Northwest Reforestation Workshop: Choosing plant materials suited to current and future climates

Case study: Post-fire ponderosa pine reforestation in central Washington

USDA Northwest Climate Hub
U.S. DEPARTMENT OF AGRICULTURE

Management goals | Maintenance of forest productivity, carbon storage, and wildlife habitat; comparison of performance of four seed sources from different source climates

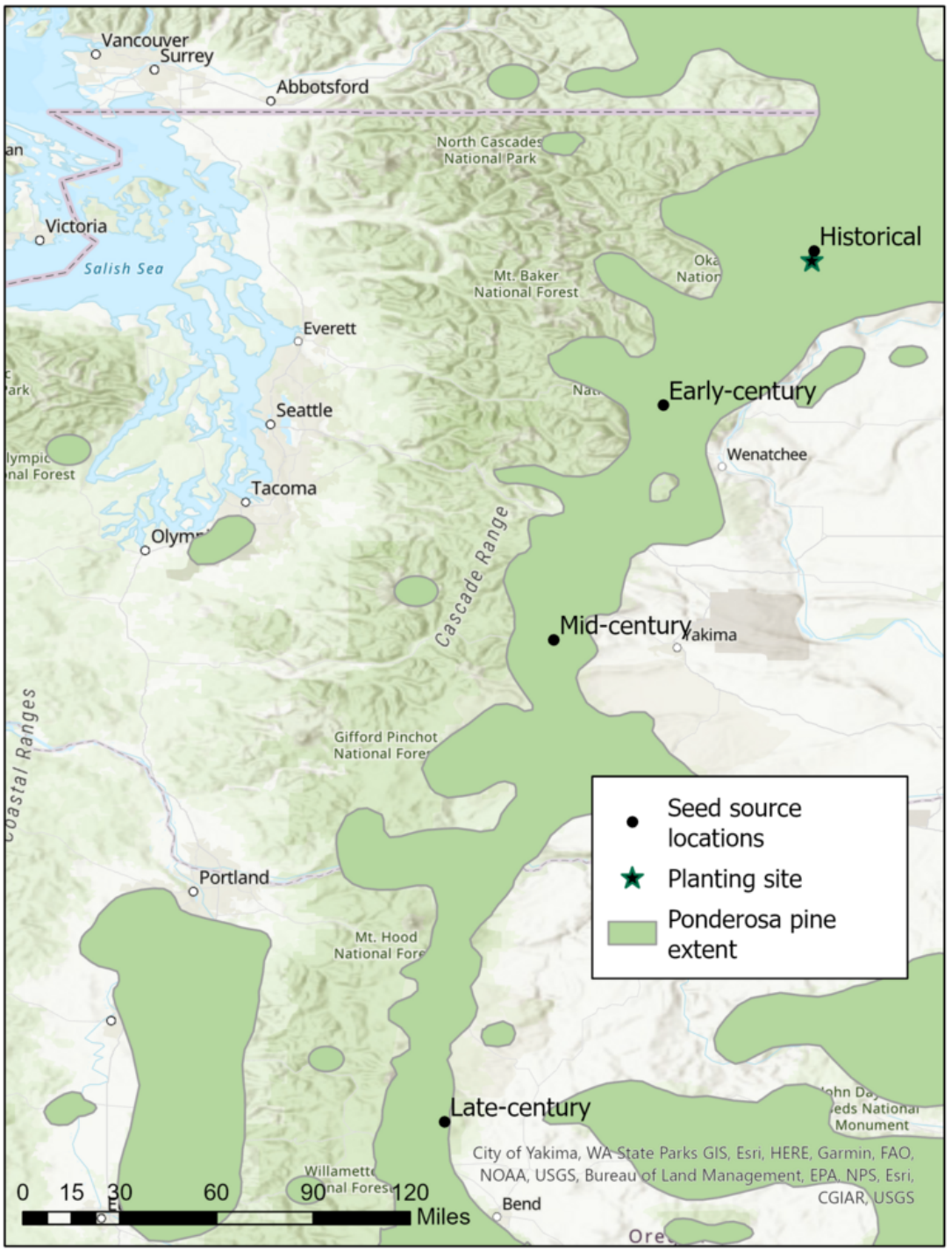
Audience | Forest managers and silviculturists

Project leads | Andrew Bower, Climate Adaptation Specialist, US Forest Service Office of Sustainability and Climate; Claire Ellwanger, Eastern Washington Zone Geneticist.

Project area | Okanogan-Wenatchee National Forest, central Washington

Organization | US Forest Service National Forest System Pacific Northwest Region

Funding sources | Internal funds from the forest and region



Planting site on the Okanogan-Wenatchee National Forest and seed source locations for four populations of ponderosa pine adapted to the site's historical (1961-1990), early-century (2011-2040), mid-century (2041-2070), and late-century (2071-2100) climate conditions.

Site Context

The planting was conducted within the burn scar of the Carlton Complex Fire, near Loup Loup Summit east of Twisp, Washington. The Carlton Complex Fire burned across more than 250,000 acres during the summer of 2014 and included a substantial component of high-severity burned area. One severely burned stand, located on the Methow Valley Ranger District of the Okanogan-Wenatchee National Forest, was selected as the planting site. The site sits at 3,800 feet elevation, receives an average of 18.7 inches of precipitation annually, and winter and summer temperatures average 25° F and 61° F, respectively. Prior to burning in 2014, the stand was dominated by ponderosa pine (*Pinus ponderosa*), an important species for maintenance of forest productivity, carbon storage, and wildlife habitat east of the crest of the Cascade mountains. The pre-fire stand likely contained minor components of Douglas-fir (*Pseudotsuga menziesii*), western larch (*Larix occidentalis*), and Engelmann spruce (*Picea engelmannii*). However, ponderosa pine was the only species targeted for this planting because it has relatively high drought tolerance and resistance to high-severity fire, traits which will be necessary to survive future climate conditions. Additionally, this site was planted as a research site to compare the performance of four ponderosa pine seed sources adapted to different source climates.

Site photo taken one year after planting, fall 2022. This planting site was burned in a wildfire and salvage logged before it was planted with ponderosa pine seedlings adapted to different climates. Photo credit: Andrew Bower, USFS

Implementation

The Seedlot Selection Tool was used to select the four planted seed sources. The seed sources were selected to reflect the historical local climate (1961-1990), and future projected climates under a high greenhouse gas emissions scenario (representative concentration pathway 8.5) for early (2011-2040), mid (2041-2070), and late-century (2071-2100, Table 1). Seedlots were assumed to be adapted to their respective historical local climate (1961-1990). The default climate variables were used: mean cold month temperature (MCMT) and summer heat-moisture index (SHM). None of the additional constraints available in the Seedlot Selection Tool were applied. Following the selection of appropriate seedlots, seed was sourced from the U.S. Forest Service Pacific Northwest Region existing inventory at the Bend Seed Extractory and grown at J. Herbert Stone Nursery.

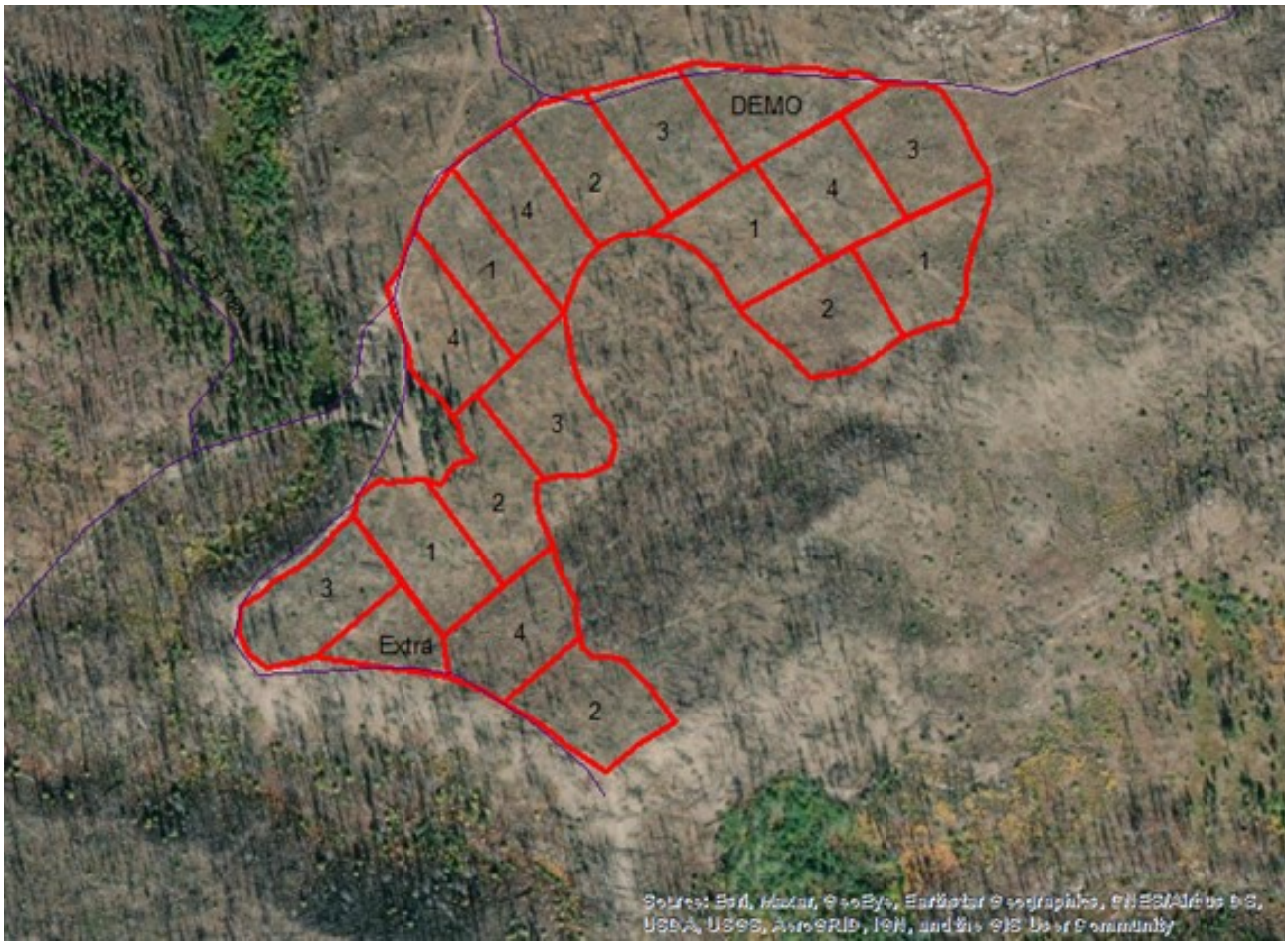
The 24-acre planting site was selected for its accessibility, relatively flat topography, and uniformly high burn severity. The planting reflected operational reforestation practices following high-severity fire and salvage logging. No additional site preparation (e.g., vegetation control) was conducted, so shrubs, graminoids, and naturally regenerating lodgepole pine (*Pinus contorta*) seedlings are present at the site, along with planted seedlings. One-year-old bare-root seedlings were planted by contract crews in the fall of 2021. Seedlings were planted at a density of 150 trees per acre, with four 1.5-acre blocks of each of the four seed sources. Shade cards were also installed next to each seedling to protect them from intense afternoon sun. Funding for this project came from the Pacific Northwest Region and the Okanogan-Wenatchee National Forest.

Table 1. Characteristics of the ponderosa pine seed sources selected for planting.

Seed source elevation	Seed Origin	Climate Period	Change in Mean Cold Month Temperature (MCMT) (°C)	Change in Summer Heat Moisture Index (SHM)
4000' – 4500'	Local seed source Zone 08014	historical/local (MCMT= -6.1 °C SHM = 96.2) (1961 – 1990)	NA	NA
3000' – 4000'	Entiat Ranger District, Okanogan-Wenatchee NF Zone 17004 ~50 mi SW of planting site	early-century (2011 – 2040)	+2.0	+52.0
< 4000'	Naches Ranger District, Okanogan-Wenatchee NF Zone 17064 ~120 mi SW of planting site	mid-century (2041 – 2070)	+3.1	+26.6
3500'- 4000'	Deschutes NF Zone 675 ~ 300 mi S of planting site	late-century (2071 – 2100)	+5.2	+33.2

Challenges and Opportunities

There were several challenges with the planning and establishment of this site. First, the selection of a seedlot location using the Seedlot Selection Tool does not always relate to available seeds in the inventory at the Bend Seed Extractory. Depleted and aging seed inventories have been a challenge within the Forest Service in recent years due to decreased harvest levels requiring fewer seed collections for reforestation. As seed required for post-fire reforestation has increased, efforts to increase seed collection capacity have begun, but have not yet met seed needs. Inventories made up mostly of older seed can have low germination rates, leading to underproduction of seedlings needed for plantings. Production of seedlings for this site was less than anticipated, leading to planting of fewer acres than planned. A further challenge for this site was that additional oversight from the project team was required to ensure that the correct seedlings were allocated to each plot. This differs from operational planting with contract crews, because being able to contrast the performance of seed sources is a key objective of this planting.



Aerial image of the planting site in 2021, where each number represents one of the four ponderosa pine seed sources planted. Credit: Andrew Bower, USFS

Future Plans

Ponderosa pine seedling with shade card one year after planting, fall 2022. Photo credit: Andrew Bower, USFS

Plans for the site include both use as a demonstration plot and for collection of detailed seedling performance data. Demonstration plots are useful for managers conducting site visits to visually compare performance of different seed sources. The project team also plans to conduct periodic monitoring of seedling survival and growth to compare performance among seed sources. Initial measurements were collected in fall 2022, one year after planting. Survival was high – between 80 and 90% – for all seed sources. However, first-year growth was greatest for the seed source that reflected the local historical climate. Additional measurements are needed to determine if these differences remain in the future; studies with other species saw major differences years after planting. Although the schedule of upcoming measurements has yet to be established, the team hopes to revisit the site at least every five years well into the maturity of the stand.