Stock Quality Targets to Increase Seedling Survival on Hotter, Drier Sites

Alternative Stocktype Options for Hot, Dry Sites

Hot, Dry Site Conditions

When a forest stand is removed, its structure and function are changed. Specifically, overstory removal alters the energy, hydrologic and nutrient cycles of the stand. These primary ecosystem functions influence the flow of resources at the restoration site (Figure 1). Seedlings planted on open restoration sites can be exposed to a 50–60°C temperature range on any day during the growing season. Dry summer season conditions are created with the combination of dry air (due to high vapor pressure deficits) and available soil water shifting from the upper soil profile (20 cm) to the lower soil profile. These changes in the energy and hydrologic cycles have a direct effect on seedling water status and gas exchange processes (photosynthesis and transpiration). Consequently, planted seedlings can exceed their physiological limits to withstand temperature and water stress during summer. These conditions are magnified in recently planted seedling because they are not fully coupled into the hydrologic cycle thereby creating greater water stress, resulting in either growth check or death.

Climate change is causing worldwide shifts in environmental conditions and is expected to have increasingly severe impacts across natural ecosystems. The International Panel on Climate Change reports that this is causing higher air temperatures, higher vapor pressure deficits and lower soil water during the growing season. These extreme environmental conditions occurred in various regions of British Columbia over the past six years. Throughout western North America, hot, dry conditions are increasing forest ecosystem vulnerability, resulting in tree mortality and uncertainty in recruitment and growth.

Forest restoration programs in western North America are challenged with rethinking and modifying their silvicultural practices to create conditions that increase seedling survival during repeated heat waves and droughts. One option is to consider new nursery cultural practices that create stocktypes maximizing seedling establishment capability immediately after planting, thereby mitigating the effects of increasingly hotter and drier sites.

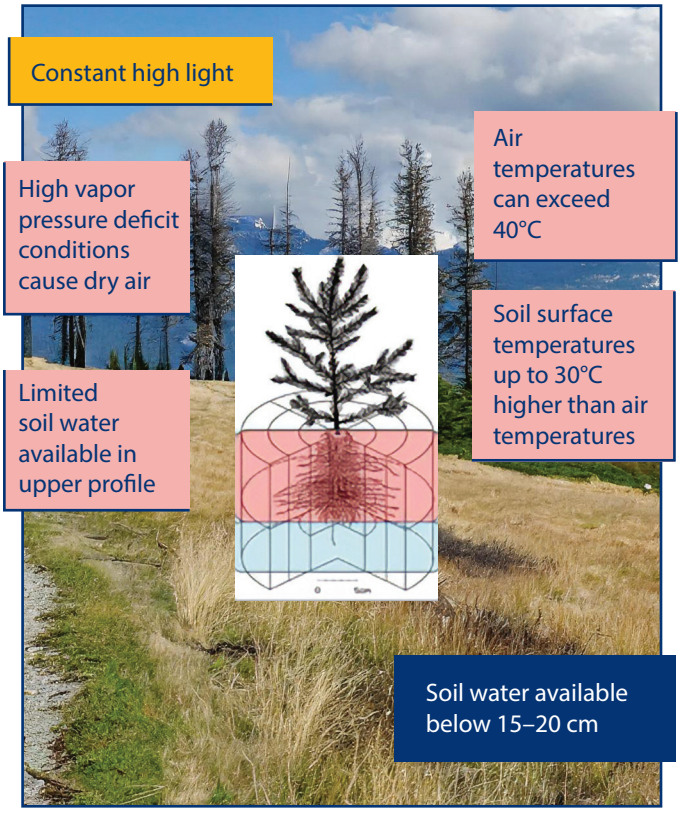

FIGURE 1. Hot, dry summer environmental conditions found on open restoration sites that can impair conifer seedling establishment on sites in western North America.

Seedling Attributes for Hot, Dry Sites

Under natural conditions, plants develop functional traits that are a trade-off between rapid biomass production and efficient resource conservation. This is why species that dominate hot, dry sites have evolved traits that confer drought resistance (e.g., root development deep into the soil profile, lower shoot-to-root ratio, improved plant water status, gas exchange and photosynthetic capability under drought conditions) that allow them to tolerate or avoid many direct effects of hot, dry site conditions.

Clear and comprehensive seedling quality information is necessary so practitioners can grow seedlings for hot, dry site conditions. By applying the Target Seedling Concept, morphological and physiological attributes are proposed, which are known to maximize seedling field performance potential under hot, dry site conditions. These attributes mirror plant functional traits of natural seedlings growing under hot, arid site conditions. An extensive review of the literature lead to the recommended stocktypes, defined by their target morphology, physiology and container cavity dimensions (Figure 2). Two stocktypes are proposed: wet-season and edge-season. The wet season stocktype is for use in the early spring- or true fall-planting, and the edge season stocktype is for use in the mid- to late spring planting.

Desired morphological and physiological attributes of the Target Seedling Stocktypes are summarized as follows, with details defined in Figure 2. First, seedlings are container-grown in deep cavities so after outplanting, root development occurs out of the plugs at depths where soil water is available late in the growing season. Second, seedlings are cultured to have optimal nutrient status and stress resistance, along with maximizing new root growth capability. Third, shoot and root systems at lift are designed to favour new root growth over new shoot growth after outplanting. The intent is to create seedlings with increased chances for improved field performance.

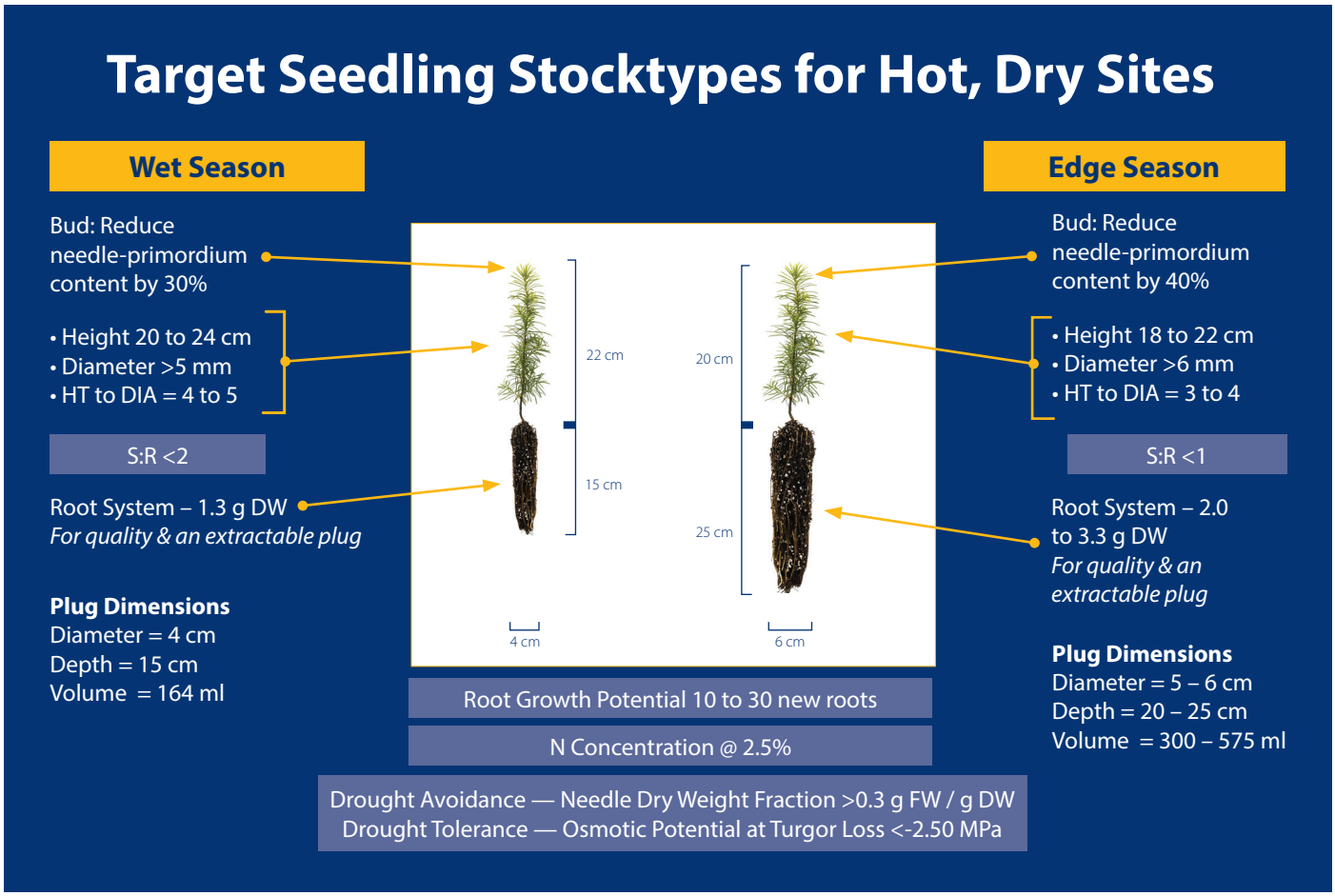

FIGURE 2. Target morphological and physiological attributes, together with plug dimensions shown to improve root-system establishment after outplanting for wet- and edge-season interior Douglas-fir stocktypes.

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For:
Forest Science, Planning and Practices Branch (2024)

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