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RESEARCH ARTICLE

Comparison of Reclamation Techniques to Re-establish Western White Pine on Smelter-impacted Hillsides in Idaho

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Abstract

In the spring of 1991, a study was initiated to identify techniques that could be used to reclaim steep hillsides at the Bunker Hill Superfund site with low pH soils and elevated concentrations of heavy metals near an old smelter site. Treatments included fertilizer to alleviate nutrient deficiencies, lime to raise soil pH, wood chips to increase organic matter content, and mulching to improve plant establishment and reduce erosion. Plots were planted to *Pinus monticola* (western white pine) seedlings alone and in combination with four species of shrubs. A mixture of eight grasses was also seeded on some plots planted to trees and shrubs to provide ground cover for erosion control. Overall, white pine survival averaged 60–80% in the best treatments after five growing seasons. The height of white pine transplants ranged between 37.1 and 69.5 cm after five years of growth across all treatments and sites which are comparable to growth rates reported elsewhere for this species. White pine survival and growth was greatest on the control, phosphorus, and lime treatments and lowest on treatments that received organic matter as an amendment primarily due to the competitive influence of herbaceous plants as opposed to any particular soil amendment. Treatments that supported high amounts of grass cover had poor white pine survival and growth, while treatments with low amounts of grass cover had high white pine survival. A combination of lime and N, P, and K fertilizer is recommended as the appropriate treatment to restore white pine in this type of environment.

Key words: **disturbance, metal toxicity, organic amendments, *Pinus monticola*, reforestation.**

Introduction

Pinus monticola Dougl. ex D. Don (western white pine) was once a dominant species in the mid-elevation forests of the inland Northwest, and was the main component of many forests in the Northern Rockies Province (Neuenschwander et al. 1999). Historically, western white pine comprised 45–55% of the volume of second-growth and mature stands in the region. By the late 1960s, the introduced fungus *Cronartium ribicola* (white pine blister rust) in conjunction with timber harvesting, mountain pine beetle outbreaks and fire exclusion, had decimated this forest type. Today, less than 10% of the historic acreage of the western white pine cover-type remains, having been largely replaced by smaller, more shade-tolerant species including *Pseudotsuga menziesii* (Mirb.) Franco (Douglas-fir), *Abies grandis* (Douglas ex D. Don) Lindl. (grand fir), and *Tsuga heterophylla* (Raf.) Sarg. (western hemlock) (Neuenschwander et al. 1999; Fins et al. 2002). In the early 1970s, the U.S. Forest Service began efforts to breed rust-resistant stock, though currently only about 5% of the estimated 5 million acres of suitable land in the Inland Northwest has been planted with rust-resistant trees (Fins et al. 2002). With rust-resistant seeds available, the major barrier to western white pine restoration is lack of suitable planting areas. Western white pine is a shade-intolerant species requiring large, open areas for establishment and survival (Klinka et al. 1984). As such, it may be an ideal species with which to reclaim lands disturbed by mining activity in the Inland Northwest.

Revegetation of smelter-impacted sites is often hampered by low soil pH, elevated metals, and loss of topsoil (Sopper 1989; Redente & Richards 1997; Kelly & Tate 1998; Chernenkova & Kuperman 1999; Redente et al. 2002; Vidic et al. 2006). Several methods have been developed to ameliorate such site conditions and enhance plant establishment and growth. Organic matter has been used as a long-term source of nitrogen on mine sites (Schoenholtz et al. 1992; Sydnor & Redente 2002; Walker 2003). Fertilizers have been widely applied to immediately mitigate nutrient deficiencies (Schoenholtz et al. 1992; Redente & Richards 1997; Redente et al. 2002; Walker 2002, 2003), while lime has been utilized to neutralize acidity on smelter-impacted sites (Redente & Richards 1997; Redente et al. 2002). Mulching (Muzzi et al. 1997; Kiikkila et al. 2001) and the planting of bareroot seedlings (Walker 2003) have also

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