University of Idaho
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# Early growth and mortality of planted interior Douglas-fir and western larch seedlings

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# Justification

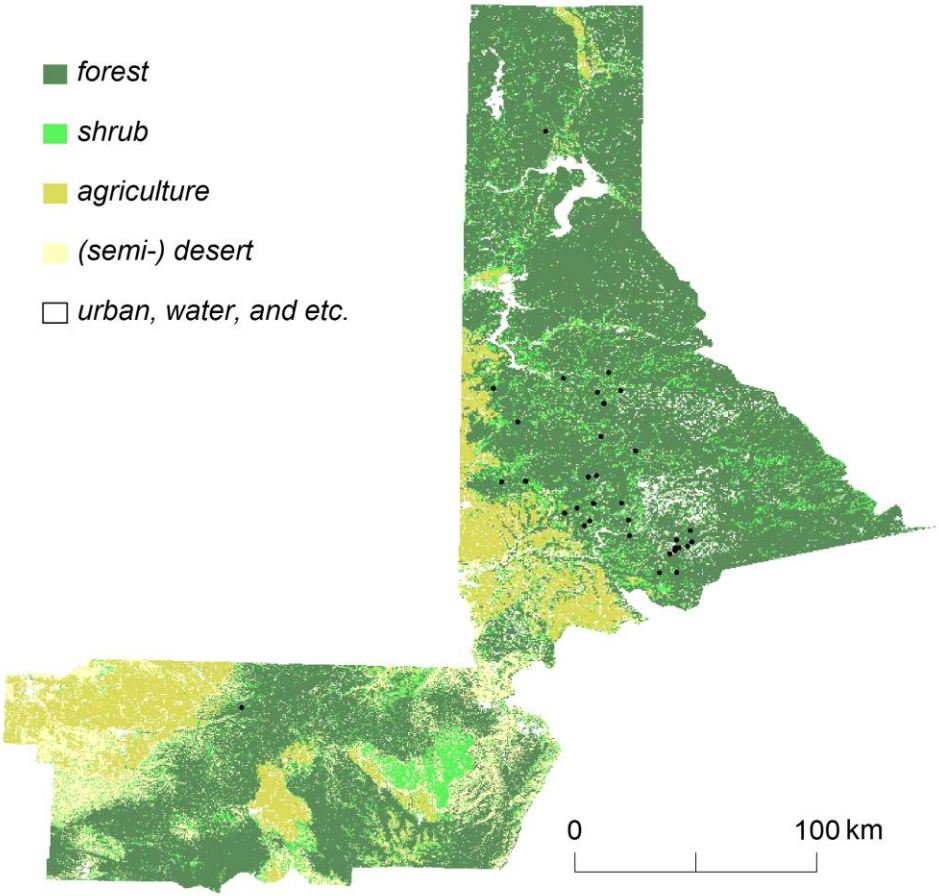
- Planting for reforestation is increasingly important in the Inland Northwest as well as elsewhere.
- Forest growth and yield models are predominantly designed to model established trees, seedlings shorter than breast height are effectively excluded from these models, even individual seedling models usually focus on established seedlings
- Poorly account for competition from non-tree vegetation
- Lack comprehensive evaluations of weather, soil, and topographical factors, as well as variability in nursery, seedlots, and containers.

# Objectives

1) assess the effects of various factors of seedling origins, morphological attributes, soil, topography, weather, and competition on early growth and mortality of planted Douglas-fir and western larch seedlings.

2) predict early seedling growth and morality using significant and influential factors from the assessment.

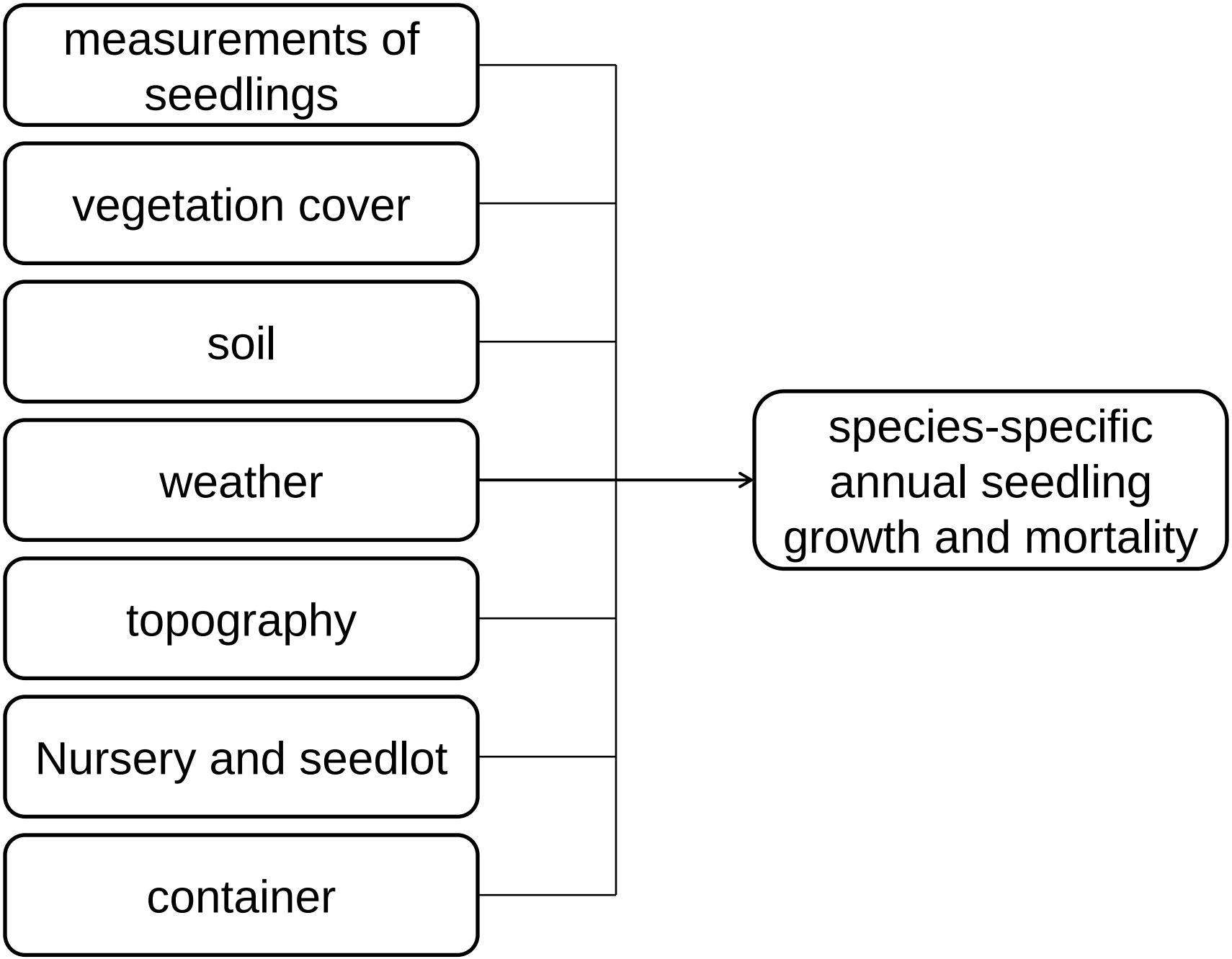
3) compare specific differences between interior Douglas-fir and western larch and provide management suggestions.





# Study area, land cover, and sample plots

- 50 plots
- 25,000+ seedlings
- annual measurements since 2016


measurements of seedlings
vegetation cover
soil
weather
topography
Nursery and seedlot
container
species-specific annual seedling growth and mortality

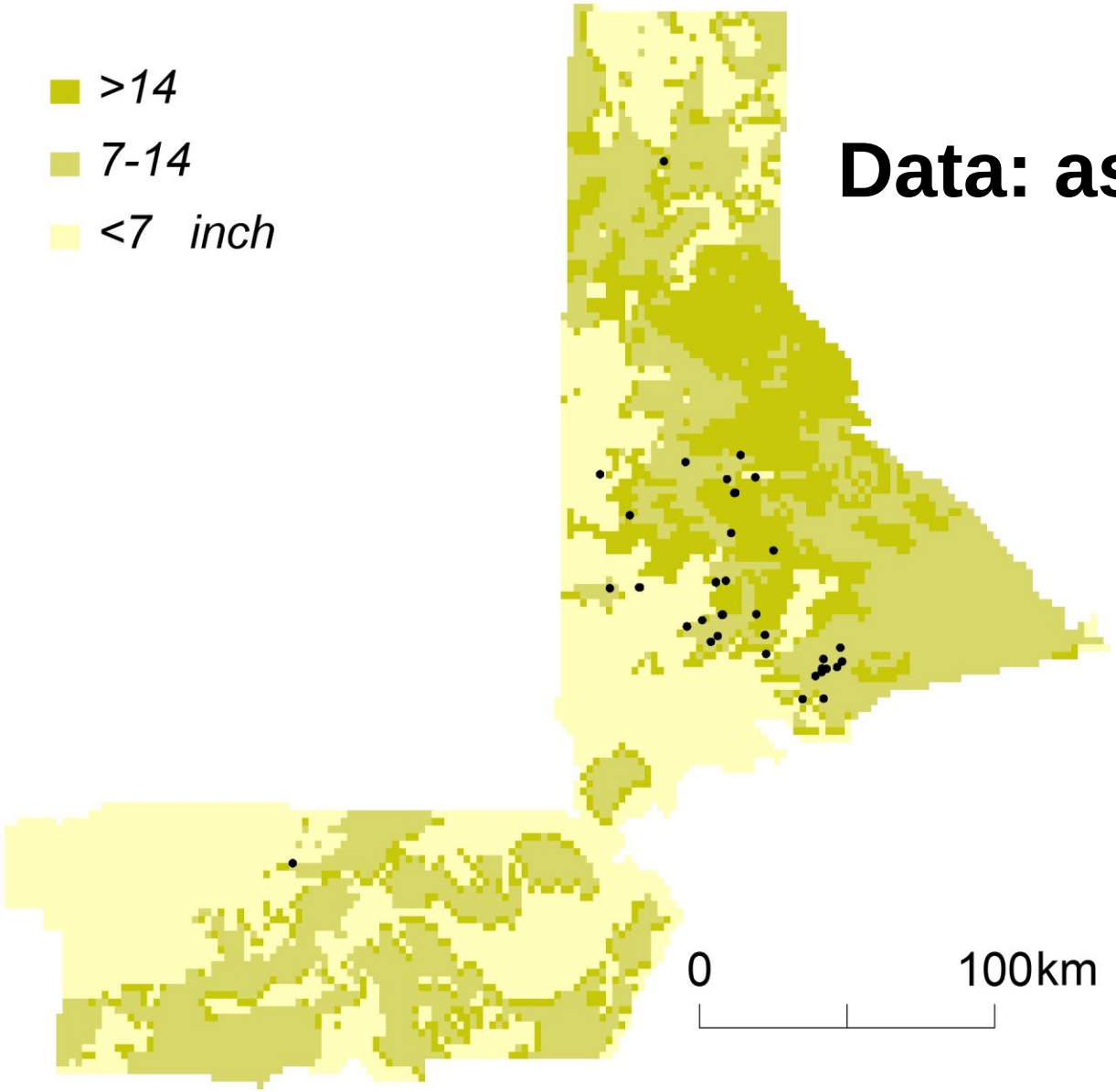
# Data: root growth potential

- Root growth potential was expressed as average number of new white roots ≥ 1 cm long produced by a seedlot.
- Assesses seedling vitality (free of disease, injury, or stress).

# Data: competition

| Competition Variable | Western Larch | Douglas-fir |
|---|---|---|
| | Mean (Range) | |
| Forb (%) | 12.2 (0 – 100) | 18.0 (0 – 100) |
| Shrub (%) | 3.4 (0 – 100) | 7.5 (0 – 90) |
| Grass (%) | 1.9 (0 – 100) | 3.4 (0 – 90) |
| Slash (%) | 27.4 (0 – 100) | 22.7 (0 – 100) |

# Data: ash cap depth



# Data

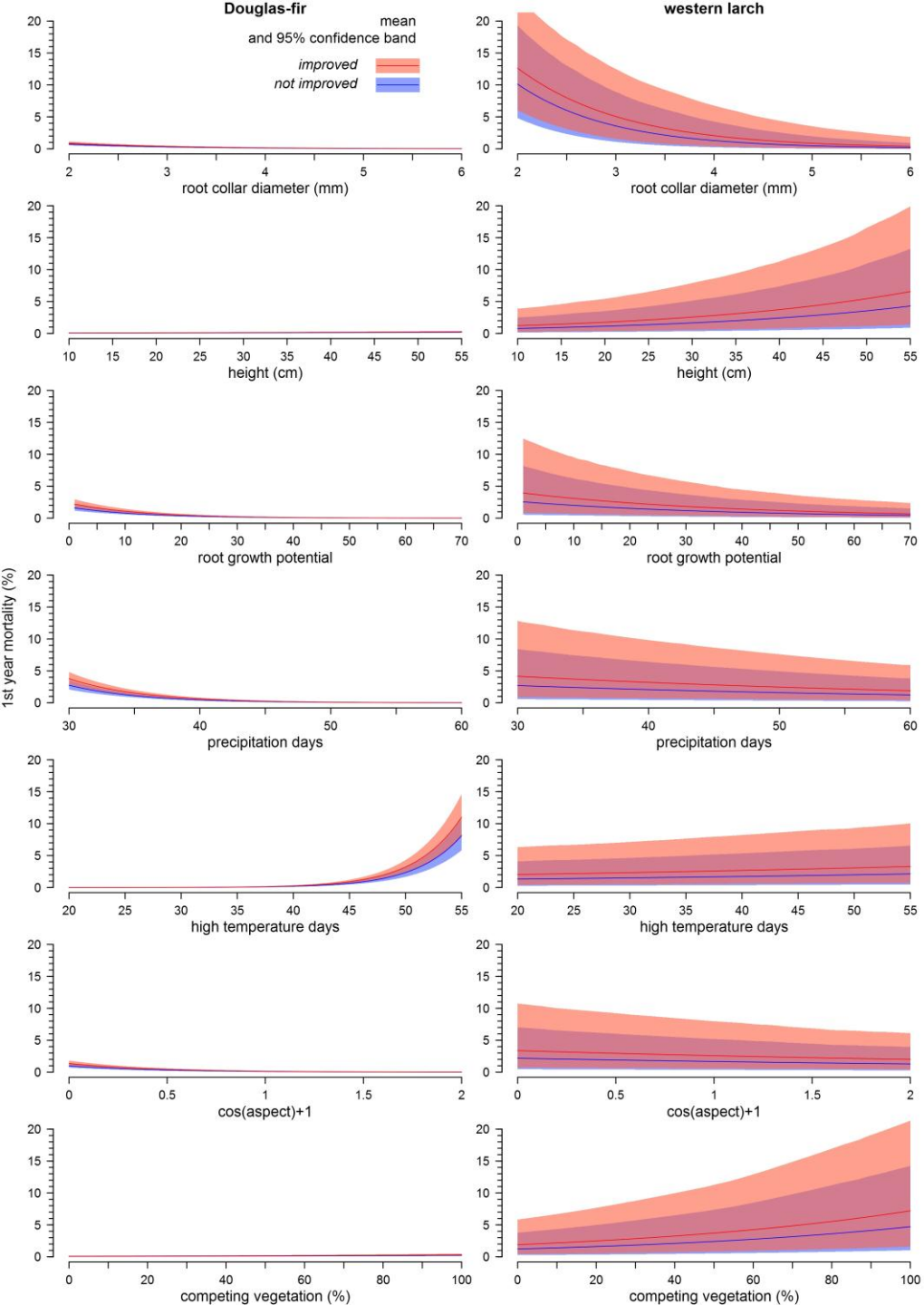
- Soil parent material: granite, basalt, alluvium, meta-sediment, or loess.
- Daily observations of precipitation, snow depth, and min., max., and average temperature from 98 stations located in the study area interpolated to sample plots.
- 30-meter resolution elevation data from the Idaho Geospatial Office used to derive elevation, slope, and aspect at sample plots.
- Nursery, seedlot, and container.

# Summary of the experimental design

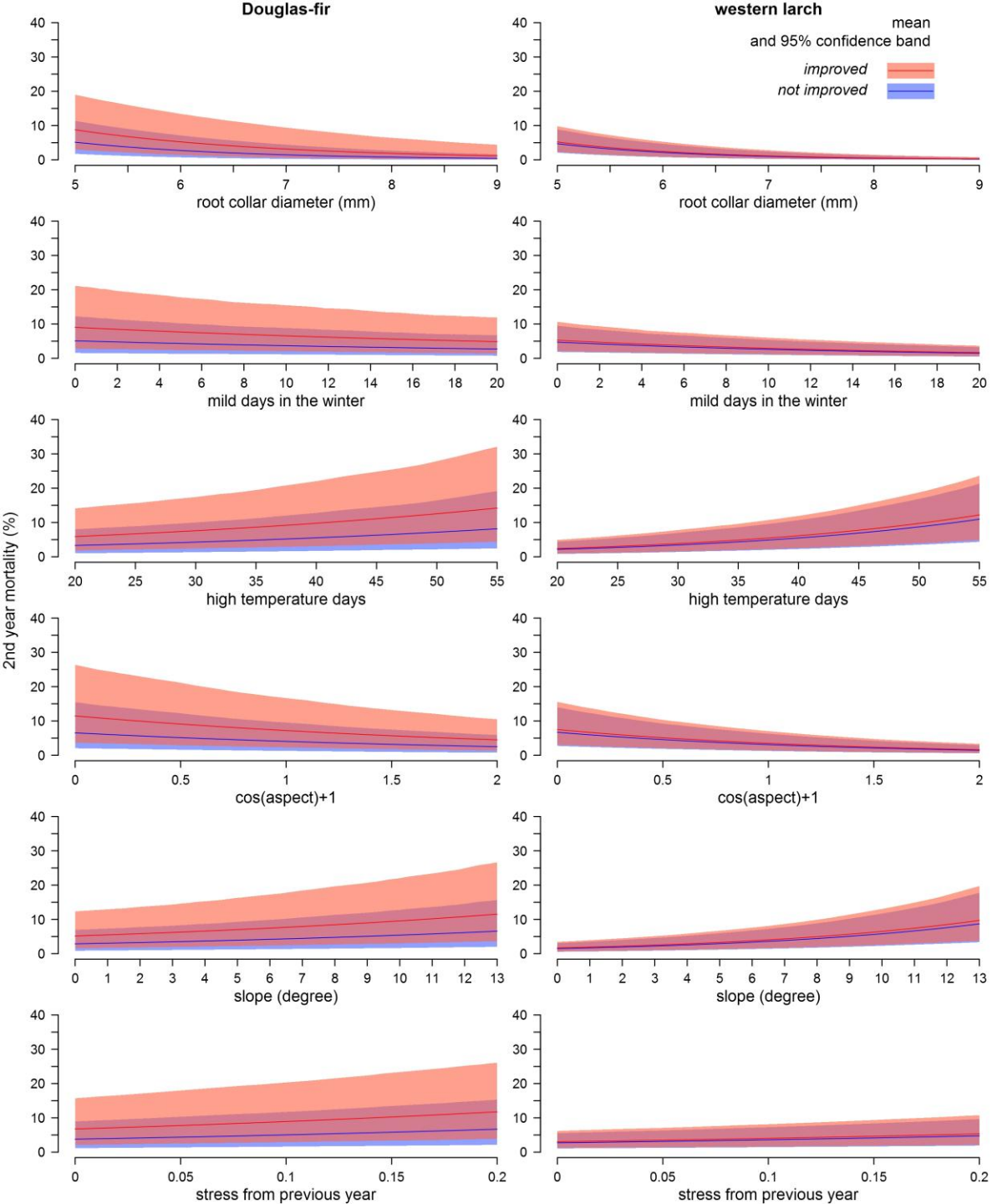
| block or treatment | total | | Douglas-fir | | western larch | |
|---|---|---|---|---|---|---|
| | 12,262 of 13,701 were improved | | 4,475 of 4,753 were improved | | 7,787 of 8,948 were improved | |
| | *No. of levels* | *avg. n per level* | *No. of levels* | *avg. n per level* | *No. of levels* | *avg. n per level* |
| soil | 5 | 2,740 | 5 | 951 | 5 | 1,790 |
| plot | 50 | 274 | 31 | 153 | 35 | 256 |
| nursery | 10 | 1,370 | 9 | 528 | 8 | 1,119 |
| seed lot | 39 | 351 | 10 | 475 | 29 | 309 |

# Summary of the data by species

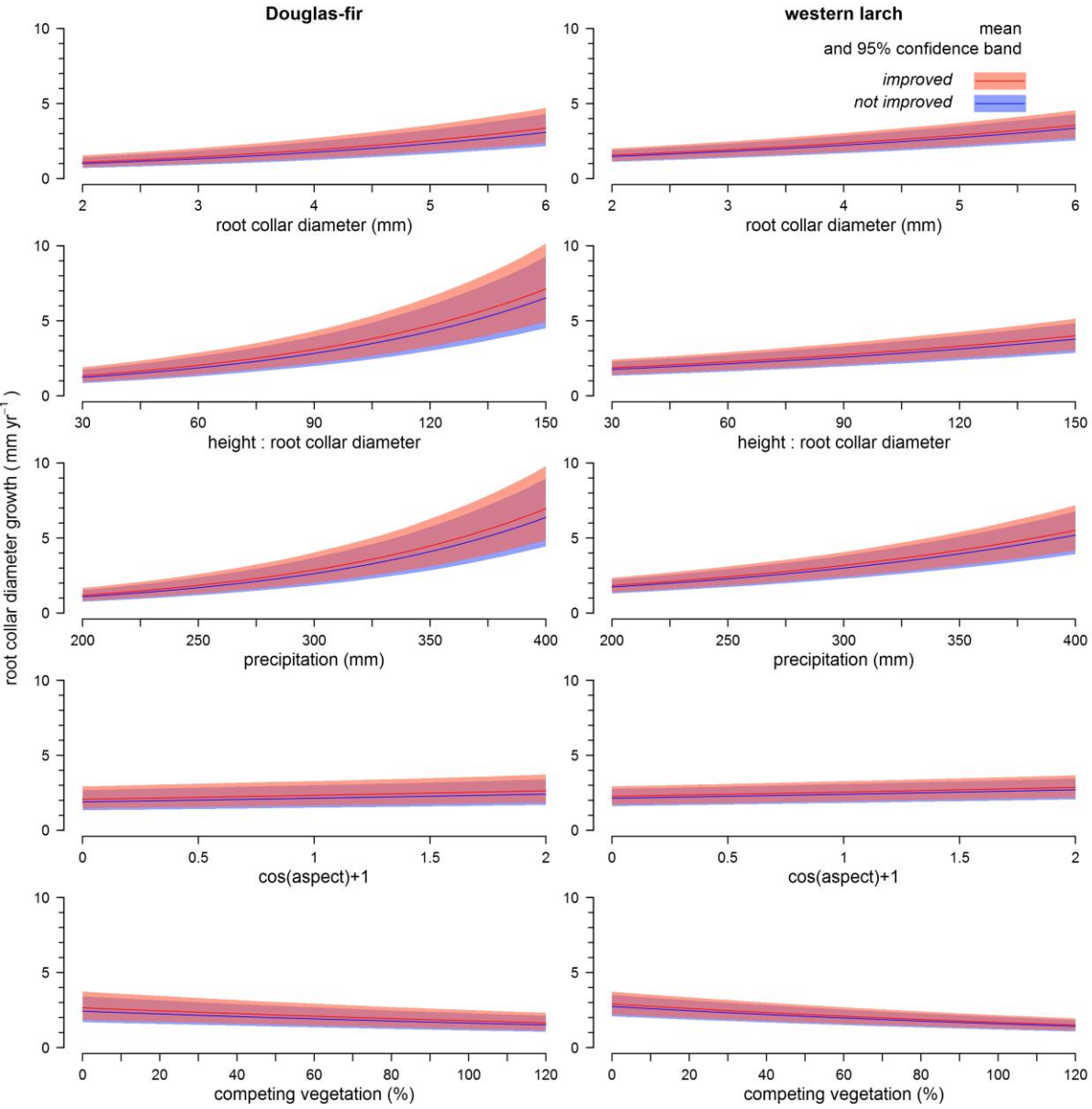
| variable | mean | min | max | CV[2] | mean | min | max | CV |
|---|---|---|---|---|---|---|---|---|
| | *Douglas-fir* *n =5,333* | | | | *western larch* *n = 9,977* | | | |
| *weather* [1] | | | | | | | | |
| precipitation (mm) | 277 | 130 | 443 | 27% | 275 | 130 | 443 | 23% |
| precipitation days | 49 | 30 | 67 | 17% | 48 | 30 | 67 | 14% |
| max temperature ≥ 29°C days | 34 | 14 | 68 | 33% | 32 | 17 | 68 | 30% |
| winter average temperature ≥ 8°C days | 9 | 0 | 23 | 61% | 8 | 0 | 23 | 52% |
| frost-free days | 153 | 97 | 173 | 10% | 152 | 114 | 180 | 12% |
| *topography* | | | | | | | | |
| elevation (m) | 996 | 845 | 1335 | 9% | 997 | 845 | 1219 | 9% |
| slope (degree) | 5 | 0 | 13 | 62% | 7 | 0 | 16 | 71% |
| cos(aspect) + 1 | 1.3 | 0.0 | 2.0 | 57% | 1.5 | 0.0 | 2.0 | 35% |
| | **mean** | **1 percentile** | **99 percentile** | | **mean** | **1 percentile** | **99 percentile** | |
| *seedling characteristics* [3] | | | | | | | | |
| initial root collar diameter (mm) | 4.2 | 2.3 | 6.4 | | 3.8 | 1.9 | 5.8 | |
| root collar diameter growth (mm $yr^{-1}$) | 3.1 | 0.1 | 11.2 | | 4.1 | 0.1 | 14.1 | |
| initial height (cm) | 29.7 | 14.1 | 45.6 | | 30.5 | 13.8 | 51.0 | |
| height growth (cm $yr^{-1}$) | 10.0 | 0.4 | 35.8 | | 22.0 | 0.7 | 80.7 | |
| root growth potential | 36.3 | 7.4 | 85.3 | | 17.3 | 0.5 | 49.1 | |
| 1st year mortality (%) | 3.7 | -- | -- | | 5.3 | -- | -- | |
| 2nd year mortality (%) | 7.5 | -- | -- | | 5.6 | -- | -- | |
| *competition* | | | | | | | | |
| competing vegetation cover (%) | 32 | 0 | 100 | | 23 | 0 | 100 | |



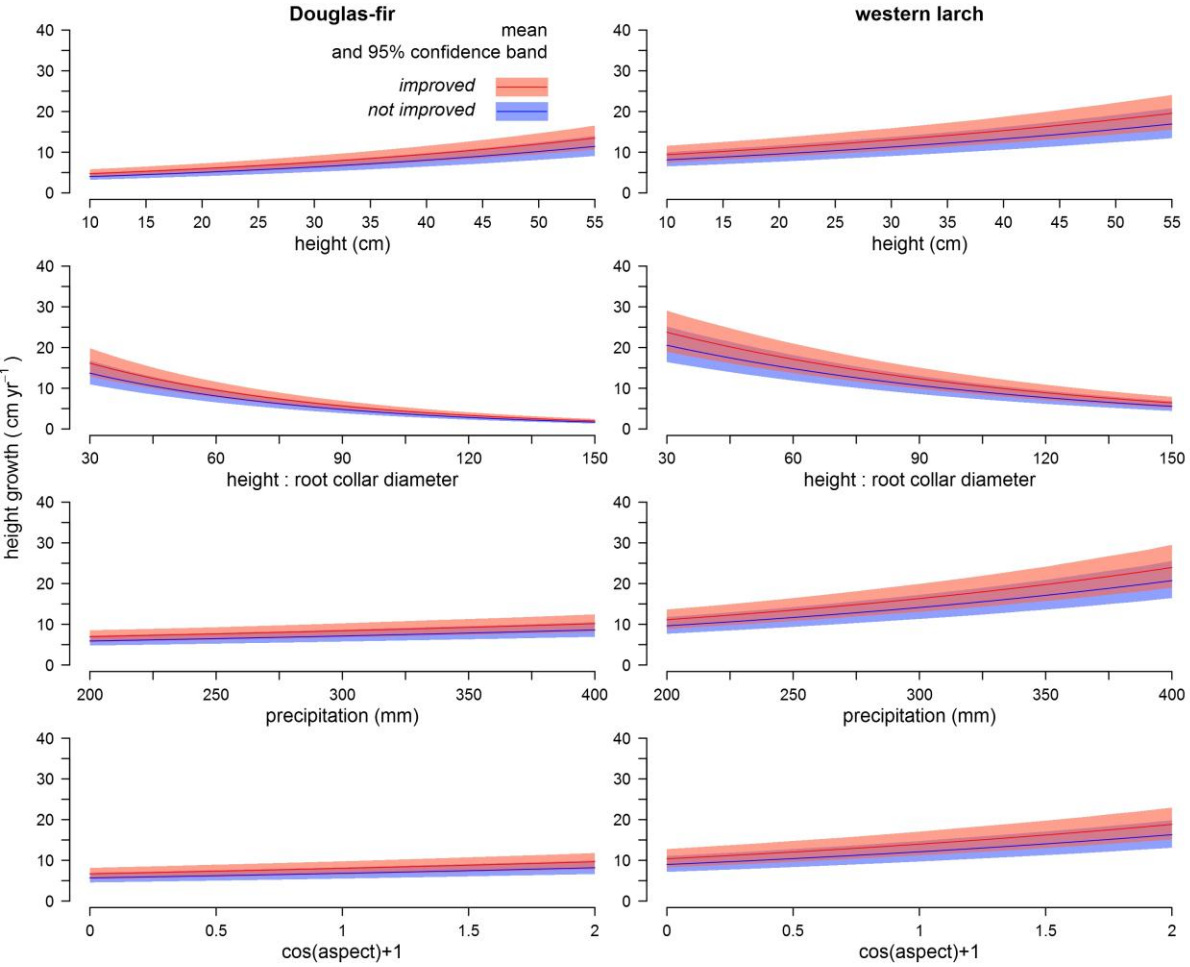

# Predicted 1st year mortality




# Predicted 2nd year mortality

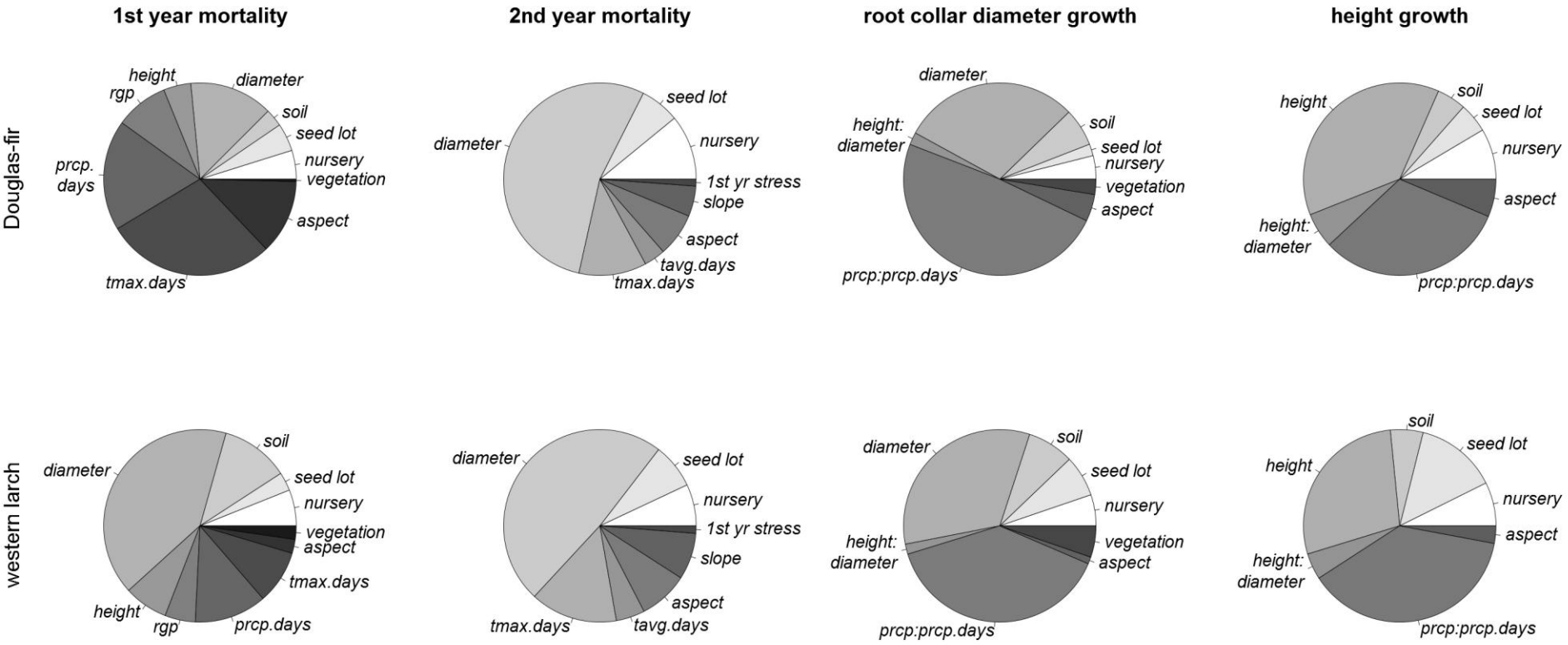



# Predicted diameter growth




# Predicted height growth

# Relative importance of predictors



| diameter (mm) | precipitation (mm) | | | precipitation days | | |
|---|---|---|---|---|---|---|
| | <250 | 250-310 | >310 | <47 | 47-51 | >51 |
| <3.5 | 17% | 11% | 14% | 16% | 13% | 10% |
| 3.5-4.2 | 13% | 11% | 9% | 13% | 9% | 11% |
| >4.2 | 6% | 9% | 9% | 6% | 9% | 11% |

| root growth potential | precipitation (mm) | | | precipitation days | | |
|---|---|---|---|---|---|---|
| | <250 | 250-310 | >310 | <47 | 47-51 | >51 |
| <12 | 36% | 9% | 3% | 36% | 7% | NA |
| 12-30 | 10% | 10% | 9% | 7% | 9% | 11% |
| >30 | 10% | 10% | 13% | 10% | 12% | 10% |

# Douglas-fir:

# total mortality in the first two years

| diameter (mm) | precipitation (mm) | | | precipitation days | | |
|---|---|---|---|---|---|---|
| | <250 | 250-310 | >310 | <47 | 47-51 | >51 |
| <3.5 | 10% | 12% | 18% | 10% | 16% | 11% |
| 3.5-4.2 | 11% | 9% | 6% | 8% | 11% | 5% |
| >4.2 | 9% | 8% | 4% | 4% | 9% | 7% |

| root growth potential | precipitation (mm) | | | precipitation days | | |
|---|---|---|---|---|---|---|
| | <250 | 250-310 | >310 | <47 | 47-51 | >51 |
| <12 | 7% | 10% | 8% | 5% | 14% | 2% |
| 12-30 | 8% | 10% | 9% | 9% | 11% | 8% |
| >30 | 13% | 9% | 19% | 10% | 13% | 13% |

# western larch:

# total mortality in the first two years

# Results I

- Mortality varied greatly among seedlings, while less variability was observed in growth.
- Mortality of Douglas-fir was lower than that of western larch in the 1st year, but two-year totals were similar between the two species.
- Mortality was lower on sites with meta-sedimentary parent material (also in alluvium for western larch), while alluvium generally was the most favorable to both diameter and height growth of both species.

# Results II

- Both mortality and growth were greater for seedlings from genetically superior seed orchards compared to wild collected, but gains in growth were small in size.
- Mortality was understandably lower for seedlings with larger containerized rooting volume (220-250 ml), but their growth also was lower.

| | Douglas-fir | | | western larch | | |
|---|---|---|---|---|---|---|
| | 80-90 | 110-164 ml | 220-250 | 80-90 | 110-164 ml | 220-250 |
| **1st year mortality** | 8.1% | 3.7% | 2.1% | 11.4% | 5.2% | 2.8% |
| **2nd year mortality** | 9.3% | 7.6% | 1.8% | 11.5% | 5.5% | NA |
| **diameter growth (**mm $yr^{-1}$**)** | 2.8 | 3.2 | 2.8 | 3.6 | 4.1 | 1.7 |
| **height growth (**cm $yr^{-1}$**)** | 6.9 | 10.2 | 10.6 | 18.9 | 22.4 | 12.9 |

# Results III

- Root growth potential was not found to be significantly related to seedling growth and mortality. It may be more influential on poorer quality sites.
- Temperature and precipitation played imperative roles in seedling growth and mortality. Greater precipitation greatly improved both diameter and height growth, while increased number of precipitation days lowered both growth and mortality.

# Thank you
# &
# Questions?