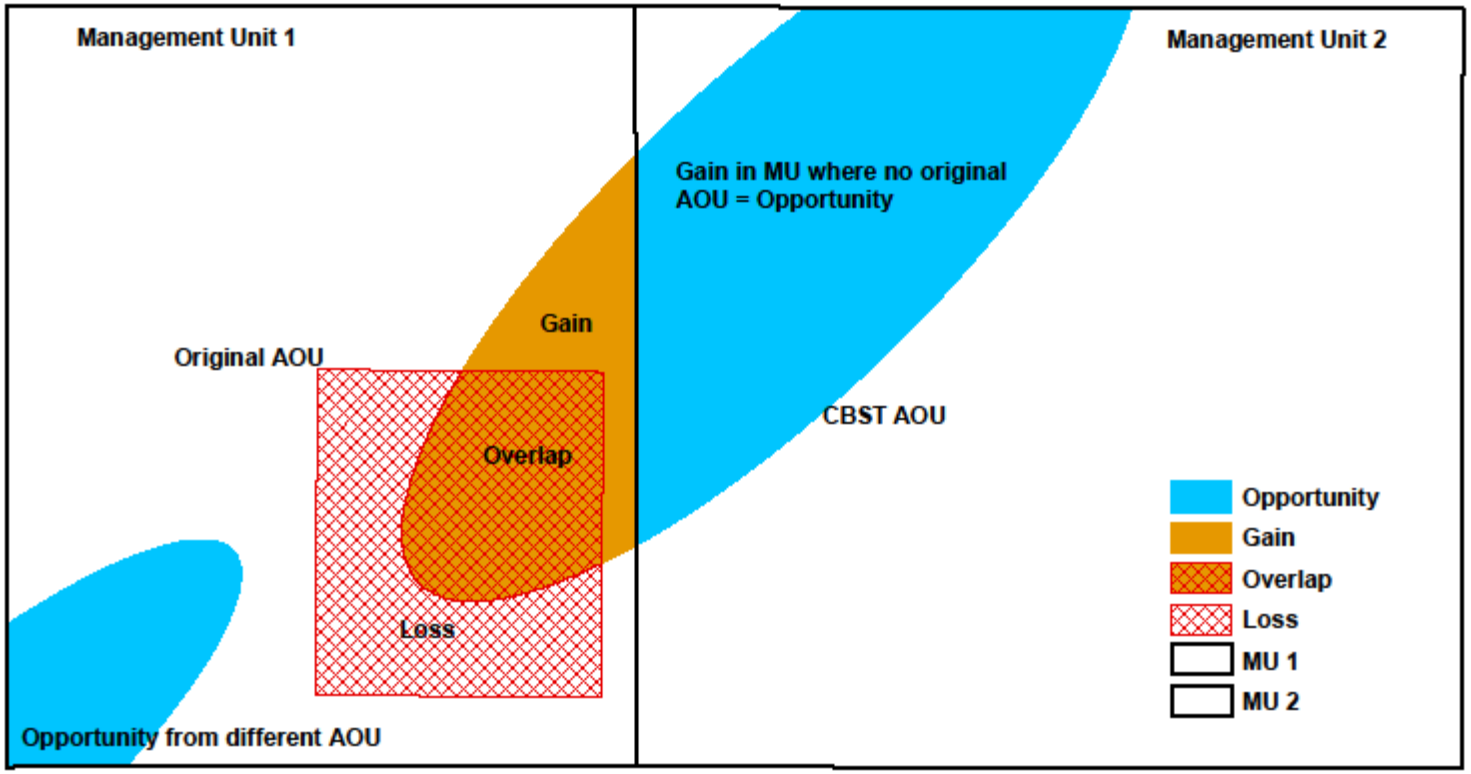
Options to address deficits

- A new Orchard with parents from drier and warmer BECvars (BC or US) could be established.
- Infuse existing orchards with drier warmer parents.
- Use A Class seed from US (if it exists & is available)
- Use A Class seed from the BEC variant with the highest genetic suitability match - POLICY OPTION (lower the GS).
- Use B Class seed (BC or US)

Seed Supply Planning under CBST

- See Handout – only lists BEC variant groups that have orchard seed – **does not list all B seedlots**.
- Overlaps in deployment between interim planning units are substantive. Check specific deployment BECvars and B inventory before considering collections.
- Keep collections to 2 to 5 years supply at most – unless you know there is a longer term need.
- Expect new or modified orchards in 5 to 10 years.

Schematic of Quantified Impact Analysis:



Impacts on TFL 37 (North Vanc Island), all species

A class seed only

Losses rel	CBST AOU relative to current AOU		
0-33%	>100%	0.34	0.5
34-66%	50-100	0.66	1
67-100%	<50%		
ty			

	ANALYSIS 2			ANALYSIS 1		
	Impact	Losses relative to AOU		Assessment	CBST AOU (gain+overlap) relative to current AOU	
				new seed source	n/a	1NEW
	low	0-33%	new+sa	expanded deplo	>100%	2GAIN
	med	34-66%		reduced deployr	50-100	3LOSS
	high	67-100%		significantly red	<50%	4SLOSS

Species	Management_Unit	BECvarGroup Name	Seed_BEC	Orchards	Current_AOU_HA	Current_AOU_PCT_Suitable	Gain_HA	Gain_PCT	Loss_HA	Loss_PCT	Loss Impact	Overlap_HA	Overlap_PCT	CBST_AOU_HA	CBST_PCT	CBST Impact
CW	TFL37	CWMLOW3	CWHvm1	set([152L, 184L, 140L, 198L, 993L	186,232	98%	53,343	29%	87,862	47%	2-M	98,370	53%	150,220	81%	3Loss
FDC	TFL37	FDCMLOW2	CWHdm	set([996L, 197L, 166L, 199L, 405L	238,438	99%	157	0%	74,412	31%	1-L	164,026	69%	164,169	69%	3Loss
FDC	TFL37	FDCMHIGH2	CWHms2	set([406L])	105,578	100%	25,259	24%	58,134	55%	2-M	47,444	45%	72,703	69%	3Loss
FDC	TFL37	FDCSMALL1	CWHms2	set([181L])	0		72,703		0		1-L	0		72,703		1New
HW	TFL37	HWMLOW3	CWHvh1	set([170L, 182L])	157,061	98%	16,829	11%	9,721	6%	1-L	147,340	94%	164,169	105%	2Gain
HW	TFL37	HWMHIGH2	CWHvm2	set([187L, 196L])	122,534	100%	30,527	25%	17,119	14%	1-L	105,415	86%	135,942	111%	2Gain
PW	TFL37	PWMALL1	CWHxm2	set([998L, 175L])	263,080	99%	86	0%	261,694	99%	3-H	164,083	62%	164,169	62%	3Loss

Impacts on Bulkley TSA - Fdi AOU opportunities!

A class seed only

Species	Management_Unit	BECvarGroup Name	Seed_BEC	Orchards	Current_AOU_HA	Current_AOU_PCT_Suitable	Gain_HA	Gain_PCT	Loss_HA	Loss_PCT	Loss Impact	Overlap_HA	Overlap_PCT	CBST_AOU_HA	CBST_PCT	CBST Impact
FDI	Bulkley TSA	FDIQLLOW1	ICHmk3	set([232L, 226L])	0		21,223		0		1-L	0		21,223		1New
FDI	Bulkley TSA	FDIPGLOW1	SBSdh1	set([225L, 233L])	0		249,148		0		1-L	0		249,148		1New
FDI	Bulkley TSA	FDICTLOW1	SBSdw1	set([231L])	0		69,724		0		1-L	0		69,724		1New

Impacts on Revelstoke TSA - Pli AOU losses!

A class seed only

Species	Management_Unit	BECvarGroup Name	Seed_BEC	Orchards	Current_AOU_HA	Current_AOU_PCT_Suitable	Gain_HA	Gain_PCT	Loss_HA	Loss_PCT	Loss Impact	Overlap_HA	Overlap_PCT	CBST_AOU_HA	CBST_PCT	CBST Impact
PLI	Revelstoke TSA	PLINELOW1	ICHdw3	set([307L])	203,847	100%	0	0%	203,847	100%	3-H	0	0%	0	0%	4SLoss
PLI	Revelstoke TSA	PLINELOW2	ICHdw4	set([337L])	203,847	100%	0	0%	203,847	100%	3-H	0	0%	0	0%	4SLoss
PLI	Revelstoke TSA	PLIPGLOW1	ICHwk2	set([237L])	68,959	100%	0	0%	68,959	100%	3-H	0	0%	0	0%	4SLoss
PLI	Revelstoke TSA	PLINELOW3	IDFmw1	set([313L])	203,847	100%	0	0%	203,847	100%	3-H	0	0%	0	0%	4SLoss
PLI	Revelstoke TSA	PLINELOW4	IDFmw2	set([347L])	203,847	100%	0	0%	203,847	100%	3-H	0	0%	0	0%	4SLoss
PLI	Revelstoke TSA	PLIPGLOW2	SBSdh1	set([220L])	68,959	100%	0	0%	68,959	100%	3-H	0	0%	0	0%	4SLoss
PLI	Revelstoke TSA	PLIPGLOW3	SBSdw3	set([352L])	68,959	100%	0	0%	68,959	100%	3-H	0	0%	0	0%	4SLoss
PLI	Revelstoke TSA	PLIPGLOW5	SBSmw	set([244L, 236L, 222L])	68,959	100%	0	0%	68,959	100%	3-H	0	0%	0	0%	4SLoss

Near Term Actions (now to 2 years)

- Effective Date of amended standards: August 6, 2018
- Gap analysis and Impact assessment tools to be made available to all stakeholders / licensees
- Broader stakeholder engagement on transition plans and selected policy development
- Transition strategy and full implementation plan
- Ongoing data and climate updates
- Monitoring framework developed

Short Term Actions (2 to 5 years)

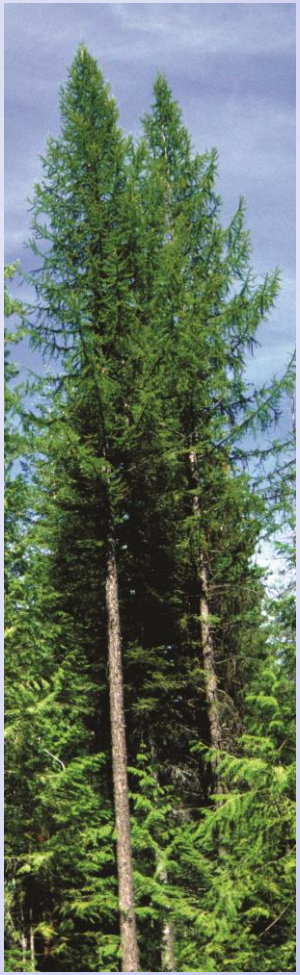
- New “SPUs"/Breeding Zones defined
- Amendments to Chief Foresters Standards to end transition period
- Increased monitoring and evaluation
- Additional research identified and initiated

Longer term Action (5+ years)

- New Seed Orchards come on stream
- Coordination with the Climate Informed Species Selection (CISS) Tool, led by RPB.

See, Ministry of Forests, Lands, Natural Resource Operations and Rural Development, **Tree Seed** and **CBST** webpages,

www.gov.bc.ca/climatebasedseedtransfer



Margot Spence, Seed Policy Officer/CBST project lead, Forest Improvement and Research Management Branch (Margot.Spence@gov.bc.ca)

Susan Zedel, Seed Resource Specialist, Forest Improvement and Research Management Branch (Susan.Zedel@gov.bc.ca)

Leslie McAuley, Decision Support Officer, forest Improvement and Research Management Branch (Leslie.Mcauley@gov.bc.ca)