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Microsite Influences on Variability in Douglas-Fir Seedling Development

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ABSTRACT

We examined the microsite characteristics of 6,048 Douglas-fir seedlings at three regeneration sites in Washington state. Our objective was to determine the microsite characteristics that were most influential on seedling growth change over time. We analyzed microsite influences both individually and in concert with one another through regression-based techniques. Microsite parameters included soil impedance, topographic, and physical parameter measurements that were recorded at each seedling's location. Akaike's information criterion (AIC) was used to determine combinations of microsite parameters that were most strongly correlated with seedling growth. Multiparameter models explained between 15 and 39 percent of the variance in diameter growth. Prevalent terms from the strongest multiparameter models included soil penetration, log presence, stump presence, skid road presence, and topography. Individual microsite parameters for each regeneration site were also assessed for importance in explaining diameter growth using two additional methods. The first approach was to isolate the parameters that appeared in the strongest multiparameter models and to sum and contrast the AIC weights of all models in which they appeared. The second approach was to regress single parameters against seedling diameter growth. Results varied by site for both methods. AIC weight sums revealed that topographical depression and berms, the presences of logs and stumps, and soil penetration (pounds per square inch) as measured by a penetrometer were most influential, with values ranging from 0.31 (berm) to 0.82 (log). Regression analysis revealed that topographical depression, log presence, and soil penetration were significantly related to diameter growth, explaining between 6 and 29 percent of the variance in diameter growth. Combined results from the three regeneration sites suggest that preferred planting locations are near berms, in the transition zone associated with skid roads, and in soil that is neither too loose nor too compacted. Results from the Randle and Orting sites indicate that planting in topographical depressions should be avoided. Results from Orting indicate that seedlings should not be placed near logs, and Randle findings suggest not planting next to stumps.

Keywords: Seedling growth, Akaike's information criterion, modeling

Tree seedling performance varies throughout forest regeneration sites in the US Pacific Northwest. Seedling performance variability can be attributed not only to tree species characteristics but also to the microsite environments that are associated with individual seedlings. Microsite environments on regeneration sites are influenced by past activities, such as harvesting, natural disturbances, site preparation, and other management and landscape conditions. Combinations of influential factors can create microsite characteristics that fluctuate at spatial extents smaller than several square centimeters (Harper 1977, Sutton 1993).

Identifying those microsite conditions that significantly influence seedling performance can provide insight into preferred site preparation and management. Past studies have attempted to define the most influential microsite characteristics but have typically considered a limited number of measured parameters. Oswald and Neuenschwander (1993) observed that microtopography (e.g., depressions and berms) and soil texture greatly influenced seedling growth. DeLong et al. (1997) found that the presence of rotten logs, berms, and exposed seedbeds were important for the establishment of white spruce (*Picea glauca* (Moench) Voss). Norway spruce (*Picea abies*) growth has been found to be stimulated by the presence of large stumps and logging slash (Jonsson 1999). Van Lear et al. (2000) discovered that the presence of stumps created a positive influence on loblolly pine (*Pinus taeda*) due to seedling ability to colonize the stump root system. Quine et al. (1991), however, found that Sitka spruce (*Picea sitchensis*) seedlings planted next to a stump showed root growth reductions due to asymmetrical root system development in response to growth barriers imposed by stumps. In addition, root growth imbalance was not compensated for on the other side of the seedling.

Soil structure is a microsite characteristic that can be easily altered by harvesting and site preparation activities with the dominant influence being soil compaction as measured by bulk density. Soil compaction influences pore-size distribution by altering the balance between aeration porosity and available water holding capacity (Siegel-Issem et al. 2005). At low levels of compaction, the balance between aeration and water holding capacity provides an ideal growing environment, as seen with ponderosa pine (*Pinus ponderosa*) (Gomez et al. 2002). As compaction levels increase, macropores, root space, and water availability decrease and result in reduced root development and therefore reduced overall tree performance (Greaten and Sands 1980, Wert and Thomas 1981, Corns 1988, Conlin and van de Driessche 1996).

Recognition of general soil and landscape characteristics that influence seedling growth can assist reforestation planning efforts by identifying preferred regeneration areas. Choosing specifically where to plant seedlings within preferred regeneration areas should be based on knowledge of the most influential microsite parameters. Consequently, identifying preferred planting locations (microsites) that can be easily discerned in the field may help tree planters locate

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