



Center for Advanced Forestry Systems
2020 Annual Meeting Project Final Report



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PROJECT ID: CAFS.19.77

PROJECT TITLE: INTERN: Gains from advanced genetics western larch across the Inland Northwestern United States

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PROJECT DESCRIPTION: The current study utilized annual measurements of over 15,000 seedlings beginning immediately after planting to evaluate growth and mortality of planted interior Douglas-fir (*Pseudotsuga menziesii* var. *glauca* [Mayr] Franco) and western larch (*Larix occidentalis* Nutt.) seedlings in northern Idaho and eastern Oregon for the first two years. These two species were selected since they are the most widely planted species in the region. These data included geographically referenced measurements of individual seedlings and vegetation cover surrounding each seedling, which enabled assessment of factors commonly considered influential on seedling growth and mortality, e.g., morphological attributes like height, root collar diameter, containerized rooting volume, and RGP, as well as site conditions and competition. Available site factors included topography, soil parent material, volcanic ash depth, and weather conditions. In addition, nursery and seedlot origin of seedlings was also available, including whether seeds were wild collected or from seed orchards and thus genetically improved for growth potential.

HYPOTHESES or OBJECTIVES: Specific objectives of this study were to: 1) assess the effects of the various factors described above on pre-establishment growth and mortality of planted interior Douglas-fir and western larch seedlings; 2) predict pre-establishment seedling growth and mortality using significant and influential factors from the assessment; and 3) compare specific differences between Douglas-fir and western larch and provide specific management suggestions. We hypothesized that precipitation would play a highly critical role in pre-establishment seedling growth and mortality. In addition, growth and mortality likely would vary considerably between seedlings originating from different seedlots and nurseries, with a trade-off between growth and mortality. Finally, there was an expectation that the above patterns hold for both Douglas-fir and western larch but differ in magnitude. Predictions based on this evaluation will be easily integrated into existing tree-level growth and yield models, while also filling in a missing link of pre-establishment seedling growth and mortality.

METHODS: Initial and subsequent annual measurements of seedling dimensions and surrounding interspecific competition were compiled from multiple field studies initiated between 2016 and 2019. The database included over 25,000 seedlings from 64 sites across northern Idaho and one in eastern Oregon, with 15,310 seedlings from 50 sites that were Douglas-fir and western larch. The data come from a fully randomized incomplete block design. Each site is an experimental block that comprised a portion of the combinations of treatments of several factors. These factors included nursery and seedlot, where seeds were either from seed orchards (i.e. improved for enhanced growth) or collected from natural stands. Additionally, the type of soil parent material and volcanic ash depth at each site were retrieved a posteriori and tested as a level of blocking across sites. There were over a thousand unique combinations of seedlot, nursery, soil parent material, and volcanic ash depth. To ensure sufficient sample sizes while utilizing a number of potential predictors, seedlings from seedlots or nurseries with ≤ 50 seedlings were excluded from our analysis, which resulted in a reduced total sample size of 13,701, of which 4,753 were Douglas-fir and 8,948 were western larch. In addition, all seedlings in this study were grown in containers, mostly in 91/130 Styroblock® containers (Beaver



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Plastics, Ltd., Acheson, AB) with 130 ml rooting volume. Seedling measurements included root collar diameter (mm) and height (cm) shortly after planting and at the end of each growth season (Table 1), when individual mortality was also recorded. Interspecific competition cover was measured within a 0.25-m² square around each seedling during the growing season. Total vegetation was divided into functional groups, including graminoids, forbs, shrubs, and ferns each at a scale of 0-100%. The sum of these four types of vegetation was used as a metric of total competition with a potential range of 0-400%. Observed interspecific competition was relatively low due to pre-planting chemical site preparation. If a seedling was missing or browsed, it was excluded from our analysis. Separate models were determined for first and second year mortality, as well as annual root collar diameter and height growth for both Douglas-fir and western larch seedlings. Selection of variables in these models was based on significance and size of parameter estimates, as well as biological expectations.

MAJOR FINDINGS:

- Observed mortality was lower for Douglas-fir (3.7%) than western larch (5.3%) in the first year. However, mortality of Douglas-fir doubled to 7.5%, which exceeded the 5.6% mortality of western larch in the second year
- Root collar diameter generally had the largest effect on mortality in both years with lower mortality for larger diameter seedlings.
- In the first year, diameter and height had larger effects on mortality of western larch, which generally was slimmer and taller than Douglas-fir, while survival of Douglas-fir was more sensitive to weather conditions.
- Scale of the effects of various variables on mortality became highly similar in the second year between the two species.
- Competing vegetation had a minimal effect on mortality in both years for both species
- Seedling mortality varied greatly across nurseries and seedlots with Douglas-fir and western larch annual mortality ranged from 0.0 to 14.7% and 3.2 to 11.0%, respectively, across nurseries, as well as 0.0 to 9.4% and 0.0 to 15.7%, respectively, across seedlots
- Western larch had higher rates of observed root collar diameter growth (4.1 vs. 3.1 mm yr⁻¹) and height growth (22.0 vs. 10.0 cm yr⁻¹) than Douglas-fir in the first two years after planting
- Precipitation, as well as initial diameter and height were the most influential predictors of growth
- Diameter and height growth was less variable than mortality across nurseries, seedlots, soil parent material and volcanic ash depth, containerized rooting volume, and genetic improvement

DELIVERABLES: Technical manuscript drafted and submitted, while final report and presentation given at 2020 CAFS IAB meeting.

MEMBER COMPANY BENEFITS:

- Developed seedling growth and mortality models that are readily consistent and aligned with the architecture of current individual tree growth and yield models, which can extend these models' coverage to seedlings before establishment, and consequently allow these models' applicability to full rotations
- Identified influential factors and specific differences in pre-establishment seedling growth and mortality provide critical information and guidance to the increasingly important reforestation practice of planting in the Inland Northwest and other regions where plantation forestry is common



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