# Genetics, breeding and deployment of western larch in British Columbia

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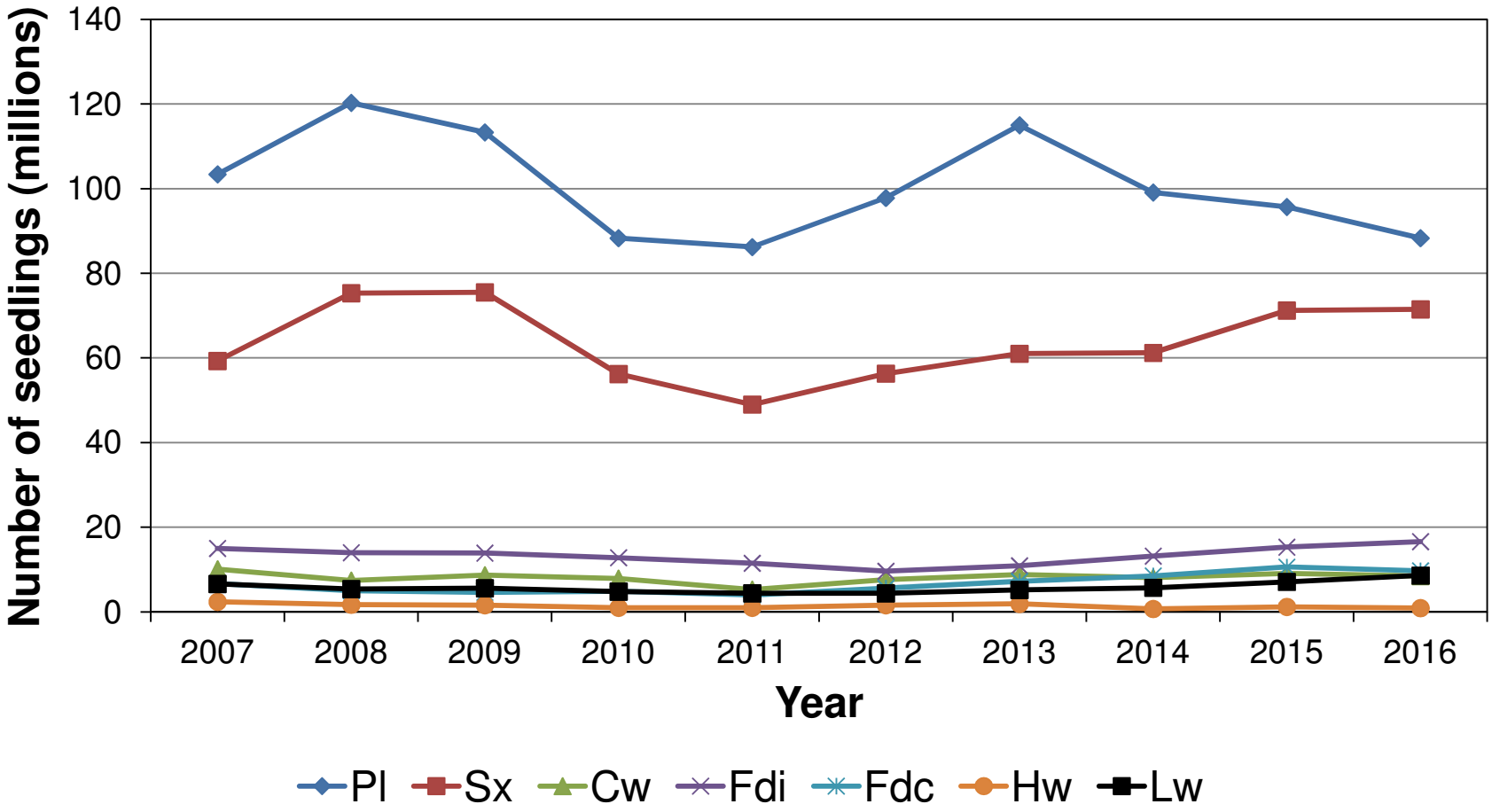
# Western larch

- Program background
- Recent developments
  - realized gain studies
  - seed deployment in light of MPB/climate change
  - 2nd generation crossing and progeny testing

# Background

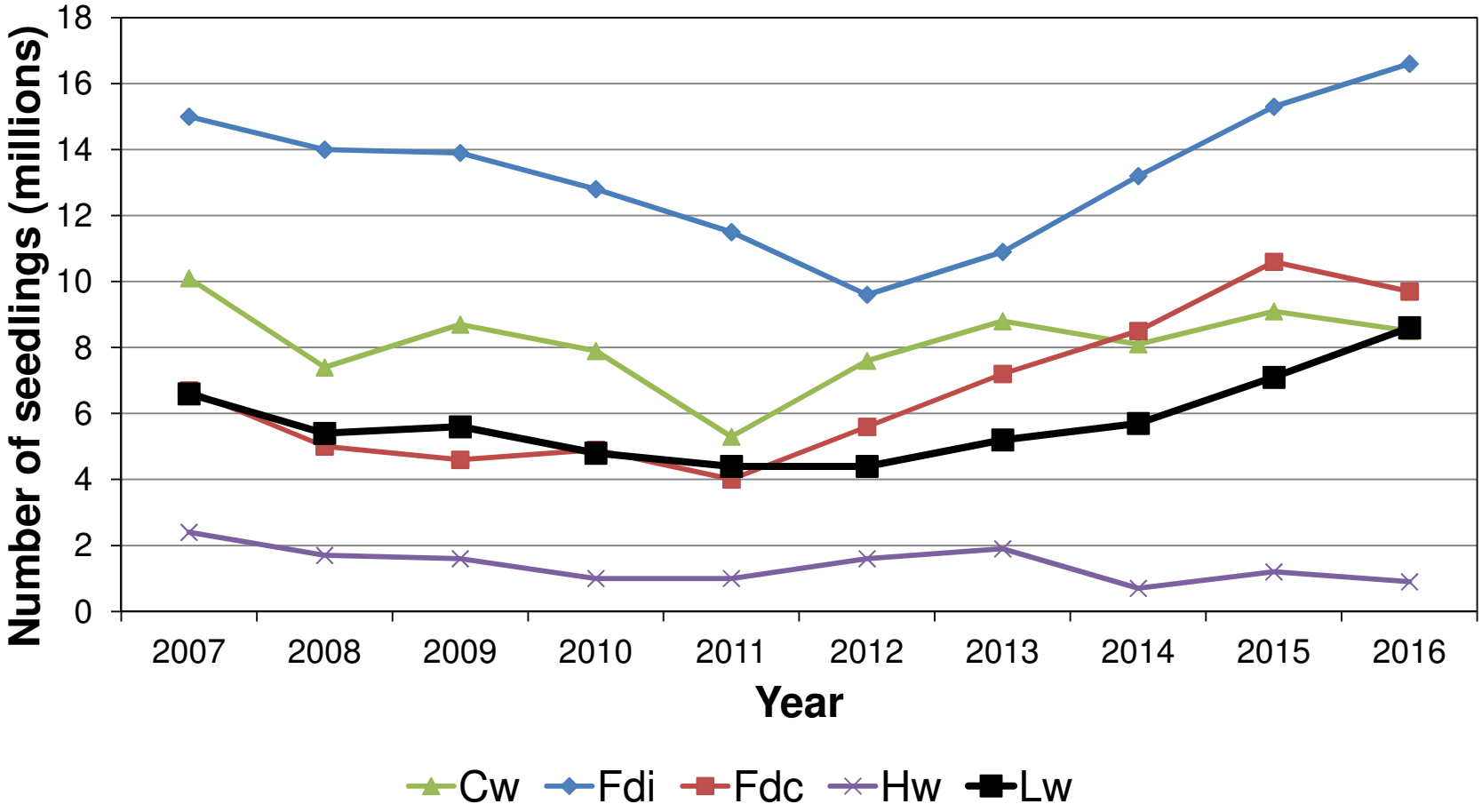
- Occupies 342 000 ha -
  <1% of total productive forest land base
- Mostly immature (60-100 years) and growing
  on good/medium quality sites
- Inventory - 57 million $m^3$ (<1% total)
- Annual harvest ~ 550 000 $m^3$ - <1% total
- Provincial commercial value is low, but
  important locally

# Seedlings planted on Crown Land in BC by species



# Seedlings planted on BC Crown Land

## - excluding interior spruce and lodgepole pine -



# Western larch characteristics: silvics

- Very shade intolerant
- Rapid early growth
- Relatively free of pests
- Responds to cultural treatments
- Readily self-prunes, good form, little taper
- Performs well in plantations
- Poor and inconsistent seed production in wild stands

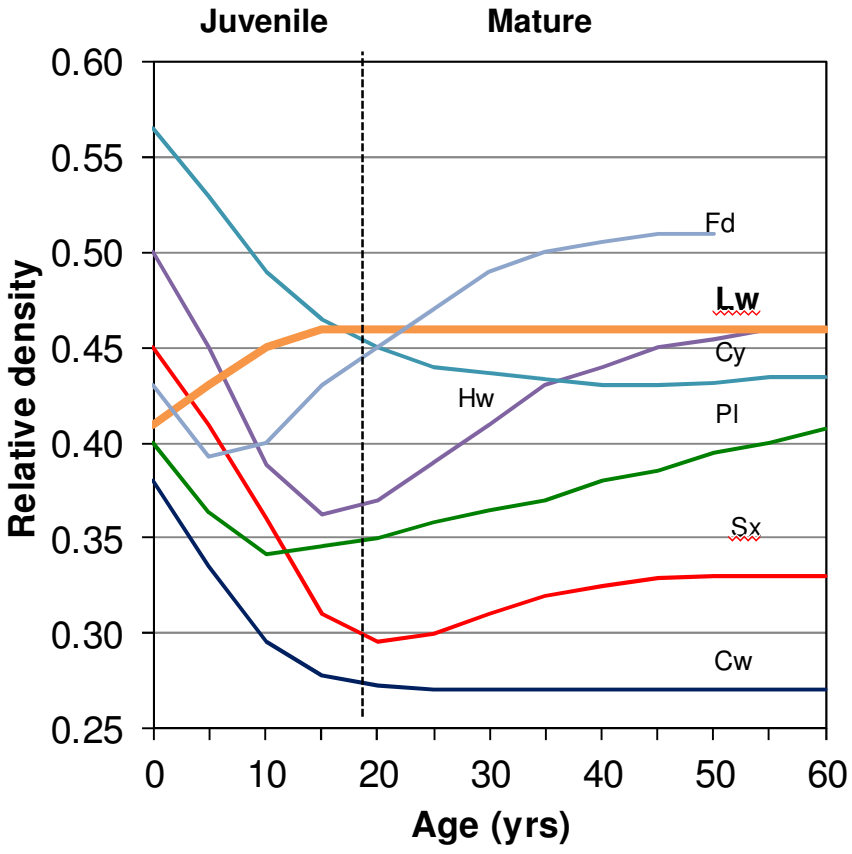
# Western larch characteristics: wood

- hard, durable and strong
- straight grained
- resistant to decay
- high density
- sorted with Douglas-fir

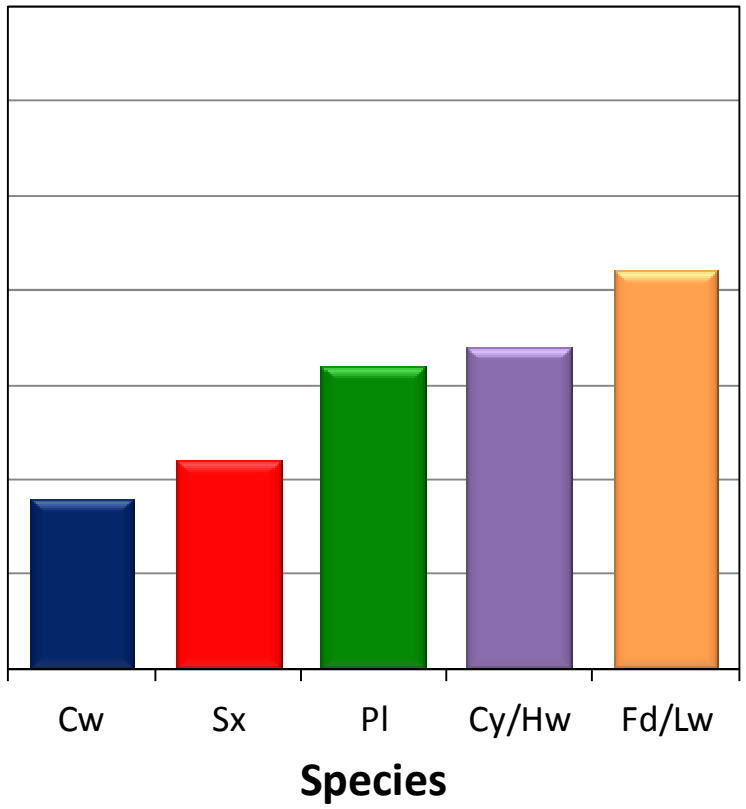
Uses: lumber, veneer, interior/exterior finishing, timbers, fuel-wood, pulp

# Western larch wood relative density at breast height

**Ring density trends (2nd growth)**




**Old growth average values**



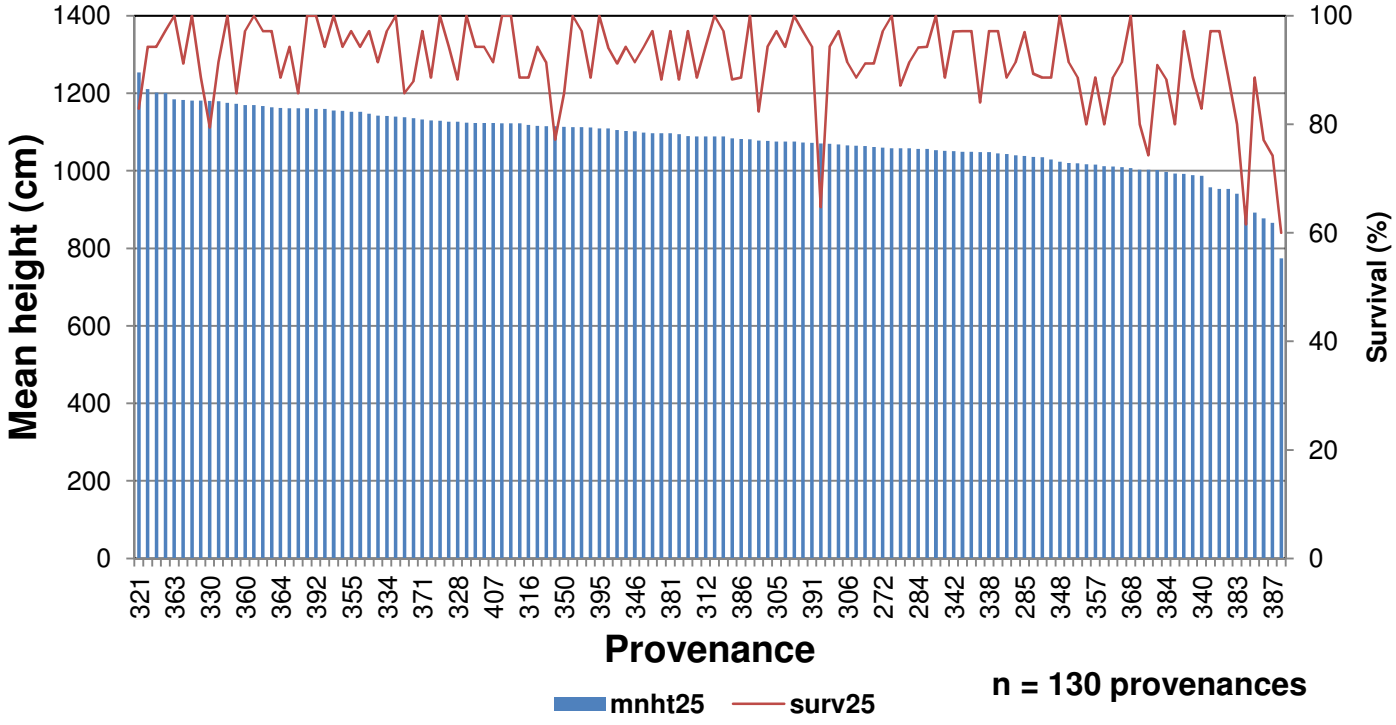

**Source: Jozsa and Sen 1992**

# Western larch characteristics: genetics

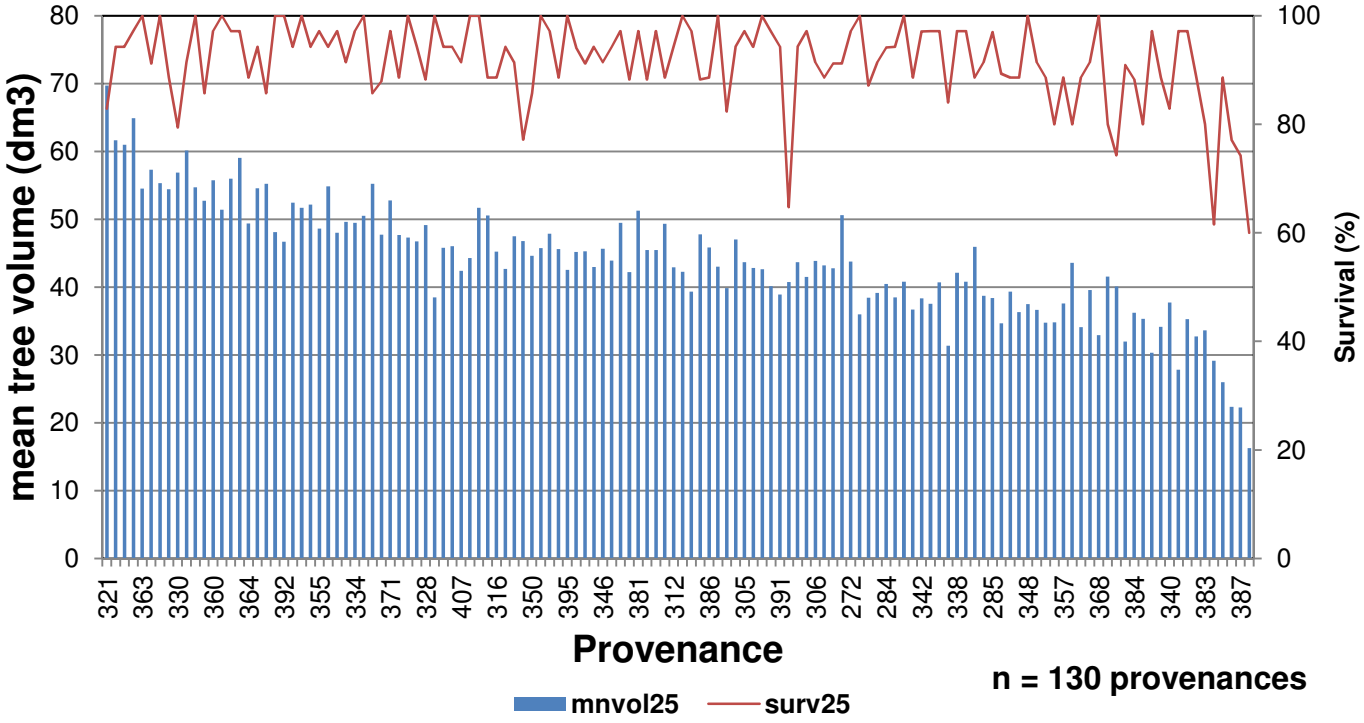
- Outcrossed mating system except in mixed stands - fecundity and growth losses with inbreeding
- Abundant genetic variation within/among populations
- Clines of adaptive traits are gentle – provenance tests
- Adapted to a broad range of environments
- Low G x E for growth traits
- B.C. populations from warm and wet areas (ICH) have highest growth potential and Meria resistance.

Lamb Creek 24-year-old  western larch range-wide provenance test

## Mean 25-year height and survival of western larch provenances in Lamb Creek range-wide provenance test



## Mean 25-year volume and survival of western larch provenances in Lamb Creek range-wide provenance test



# Western larch tree improvement in B.C.

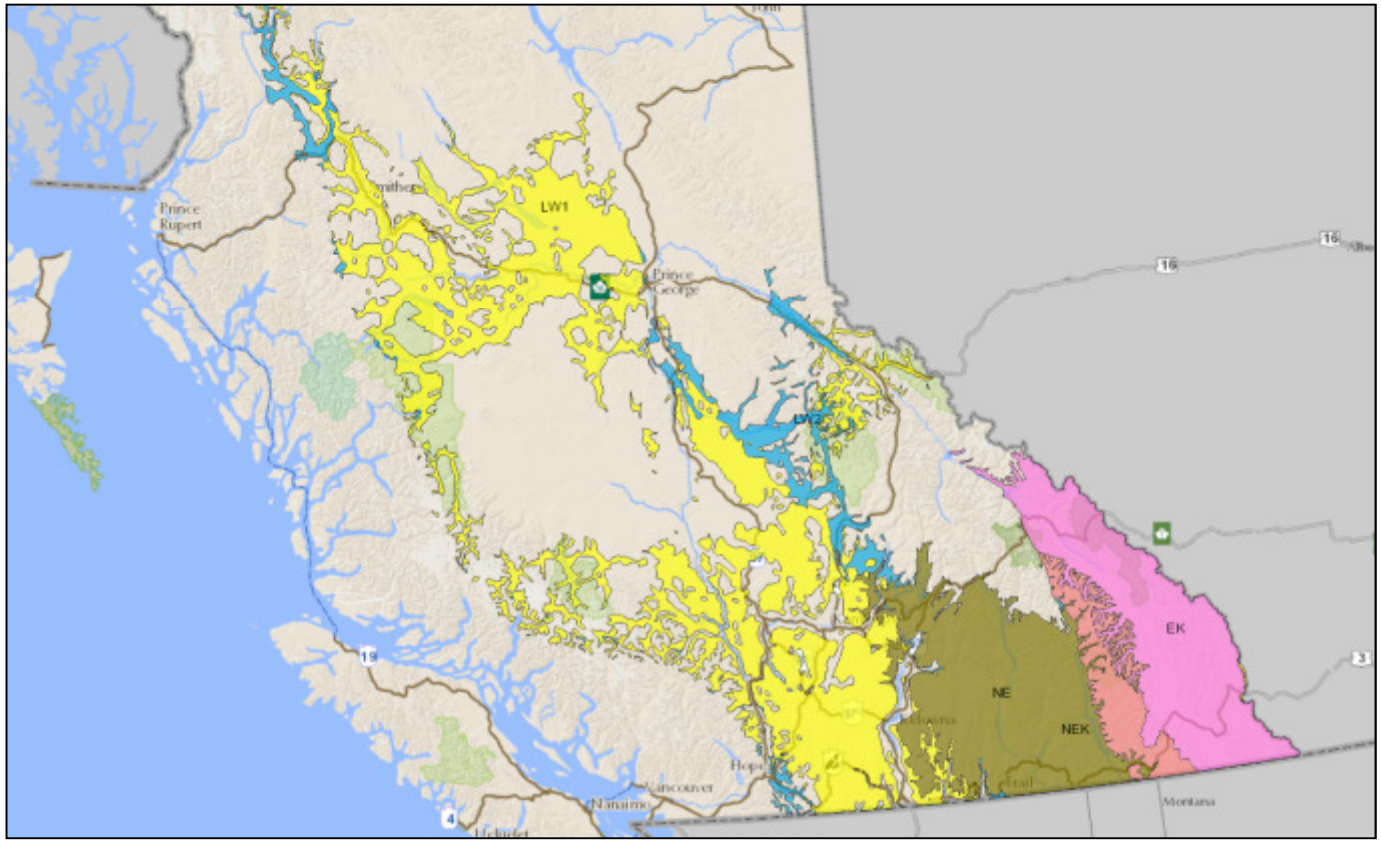
Initiated: 1987 in response to Regional request

Objective: Develop well-adapted seed, selectively bred to produce trees with improved volume growth and quality, while maintaining acceptable levels of genetic diversity

# Program Components

- Recurrent selection for general combining ability
- Traits - height, diameter, volume, (Armillaria ???)
- Phenotypic selection in natural stands
- Wind-pollinated genetic testing on high-quality sites
- Soil-based seed orchards

# Western larch seed planning zones



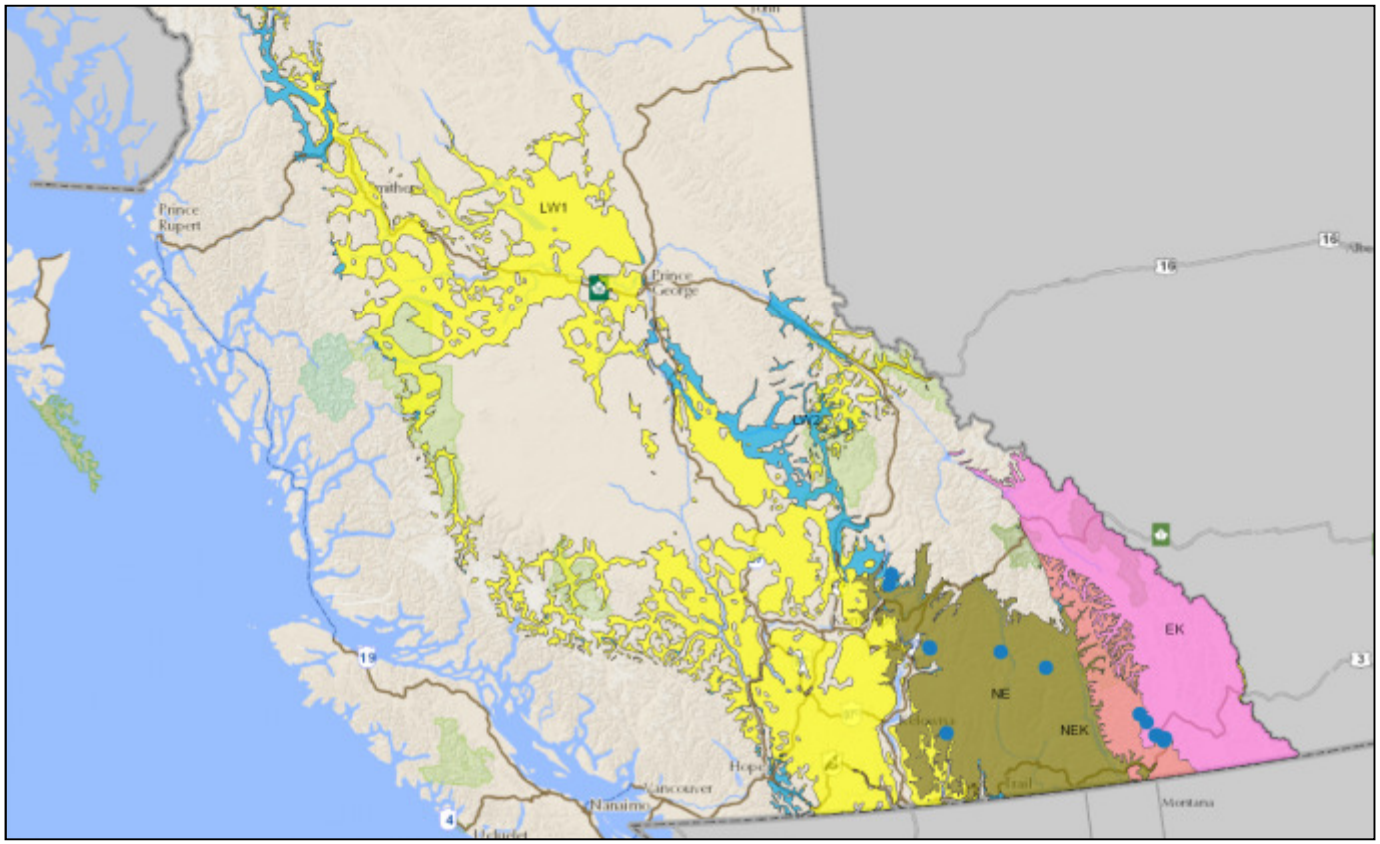
# Western larch parent tree selection

| Seed Planning Zone | Accessions |
|---|---|
| East Kootenay | 250 |
| Nelson | 359 |
| Total | 609 |

# Western larch wind-pollinated progeny tests

| Test Series | Zone | Sites | Year Planted | Local families | Non-local families | Test Trees |
|---|---|---|---|---|---|---|
| 1 | EK | 3 | 1991 | 140 | 62 | 32,320 |
| 2 | NE | 4 | 1993 | 192 | 32 | 35,840 |
| 3 | EK | 4 | 1995 | 110 | 50 | 20,480 |
| 4 | NE | 3 | 1996 | 165 | 45 | 26,880 |
| Total | | 14 | | 607 | 189 | 115,520 |

# Western larch wind-pollinated progeny tests



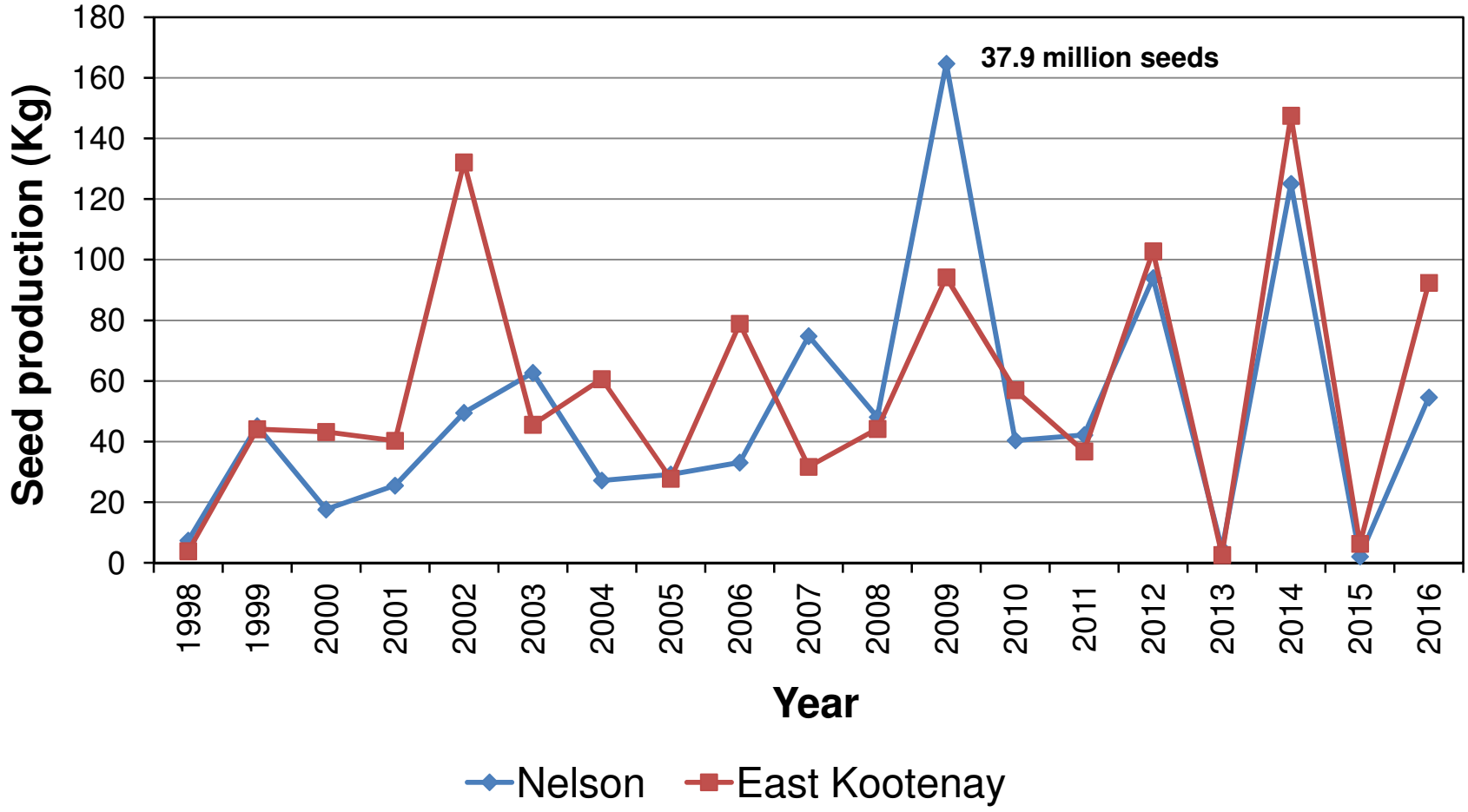

Angus Creek Lw progeny test

# Seed Orchards

- Three soil-based seed orchards in north Okanagan:
  two at Kalamalka established in 1990,
  one private orchard (Coldstream – NE/EK high)
- East Kootenay (40 clones); Nelson low (67 clones);
  Nelson high (39 clones)
- First cone crop (13 hl) - Fall 1998
- Averaging ~ 40 seeds/cone.

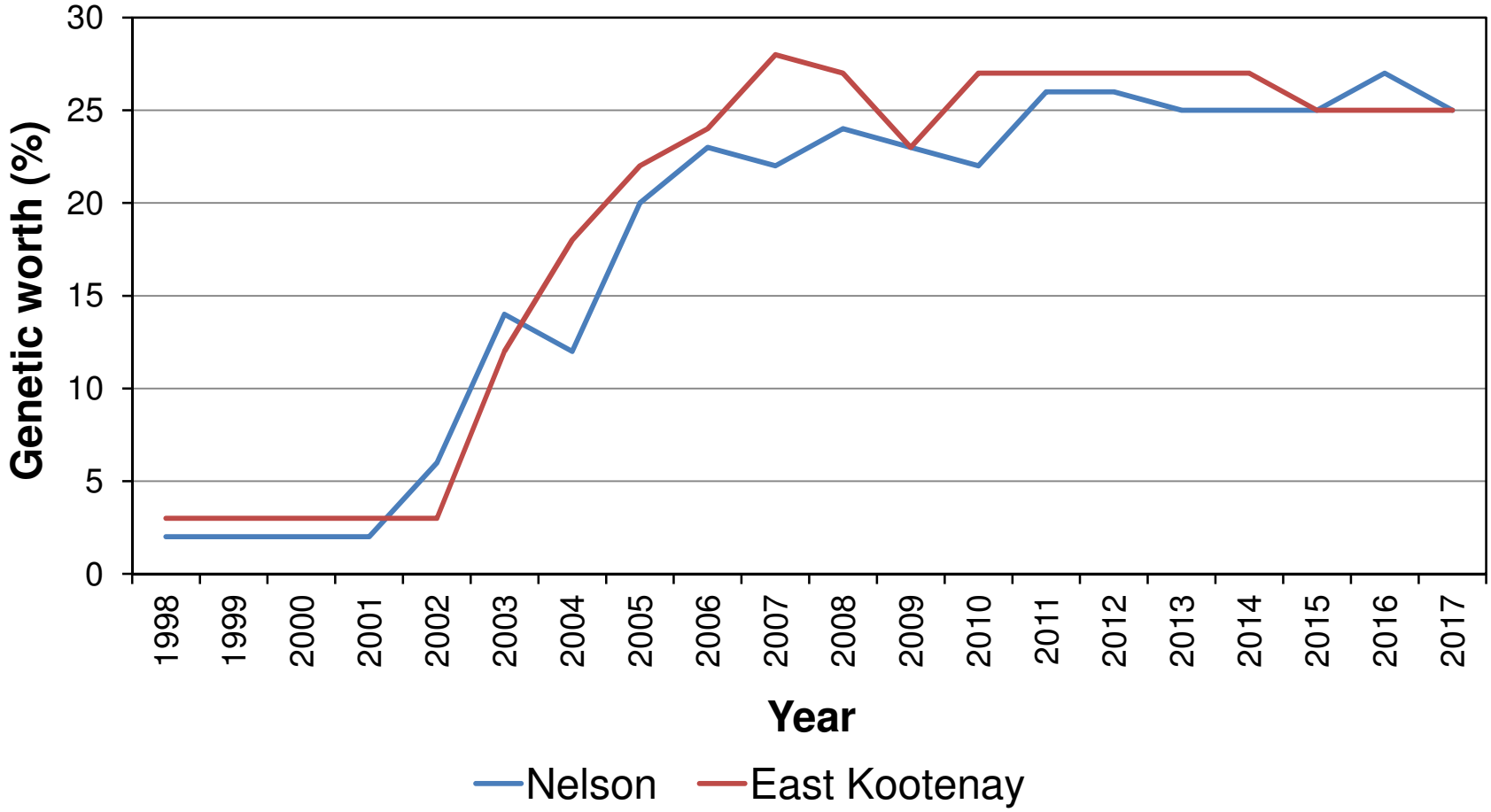
**Western larch cone collection - Kalamalka**

# Western larch seed orchard seed production in B.C.



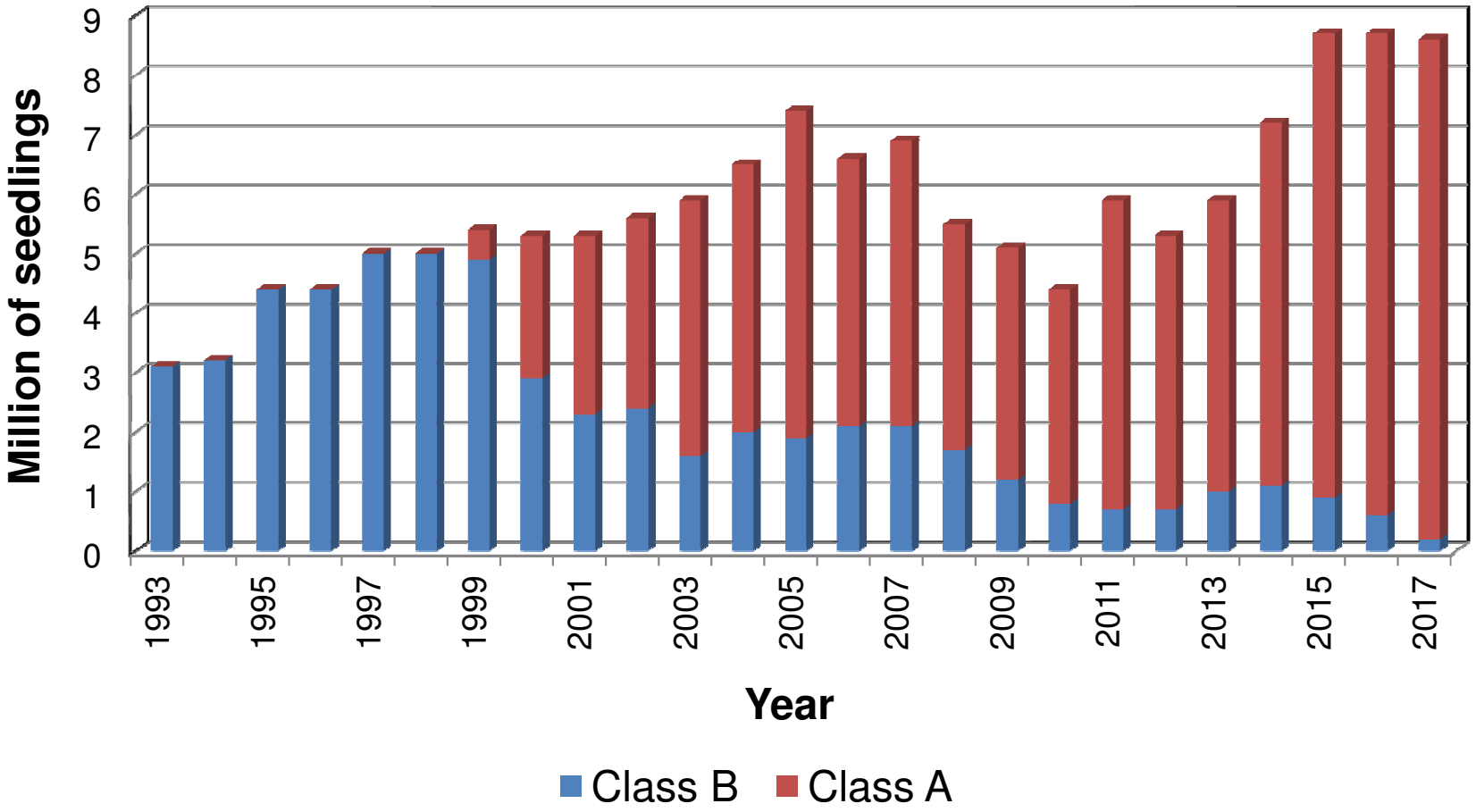

Lw: 1 Kg = 230,000 seeds

# Genetic worth of western larch class A seedlots in B.C.




* Genetic worth is the average parental breeding value for stem volume at rotation age (60 years)

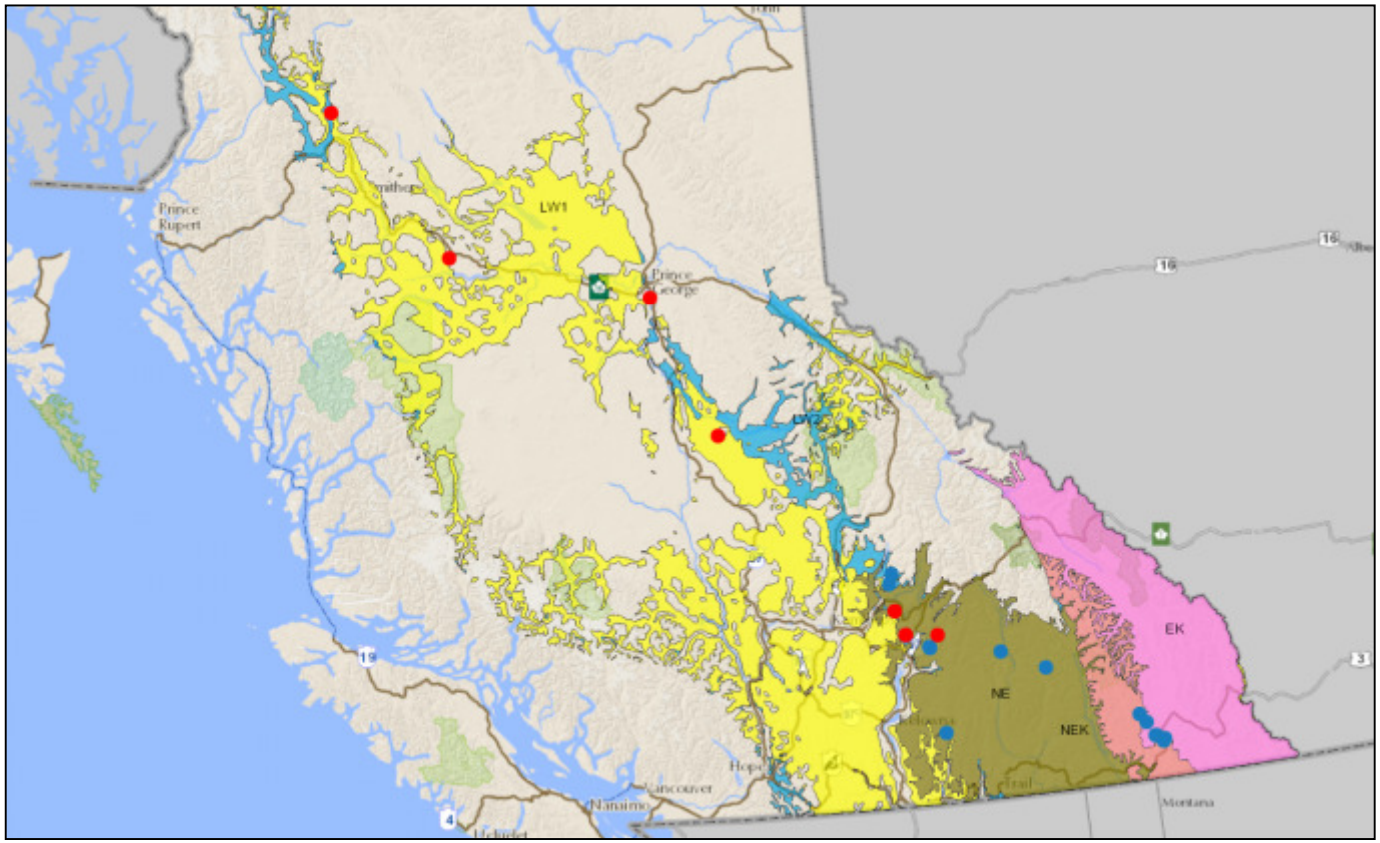
# Western larch seedlings requested by genetic class and year in B.C.




Crossing for second-generation testing is complete


KEEP
COOL

# Location of new western larch 2nd generation progeny tests




First generation tests  2nd generation tests

# New interim seed deployment zones

Chief Forester's request:

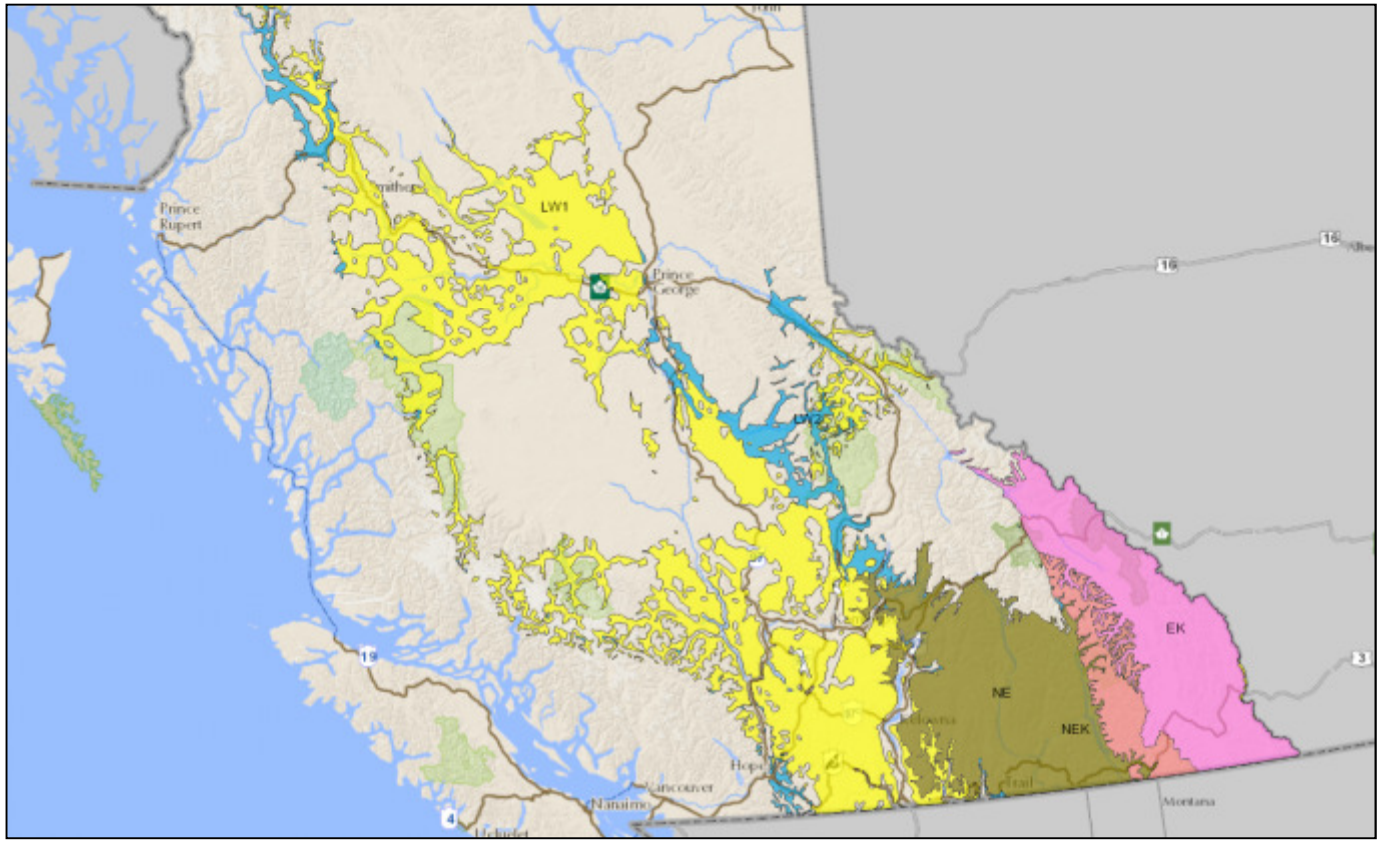
1. in response to climate change and MPB outbreak, evaluate expanded use of western larch outside of its natural range;

2. establish climate-based seed zones and seed transfer rules for planting western larch in B.C.

**Rehfeldt G.E. and B. C. Jaquish. 2010. Ecological Impacts and associated management strategies for western larch in the face of global warming. Mitigation and adaptation strategies for global change. 15(3):283-306.**

# Planting outside natural range

# Existing (NE and EK) and interim (LW1 and LW2) western larch seed planning zones



East Kootenay class A seedling near Kispiox (LW1) four years after planting

# Realized gain genetic tests

Objective: estimate yield on an area basis for operational and improved seedlots planted on contrasting sites and different levels of spacing.

Design: RCB layout with multiple sites and 2 replicate blocks per site.

**Six-year-old elite western larch tree at Burton realized gain test site.**

# Realized gain test series and populations

1) Nelson SPZ: planted 2004
   - Elite – 5 full-sib families - high BV parents
   - Seed orchard low – seedlot 60732 (GW +6)
   - Seed orchard high – seedlot 60748 (GW+12)
   - Control – bulk of 10 wild-stand seedlots

2) East Kootenay SPZ: planted 2005
   - Elite – 5 full-sib families - high BV parents
   - Seed orchard low – seedlot 60733 (GW +10)
   - Seed orchard high – seedlot 60749 (GW +18)
   - Control – bulk of 10 wild-stand seedlots

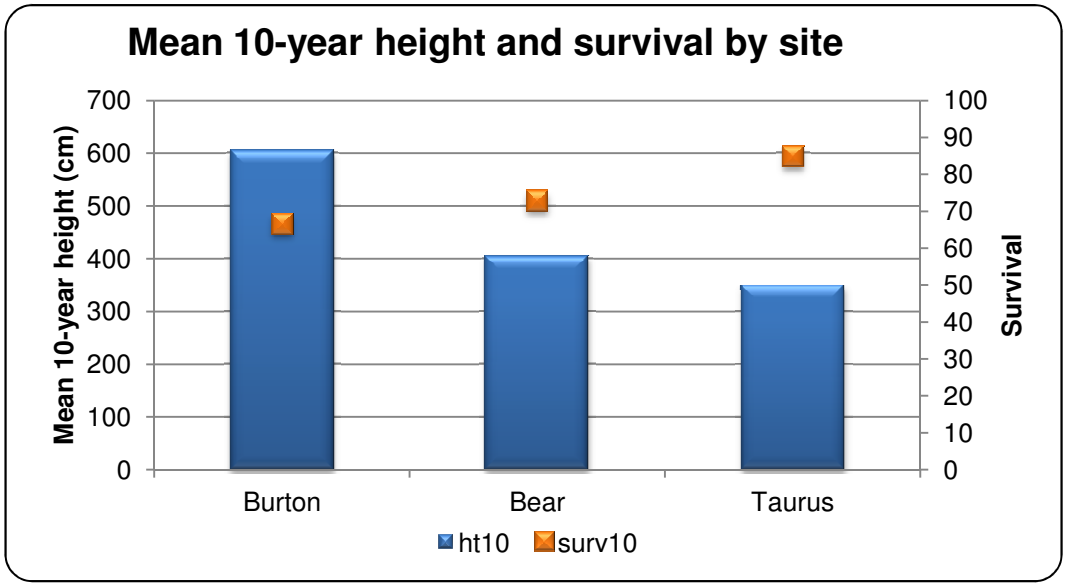
# Realized gain experimental design

- Nelson – 3 sites: Bear Ck (ICHdw1)
  Burton (ICHmw2)
  Taurus Lake (MSdm1)

- East Kootenay – 2 sites: Semlin E (MSdm1)
  Semlin W (MSdm1)

  - Randomized complete-block design
  - 2 replications per site
  - experimental units: 144 tree square plots

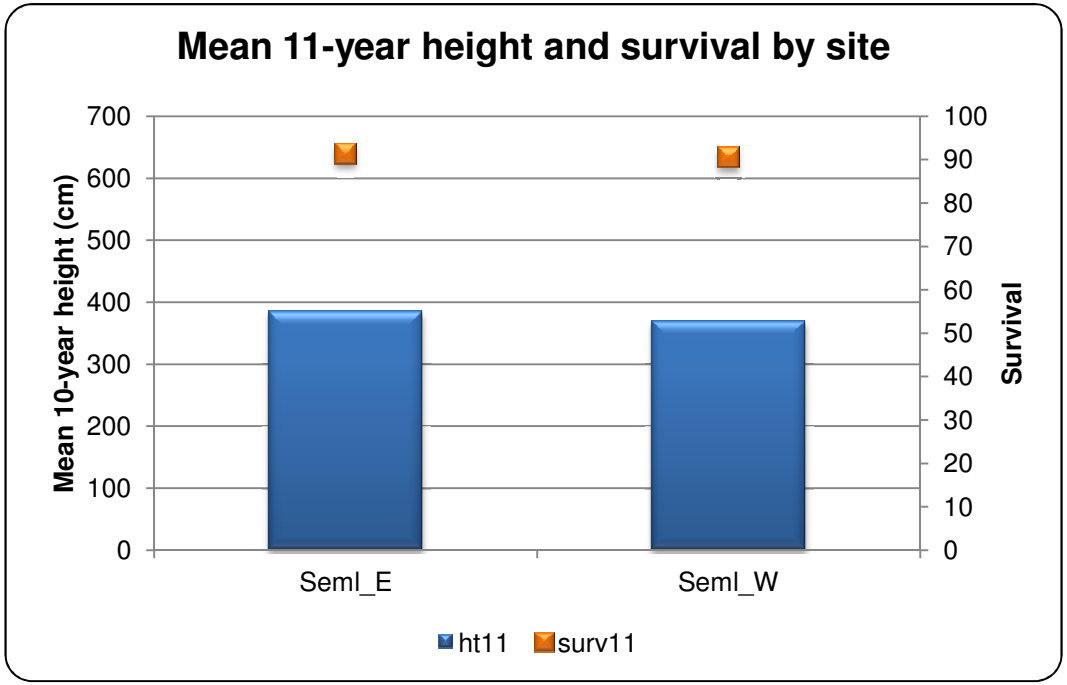
  Three levels of spacing –
  1.5 x 1.5m, 2.5 x 2.5m and 3.5 x 3.5m




# Nelson SPZ

## Tests of fixed effects: ht10

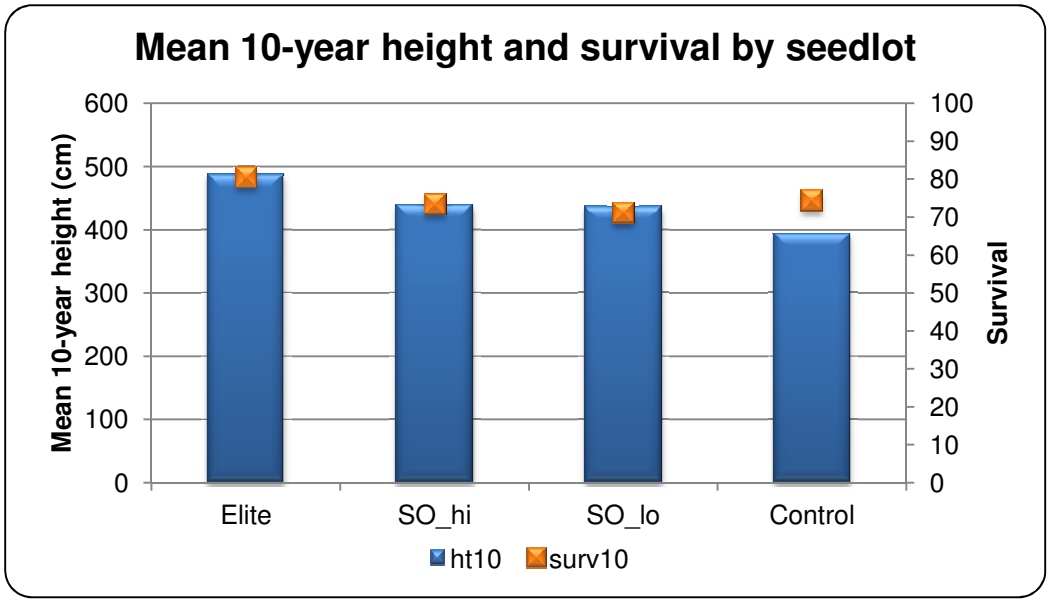
| Factor | Prob>F |
|---|---|
| Site | 0.0006 |
| Burton vs Bear | 0.0006 |
| Burton vs Taurus | 0.0003 |
| Bear vs Taurus | 0.0298 |




# East Kootenay SPZ

## Tests of fixed effects: ht11

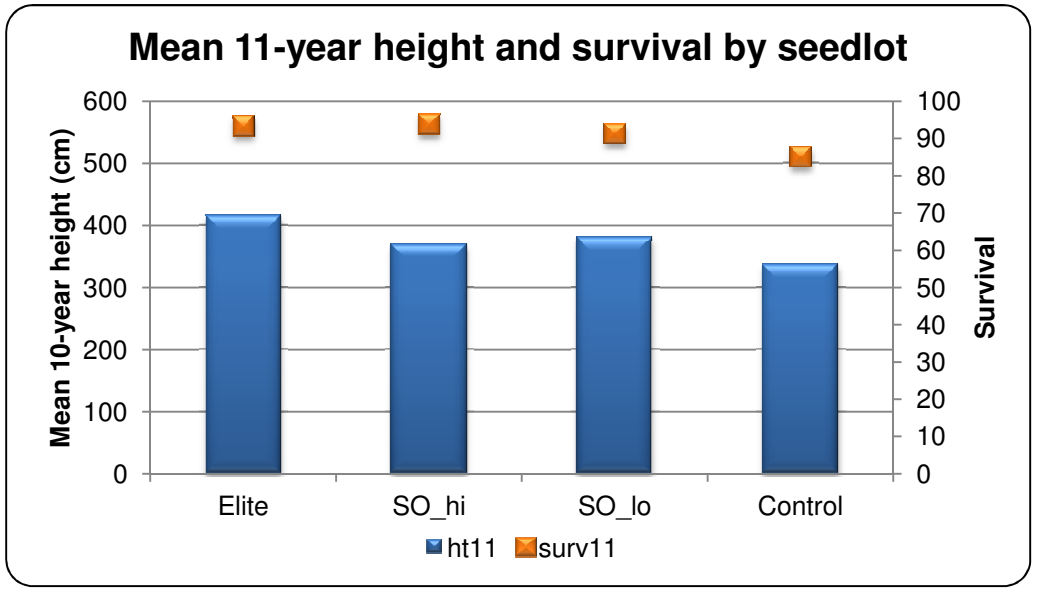
| Factor | Prob>F |
|---|---|
| Site | 0.5864 |




# Nelson SPZ

**Tests of fixed effects: ht10**

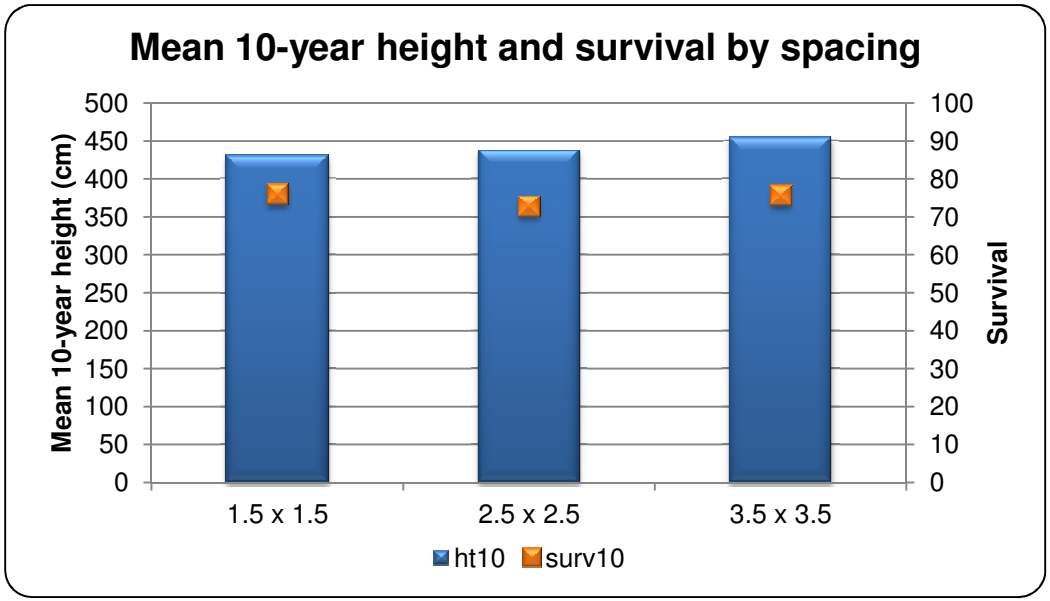
| Factor | Prob>F |
|---|---|
| Seedlot | 0.0001 |
| Control vs Elite | 0.0001 |
| Control vs SO_lo | 0.0001 |
| Control vs SO_hi | 0.0001 |
| Elite vs SO_hi | 0.0001 |
| Elite vs SO_lo | 0.0001 |
| SO_hi vs SO_lo | 0.1592 |




# East Kootenay SPZ

**Tests of fixed effects: ht11**

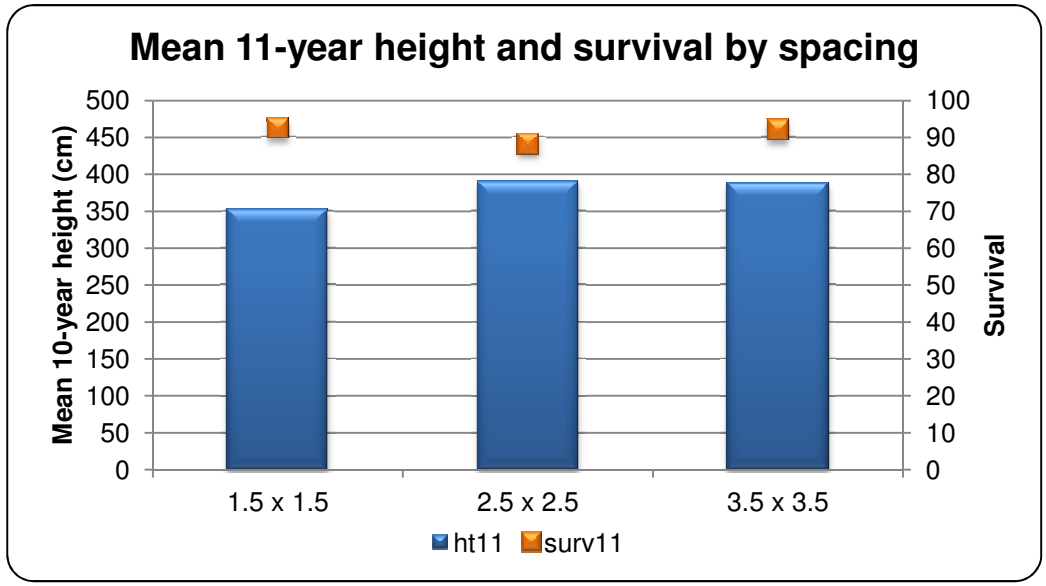
| Factor | Prob>F |
|---|---|
| Seedlot | 0.0001 |
| Control vs Elite | 0.0001 |
| Control vs SO_lo | 0.0001 |
| Control vs SO_hi | 0.0001 |
| Elite vs SO_hi | 0.0001 |
| Elite vs SO_lo | 0.0001 |
| SO_hi vs SO_lo | 0.0014 |




# Nelson SPZ

### Tests of fixed effects: ht10

| Factor | Prob>F |
|---|---|
| Spacing | 0.0001 |
| 1.5 vs 2.5 | 0.0306 |
| 1.5 vs 3.5 | < 0.0001 |
| 2.5 vs 3.5 | 0.0002 |




# East Kootenay SPZ

### Tests of fixed effects: ht11

| Factor | Prob>F |
|---|---|
| Spacing | 0.0001 |
| 1.5 vs 2.5 | < 0.0001 |
| 1.5 vs 3.5 | < 0.0001 |
| 2.5 vs 3.5 | 0.1645 |

Western larch plot in AMAT planting in California

*Photo: Greg O'Neill*


Gary Lloyd memorial *Larix* tree
Skeena Stikine Resource District