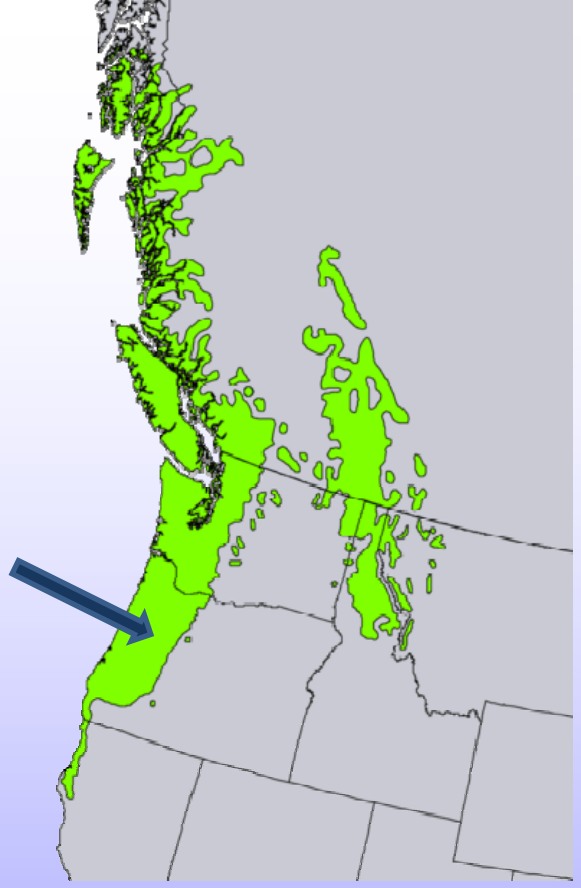
Developing durable western redcedar populations for a changing climate

John Russell and Alvin Yanchuk
British Columbia Forest Service

Western redcedar challenges



Growth/adaptability

Heartwood durability

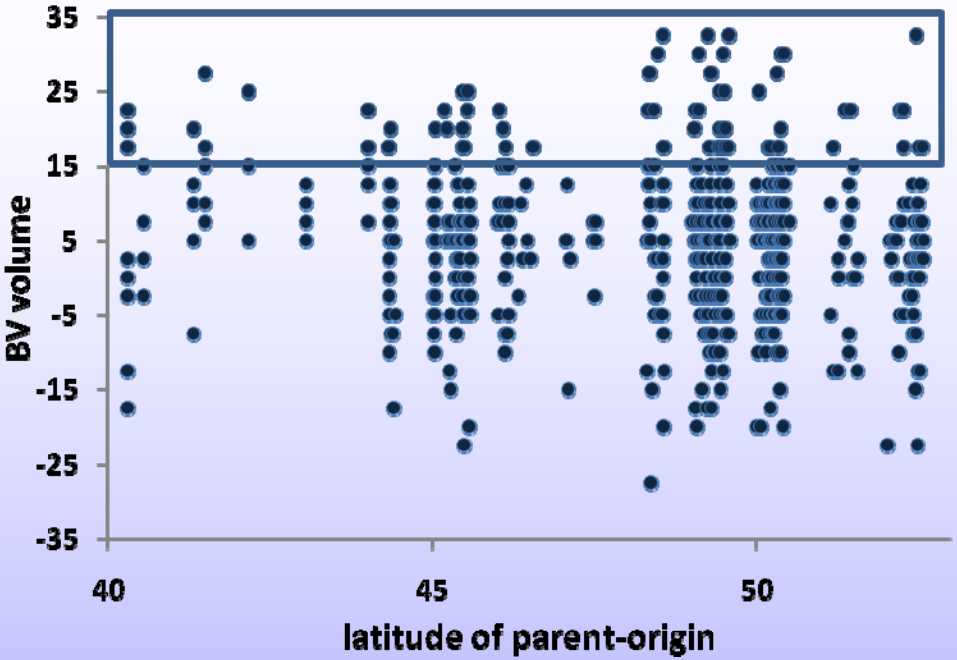
Ungulate damage

Cedar leaf blight

- Currently multiple populations and generations
- Move to one durable population
- Cross resistance
- Known and future unknown pests

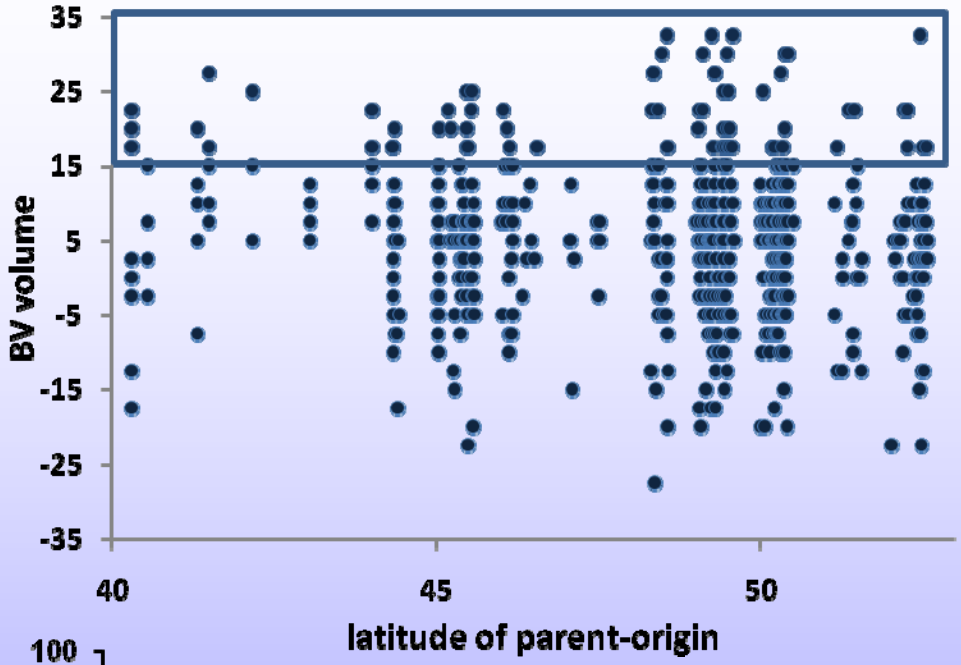
Growth and adaptability

Growth and adaptability



- ~1000 parental BVs for volume
- N. California to N. British Columbia

Growth and adaptability



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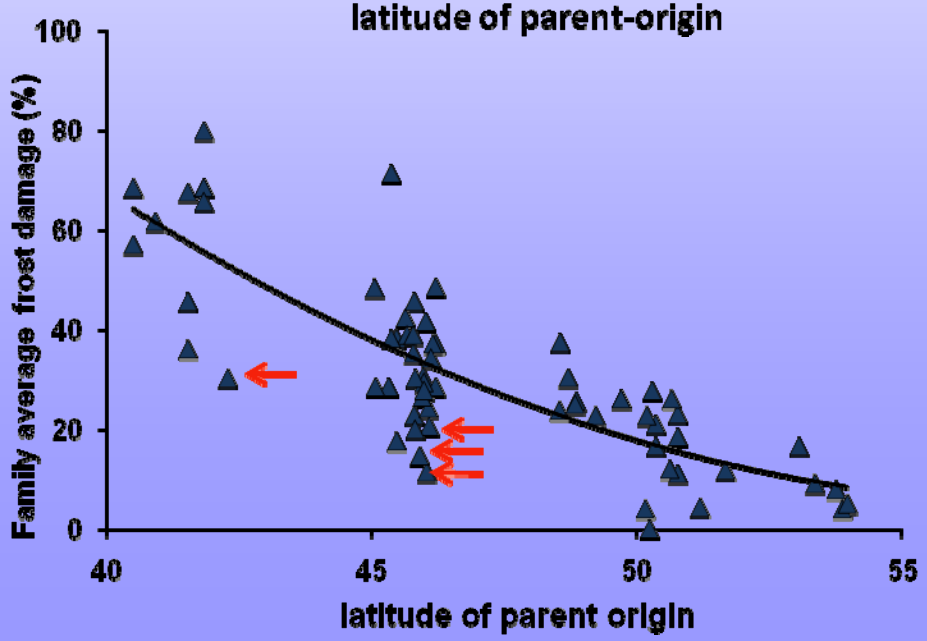

← = top BV southern PNW parents

Heartwood pathogens

Pathogen Disease Name	Synonyms	Decay Type	Western Redcedar	Yellow-cedar
***Armillaria* spp.** Armillaria root rot	*Armillaria solidipes, A. ostoyae, A. obscura, A. mellea*	Root, White	√	√
Phellinus weirii laminated root rot	*Poria weirii, Fomitiporia weirii, Fuscoporia weirii, Inonotus weirii, Phellinidium weirii*	Root, White	√	√
Heterobasidion occidentale annosus root rot	*Heterobasidion annosum, Fomes annosus, Fomitopsis annosa, Polyporus annosus*	Root, White	√	
Onnia tomentosa Tomentosus root rot	*Inonotus tomentosus, Polyporus tomentosus, Coltrichia tomentosa*	Root, White	√	
Phaeolus schweinitzii schweinitzii butt rot	*Polyporus schweinitzii*	Root, Brown	√	
Physisporinus rivulosus white butt rot – white laminated rot	*Ceriporiopsis rivulosa, Polyporus rivulosus, Poria albipellucida, Poria rivulosa, Rigidoporus rivulosus*	Heart, White	√	
Perenniporia subacida stringy butt rot	*Poria subacida, Polyporus subacida, Poria fuscomarginata*	Heart, White	√	
Phellinidium ferrugineofuscum	*Phellinus ferrugineofuscus, Polyporus ferrugineofuscus*	Heart, White	√	
Porodaedalea pini red ring rot	*Phellinus pini, Fomes pini, Trametes pini*	Heart, White	√	√
Ganoderma applanatum white mottled rot	*Fomes applanatus, Polyporus applanatus*	Heart, White	√	
Fomitopsis pinicola brown crumbly rot	*Fomes pinicola*	Heart, Brown	√	√
Laetiporus conifericola brown cubical rot	*Polyporus sulphureus*	Heart, Brown	√	
Postia sericeomollis brown cubical & pocket rot	*Oligoporus sericeomollis, Polyporus sericeomollis, Poria asiatica, Poria sericeomollis, Tyromyces sericeomollis*	Heart, Brown	√	√

Heartwood durability and secondary extractives

Heartwood durability and secondary extractives

living heartwood: tropolones

⬆ antimicrobial; ⬇ concentration

wood in service: lignans

⬇ antimicrobial; ⬆ concentration; ⬇ leaching

Heartwood durability and secondary extractives

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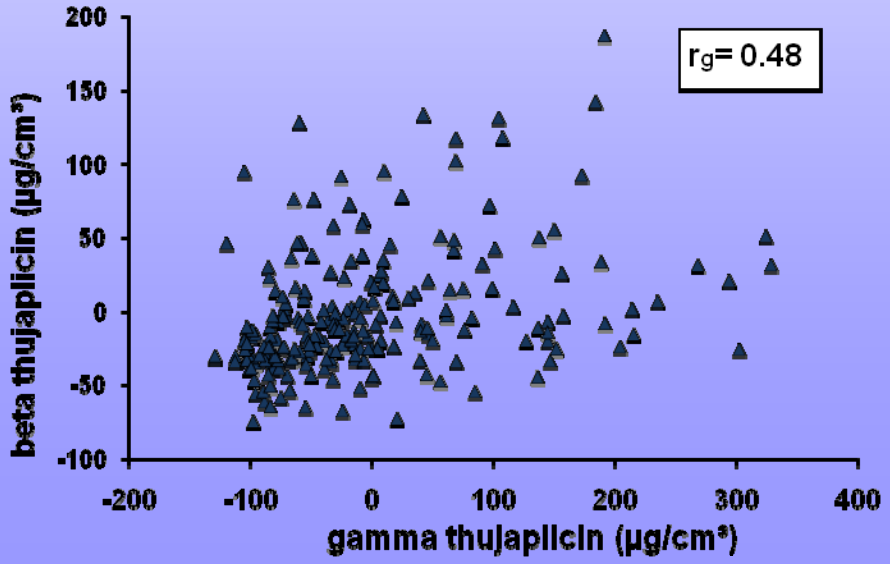
⬆ antimicrobial; ⬇ concentration

wood in service: lignans

⬇ antimicrobial; ⬆ concentration; ⬇ leaching

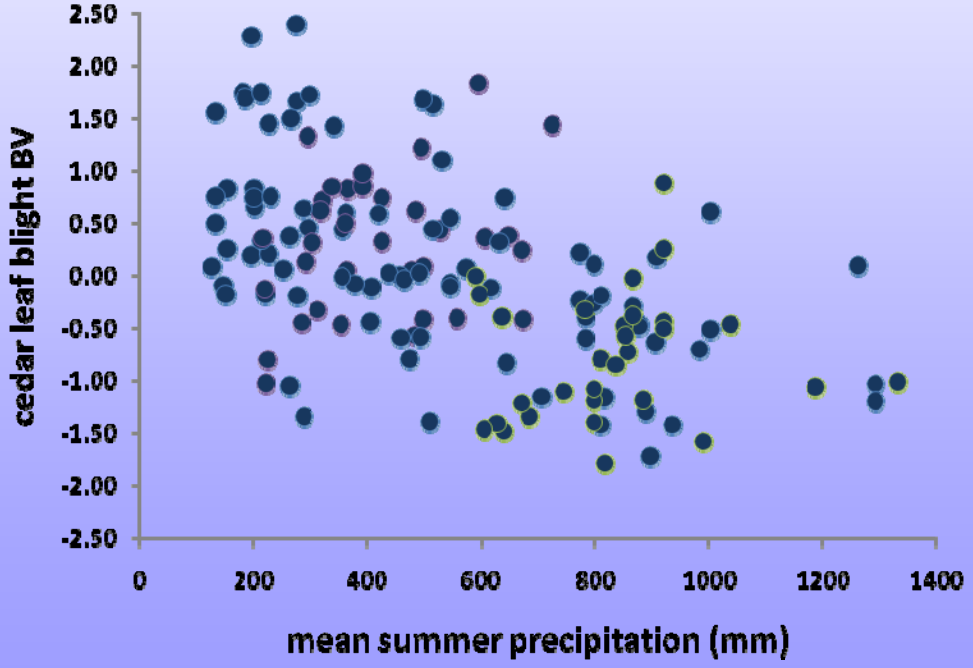
350 CVs for heartwood extractives



	Unknown lignan	α-thujaplicin	β thujaplicin	γ thujaplicin	volume
Plicatic acid	0.86	**0.48**	0.15	**0.49**	**0.42**
Unknown lignan		0.33	0.17	**0.46**	0.35
α-thujaplicin			**0.56**	**0.66**	**0.44**
β-thujaplicin				0.33	0.28
γ-thujaplicin					0.31

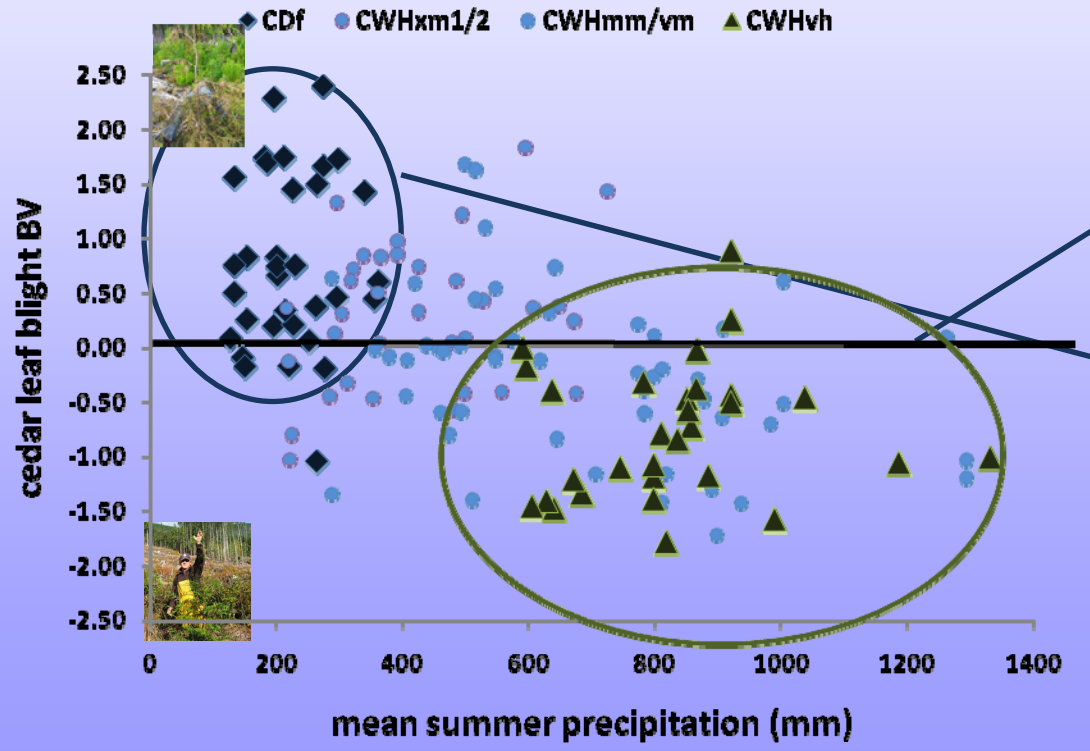
Cedar leaf blight (*Didymascella thujina*)

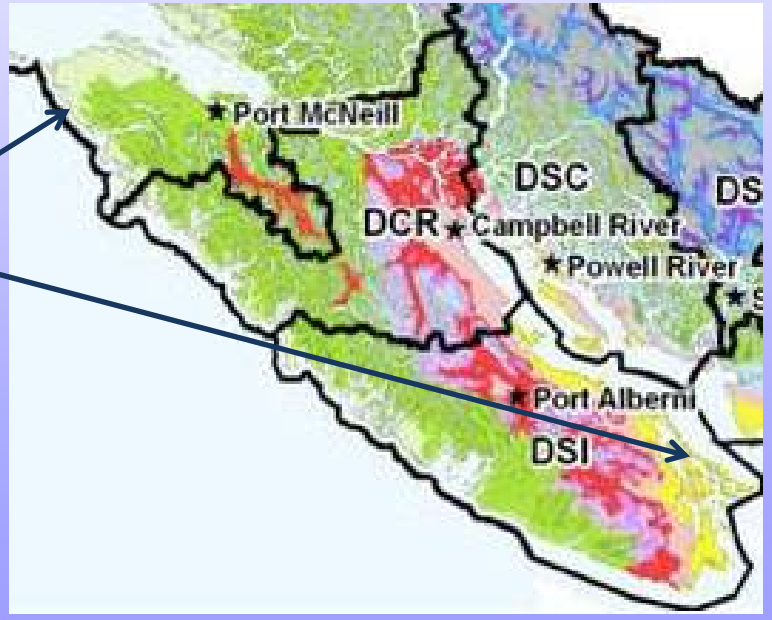
- occurs throughout western redcedar range
- more extensive in warm, humid environments
- growth reduction/mortality
- increasing over last two decades
- 1000 parental BVs as per volume
- resistance related to climate of parent origin



Cedar leaf blight resistance

- **Soegaard (1960s):** dom. major gene for resistance in Th.standishii,absent in Th. plicata
- **BCFS :** quantitative variation for resistance related to climate of parent origin
- 1000 parental BVs CLB intensity (same tests/parents as volume)





Ungulate damage/ resistance

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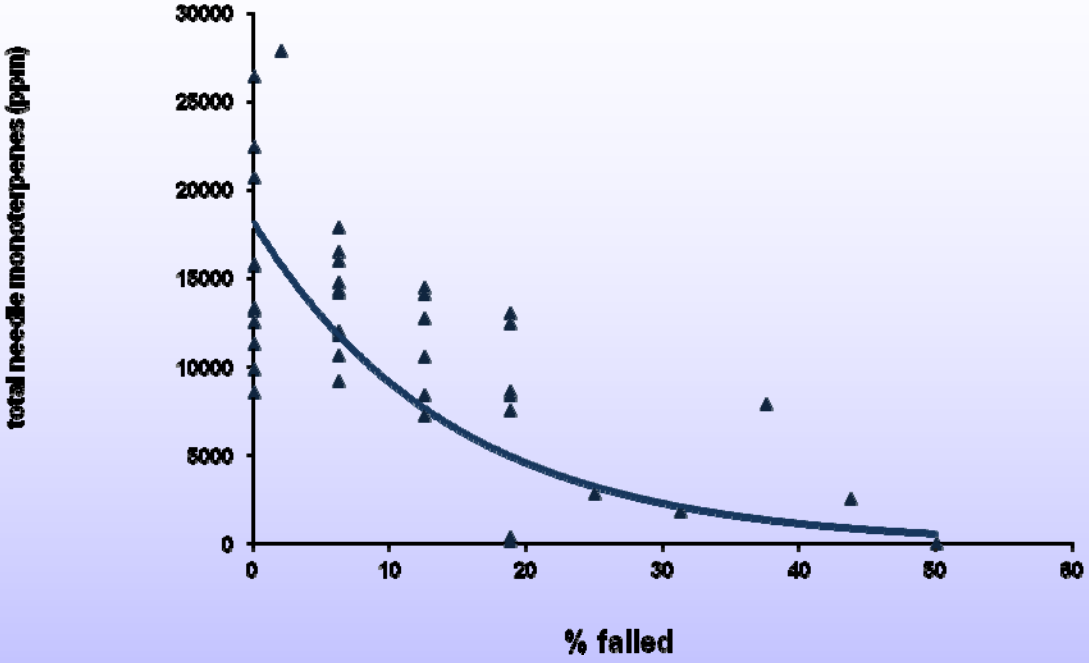
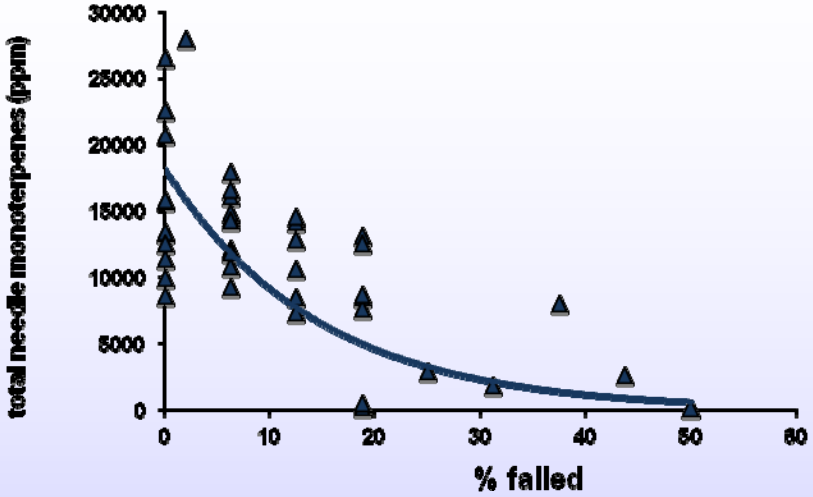
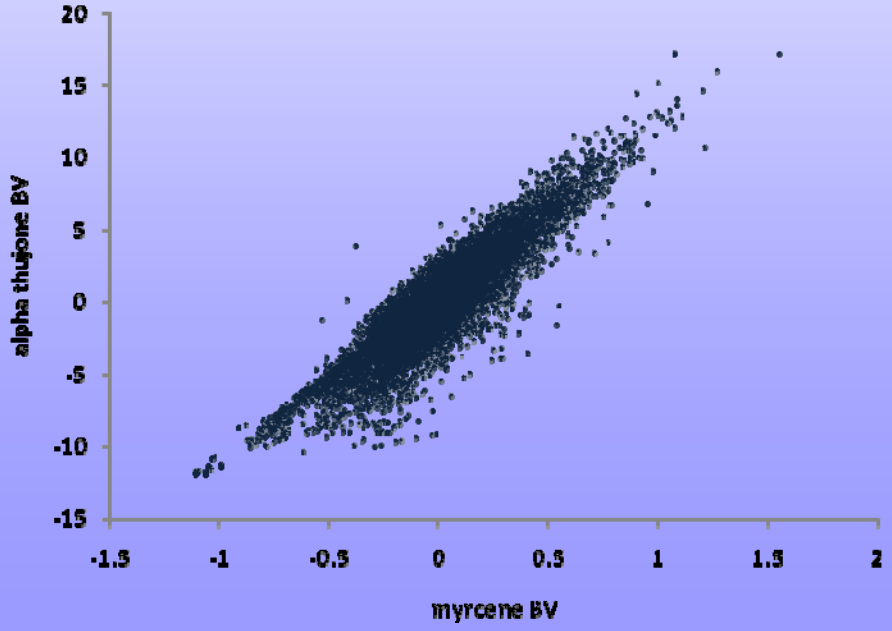
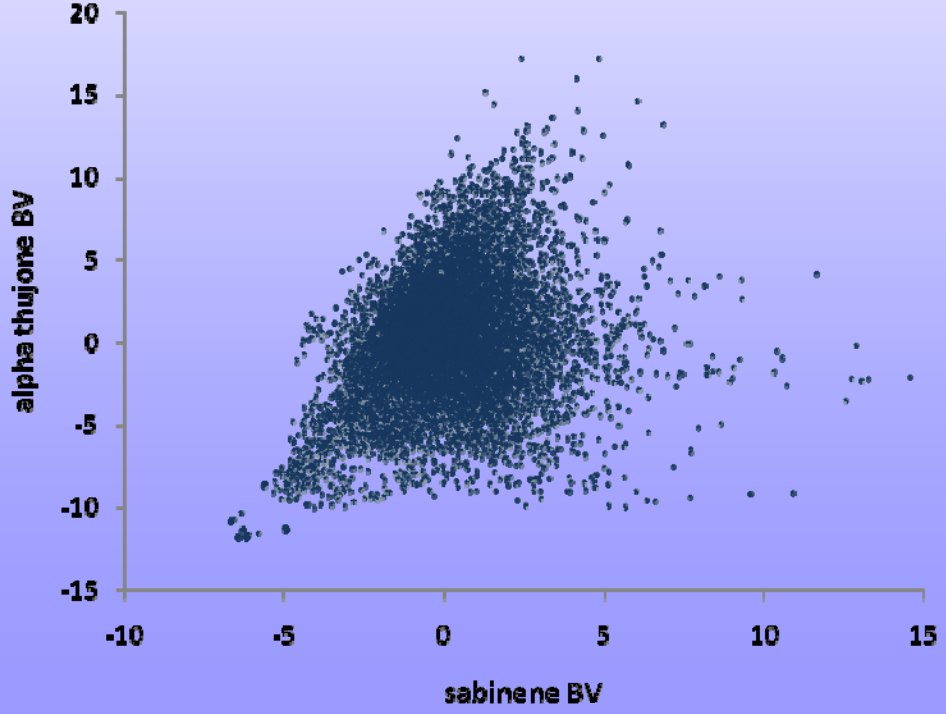


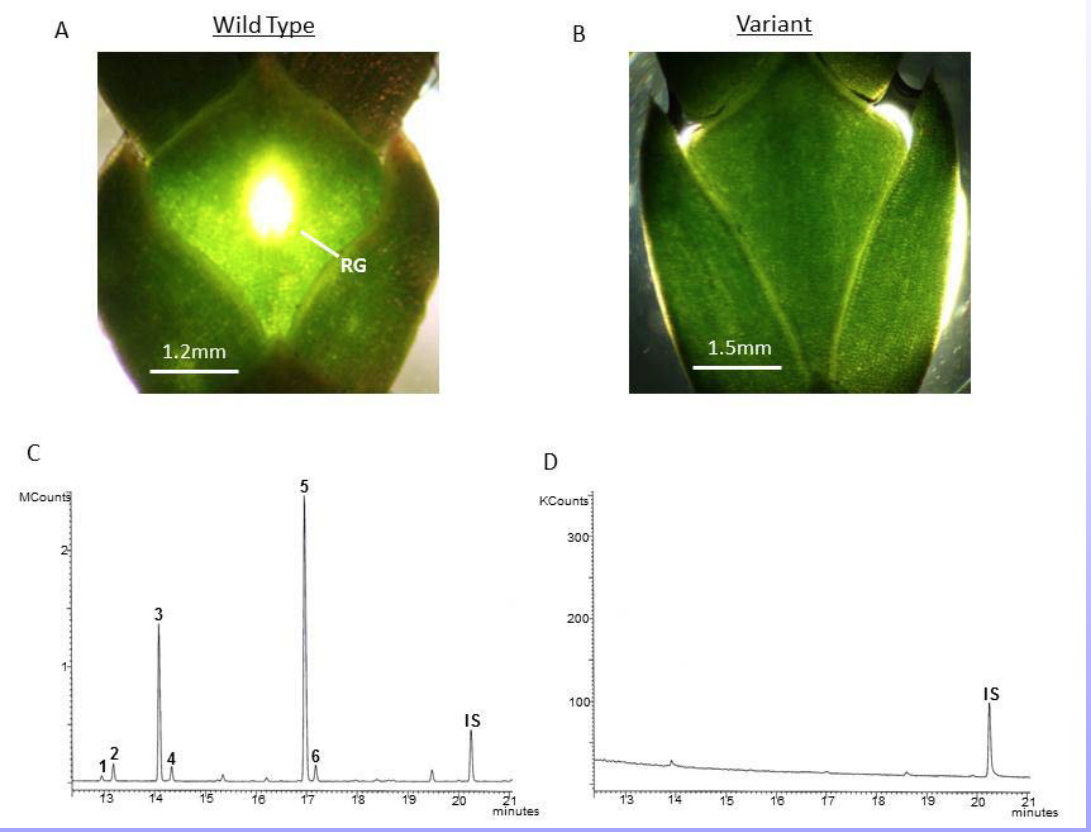
Ungulate damage/ resistance

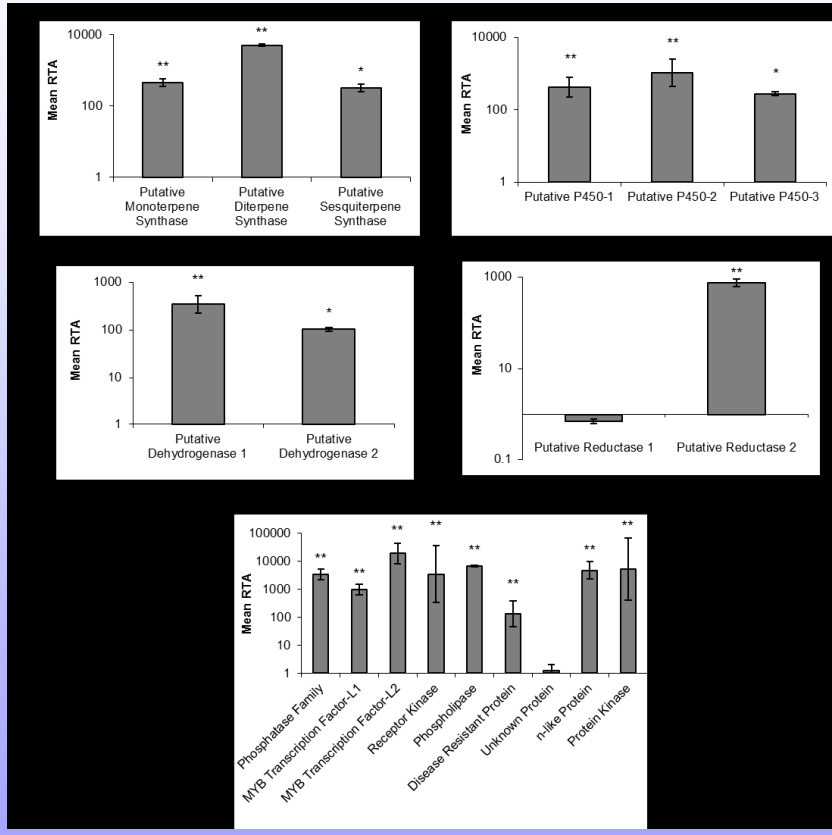


- ~ 15,000 BVs for major monoterpenes
- Currently breeding 3rd generation









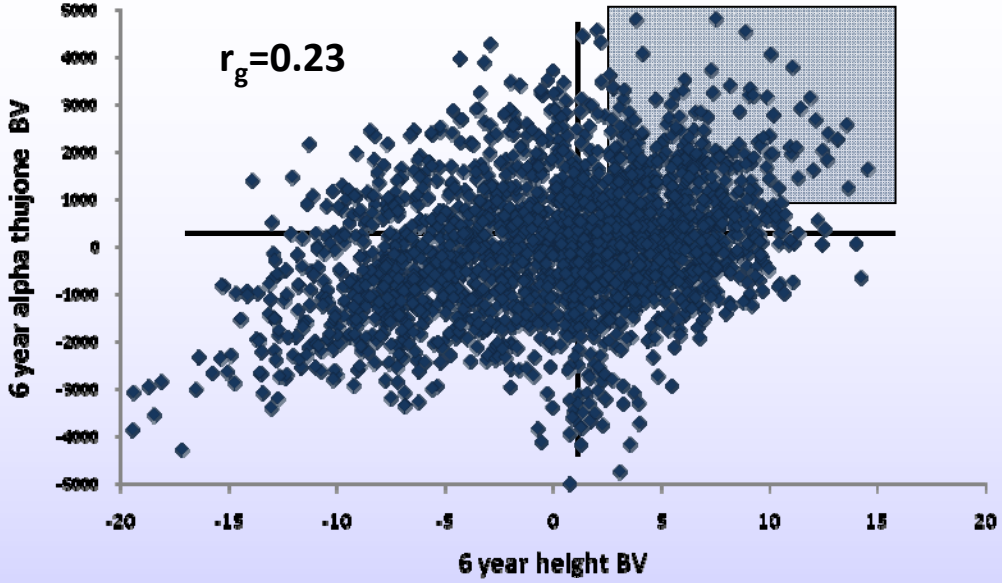
1) thujene, 2) α-pinene, 3) sabinene, 4) myrcene, 5) α-thujone, 6) β-thujone, and IS) internal standard (9-carbon acetate).

RTA is the relative transcript abundance between the wild type and variant genotypes.

Genetic correlations among traits

Genetic correlations among traits

Needle monoterpenes and growth



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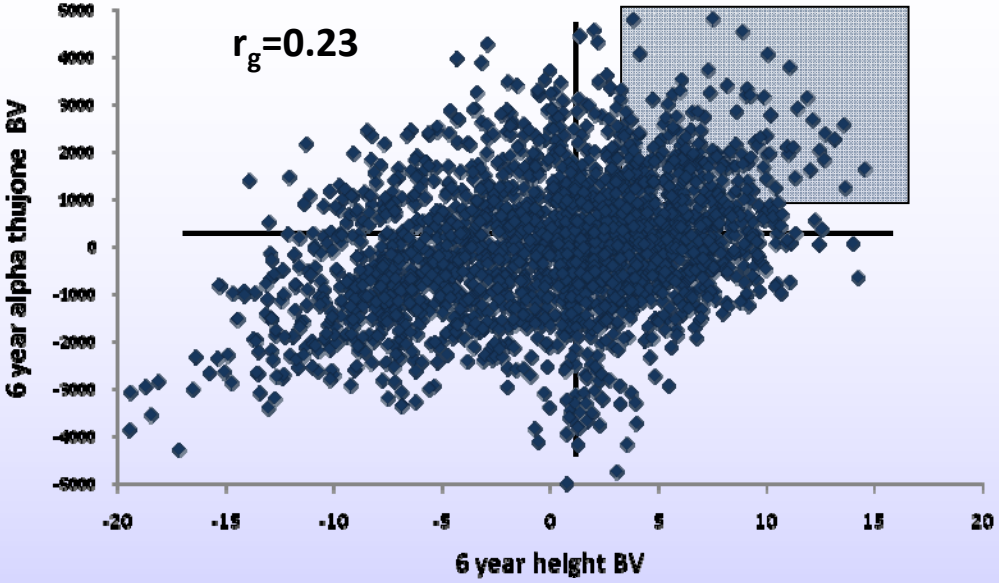
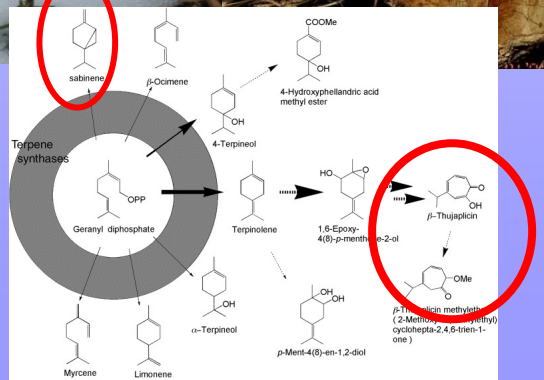
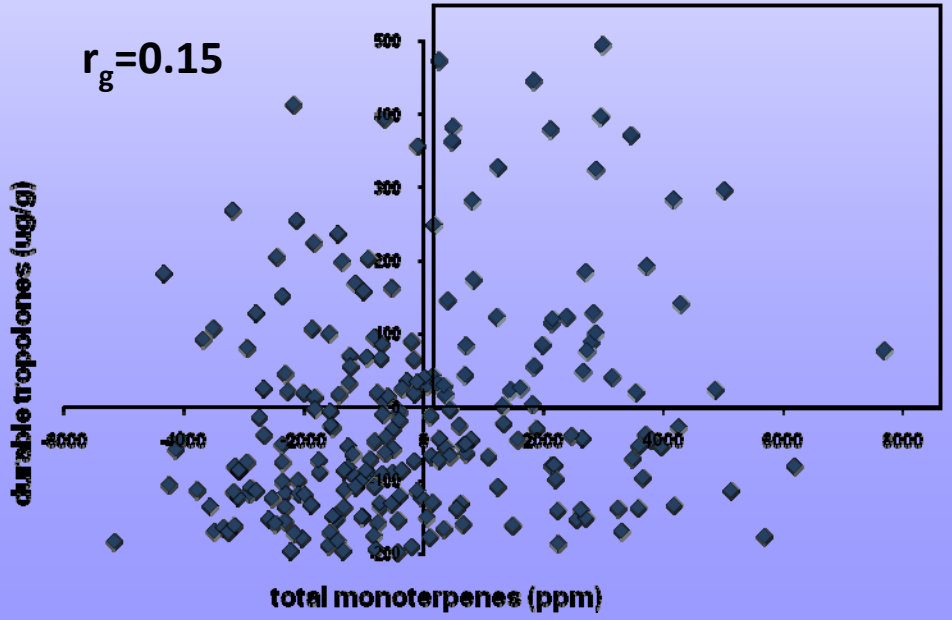


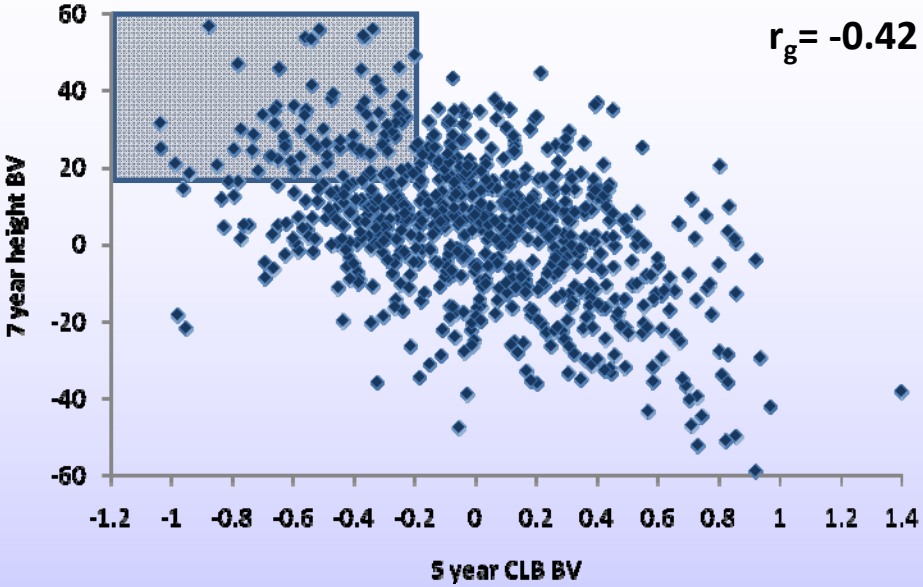
Needle monoterpenes and heartwood extractives





Genetic correlations among traits

Cedar leaf blight and growth



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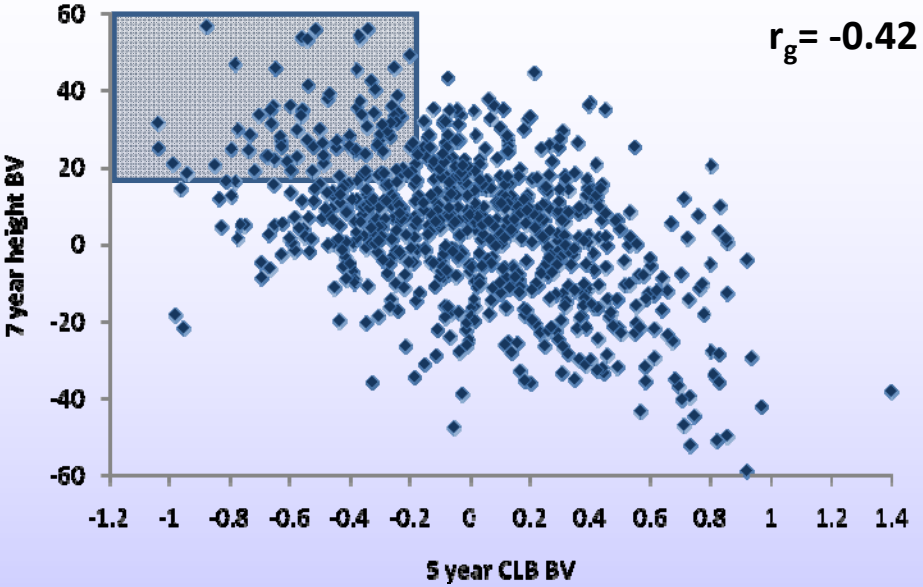
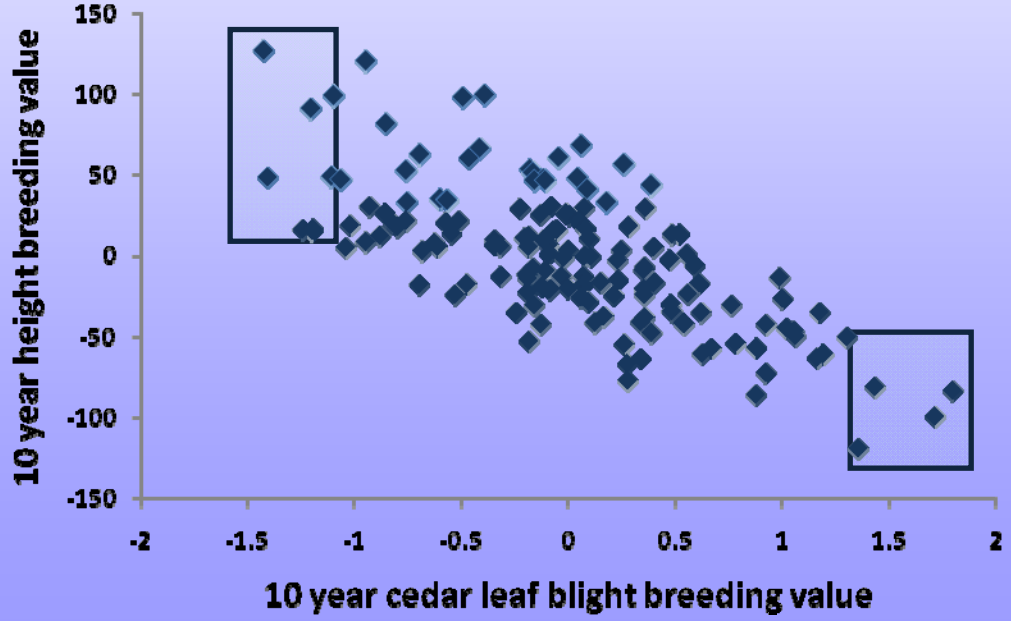
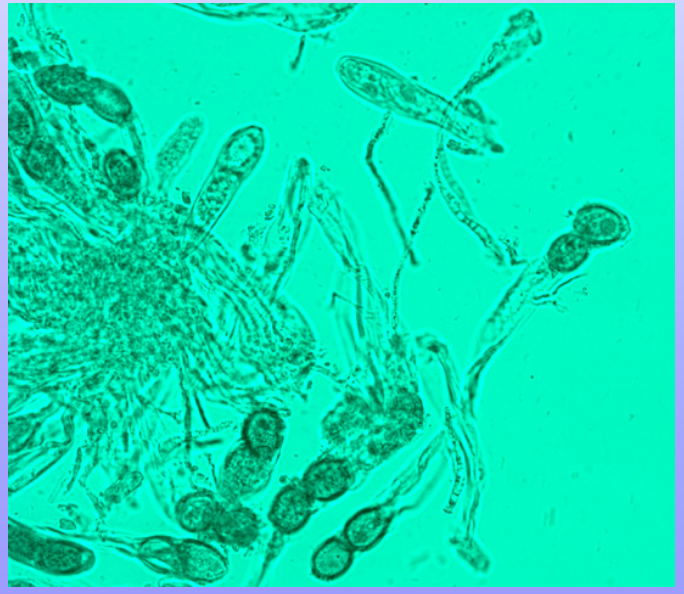


Cedar leaf blight and secondary extractives???

CLB resistance mechanisms

- identified resistant parents
- CREATE grant: University of Victoria
  - resistance mechanisms
  - role of secondary chemicals
  - early screening system
  - genomics



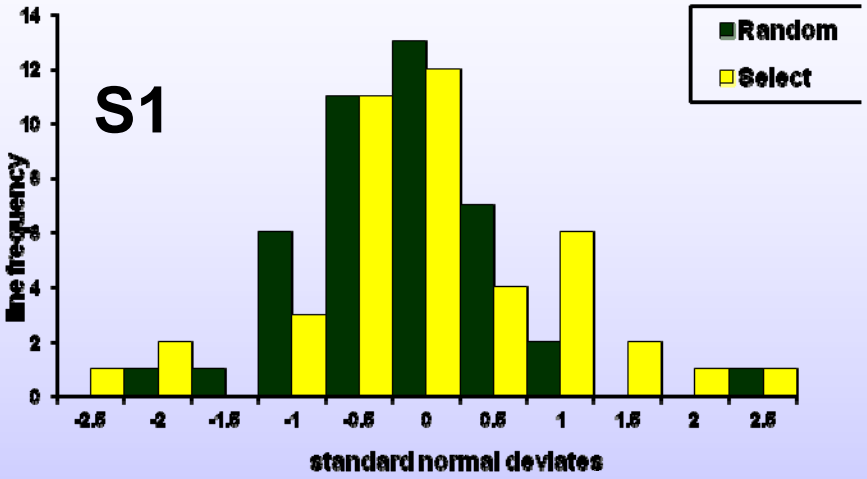


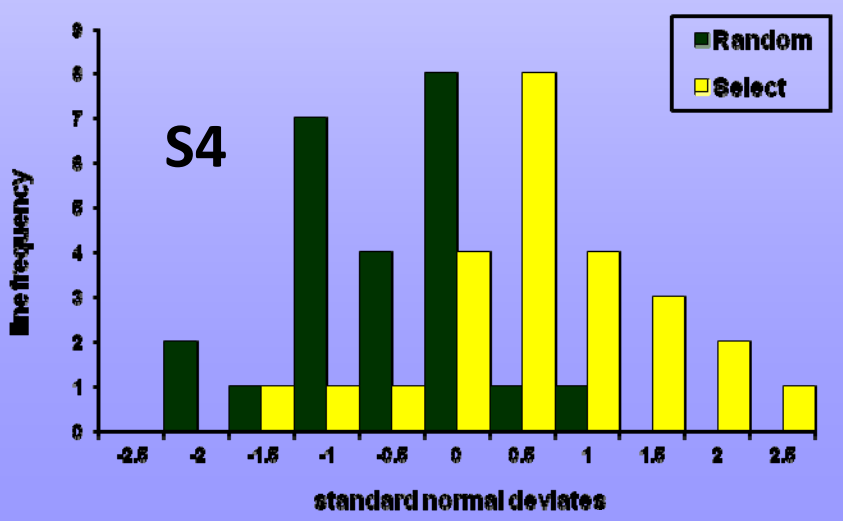
Western redcedar breeding program

Breeding tools

- Flowers early, prolific
  - Accelerated breeding
- Selfs with minimal IBD
  - Perfect assortative mating

Cw accelerated breeding research project
5 generations in 10 years

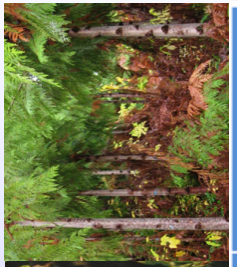


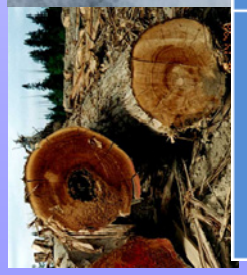


Breeding tools

- propagates vegetatively
- maintain juvenility
- clonal research/deployment

	Growth				CLB				Foliage Terpenes				Htwd Extractives			
Growth		X	X	X		X	X			X	X			X	X	
			X	X			X				X				X	
				X												
CLB						X	X	X		X	X			X	X	
							X	X			X				X	
								X								
Foliage Terpenes										X	X	X		X	X	
											X	X			X	
												X				
Htwd Extractives														X	X	X
															X	X
																X





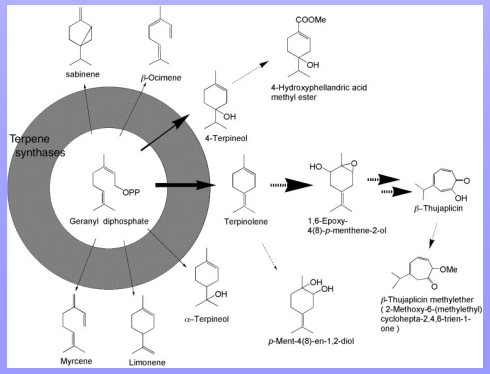
Western redcedar genotype				
1	Yes	No	Yes	Good
2	No	Yes	Yes	Average
3	Yes	No	No	Average
4	Yes	Yes	No	Average
5	Yes	Yes	Yes	Good
…				
100+	No	No	Yes	Good

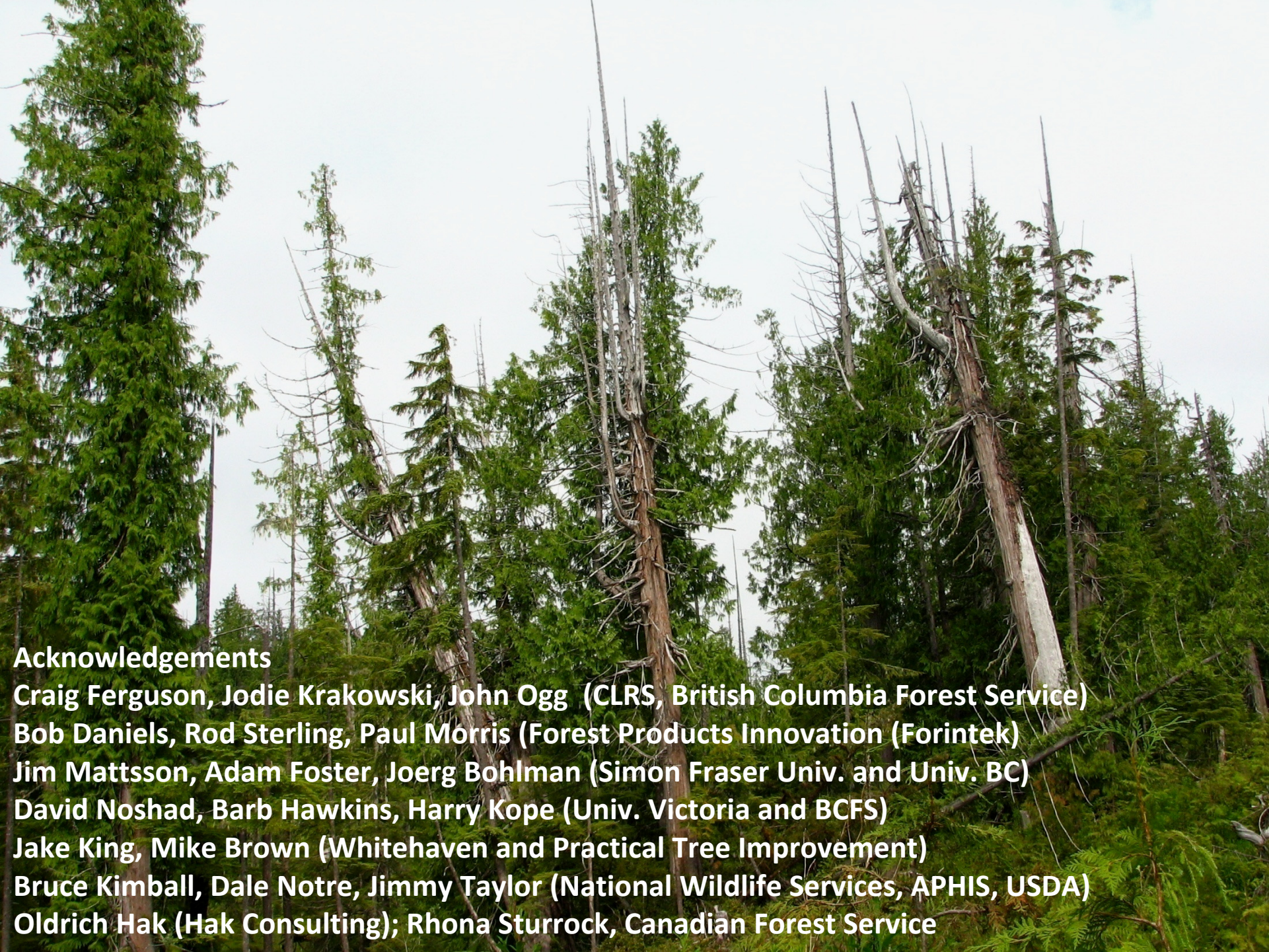
	Growth				CLB				Terpenes				Htwd			
Growth		X	X	X		X	X			X	X			X	X	
			X	X			X				X				X	
				X												
CLB						X	X	X		X	X			X	X	
							X	X			X				X	
								X								
Foliage										X	X	X		X	X	
											X	X			X	
												X				
Htwd														X	X	X
															X	X
																X

Genomics Studies

2. Heartwood extractives:Mattsson(SFU) and Bohlmann (UBC)

- Identification of biosynthesis genes
- Genetic/anatomical marker





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