Published in proceedings of "Interior Douglas-Fir: The Species and Its Management" held February 27 – March 1, 1990 in Spokane, WA, USA.
Compiled and edited by D.M. Baumgartner and J.E. Lotan, Washington State University Extension, Pullman, WA.
(Bulletin Office, WSU, PO Box 645912, Pullman, WA 99164-5912.) MISC0230. 301 pp.

MICROSITE ENVIRONMENTS AND THEIR EFFECT ON PLANTED DOUGLAS-FIR SEEDLINGS IN NORTHERN IDAHO

Jonalea R. Tonn and Russell T. Graham

ABSTRACT

Microsite environments are one of the most crucial factors affecting seedling performance, and selecting favorable microsites can mean the difference between success or failure of seedlings and, thus, the plantation. Ideally, microsites should provide not only conditions that enhance seedling survival, but also conditions that encourage superior growth compared to any immediate competing vegetation.

Choosing desirable microsites for planting has the potential of improving both short-term and long-term site productivity. Various microsite characteristics including shade, burn intensity, competing vegetation, soil wood, and woody residue were evaluated as potential predictors of favorable microsites for Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco). This paper presents criteria that will enable land managers and tree planters to better recognize favorable microsites and to select planting microsites favorable to first-year seedling performance.

Keywords: site preparation, seedling, biomass, survival

INTRODUCTION

In 1940, Schopmeyer stated that although forest planting had been carried on for more than a quarter of a century in the Northern Rocky Mountain Region, the ultimate in planting practice had not yet been attained. Today, 50 years later, there is still room for improvement, and successful forest plantations in northern Idaho are a continuing goal of those involved in regeneration.

When forest land managers plan for reforesting an area they have more at stake than just planting seedlings. Their actions will have a bearing on site productivity for many years. The managers' prime concern is to produce a healthy, rapidly growing tree. Several ways of accomplishing this include choice of silvicultural system, site preparation, stock characteristics, and selection of a favorable microsite for the planted seedling (Greaves 1978).

Site preparation practices can be detrimental to forest sites and productivity. Thus it is important that forest land managers create microsites that enhance seedling establishment and growth (Rainville 1987). Planting in favorable spots can simplify the planting process by eliminating the need for site preparation in addition to slash disposal.

Tree planters have the opportunity to select the best available microsite if they are given the knowledge necessary to make a sound ecological decision (Hite 1976). The key here is being able to make the right choice. Once microsites have been created it becomes the land manager's responsibility to present the tree planter with guidelines for choosing the best available planting spot, i.e., the one that will offer the seedling the best conditions for performance based on survival, growth, and biomass production.

Limited research has been conducted on planting microsites and their effect on tree survival, growth, and biomass production. Schopmeyer (1940) reported that good planting sites such as in the shade of logs or stumps were not being used by planters. Live shade may increase moisture competition, intensify animal damage, and weaken seedlings with respect to falling litter (Newton 1973; Hite 1976). Gutzwiler (1976) noted there were widely varied and conflicting research results on the effect of shade on performance of planted seedlings. During extremely dry planting conditions on a study site in New Mexico, Douglas-fir survival rates were doubled when seedlings were planted in the shade of shrubs when compared to those planted in the open (Coffman 1975). Coffman (1975) pointed out that even though first-year survival increased when planting under shrubs, it does not necessarily follow that long-term survival will increase. However, future growth hinges on seedlings being able to survive the first year. In 1955, Roy cautioned planters to avoid planting seedlings next to unbarked logs for fear the bark would eventually slip off and crush the seedling. In 1976, Weadick recommended that, when possible, trees should be planted on the north or east side of logs, stumps, brush piles, chunks of wood, rocks, and brush patches to take advantage of existing shade. Selter and Pitts (1986) studied microsites and seedling survival of Shasta red fir (*Abies magnifica* A. Murr.) and found that seedling survival was greater on artificially shaded plots than on similar plots that were not shaded but were left exposed to the sun.

After analyzing test results of Sitka spruce (*Picea sitchensis* [Bong.] Carr.) in Alaska, Shaw *et al.* (1987) suggested that exposed mineral soil be avoided during planting because of problems with frost heave. They felt that in addition to lowering early survival rates, frost heave may reduce stability of trees later due to malformed rooting. In addition, they believe that some improvement in early height growth and survival may be obtained by planting in undisturbed duff, particularly near stumps.

In 1987, Flint and Childs assessed the effects of soil surface shading and mulching treatments and two vegetation control techniques on soil temperature, availability of soil water, and growth of bareroot Douglas-fir seedlings in Oregon. First-year growth data showed no statistical difference among treatments; however, significant differences were measured in the second year. They attributed this to a combination of effects of nursery

Published in proceedings of "Interior Douglas-Fir: The Species and Its Management" held February 27 – March 1, 1990 in Spokane, WA, USA.
Compiled and edited by D.M. Baumgartner and J.E. Lotan, Washington State University Extension, Pullman, WA.

(Bulletin Office, WSU, PO Box 645912, Pullman, WA 99164-5912.) MISC0230. 301 pp.

conditions and transplanting stresses on first-year outplanted seedlings. Flint and Childs (1987) concluded that treatments that increase microsite water use efficiency may increase seedling survival beyond standard shading techniques by allowing enhanced seedling growth.

When soil moisture is severely limiting, even minor amounts of competing vegetation have an effect on seedling survival and growth. Grasses often have massive root systems, which rapidly occupy the rooting zone and deplete soil moisture. This in turn leads to reduced growth or death of the seedling (Barber 1984).

From research in central Idaho, Geier-Hayes (this proceedings) concluded that while Douglas-fir regeneration appears to be favored by vegetative protection on many habitat types, not all vegetative species are good covers; e.g., graminoids and forbs do not provide good cover.

In the Inland Northwest, planting success has been judged mostly on early survival. In turn, attention to survival has brought about major improvements in nursery practice and stock handling as well as in site preparation and planting practice (Wellner 1976). Survival can be further enhanced by addressing the issue of microsite selection which is one of the most crucial factors affecting seedling performance.

Many microsite surface conditions come into play with a newly planted seedling. Our study was designed to investigate the effects of various microsite conditions on first year survival and biomass production of Douglas-fir. Another objective was to identify predictors of favorable microsites such that they could be used by tree planters.

SITE DESCRIPTION

The study is located on the Deception Creek Experimental Forest, which falls within the boundaries of the Fernan Ranger District of the Idaho Panhandle National Forests. The site is at an elevation of 3,800 feet. Aspects are southeast and northeast with some short ridges present. Slope ranges from 30-45%. The habitat type is *Tsuga heterophylla/Clintonia uniflora* (Cooper *et al.* 1987). The soil is a Typic Vitrandept with Eutric Glossoboralf inclusions. The type is characterized by moderately deep, medium textured residual material with low to moderate dissection, meta-sedimentary bedrock and steep slopes. Average annual precipitation is 55 inches with a mean annual temperature of 47°F (Finklin and Fischer 1987).

SITE HISTORY

Prior to 1983 the site was occupied by a 100-year-old defective stand of western hemlock (*Tsuga heterophylla* (Raf) Sarg.), grand fir (*Abies grandis* (Dougl.) Lindl.), and western white pine (*Pinus monticola* Dougl.). In 1983 the stand was clearcut, and in 1984 it was broadcast burned with a moderate burn intensity (see Ryan and Noste 1982 for an explanation of fire severity classes).

STUDY ESTABLISHMENT

Douglas-fir seed was collected locally and seedlings were grown for one year in 8 inch plastic containers at the Coeur d'Alene Nursery, Coeur d'Alene, Idaho. A total of 1,200 Douglas-fir seedlings were planted during the second week of September 1985. Seedlings were planted using systematic random placement, with 8-foot spacings. To guarantee uniformity in planting, the same tree planters were used throughout the study. Planting sites included small concentrations of organic matter, cleared areas, and undisturbed sites.

METHODS

In 1986, 60 seedlings were chosen at random at 4 week intervals for a total sample of 240 seedlings. A microsite plot was delimited by placing a 12-inch diameter circular metal plot frame over the seedling with the seedling as the plot center. Microsite descriptions were recorded for each seedling. Ocular estimates were made for percentage of vegetative cover, shade, burned surface, soil wood, position of the microsite in relation to the immediate area, and general microsite description. Both cover type and percentage were recorded on each microsite. Soil wood was defined as wood in the process of being incorporated into the soil, going to a depth of at least 1/2 inch, and penetrable by seedling roots.

Woody residue was quantified as to type, amount and size of residue pieces that intersected the plot circumference.

Any shade cast on the seedling during the hours of 1000-1400 hours and from a distance of less than 15 feet from the microsite was recorded. Objects casting shade included stumps, shrubs, or rocks.

Burn intensity was initially recorded as slight, severe or extreme. Because the entire study had been subjected to a fairly even moderate burn, we eventually simplified the description to two categories—burned or not burned.

Woody residue decay condition was categorized as new (previous year's), incipient (beginning to decay), or advanced (severely decayed). In addition to recording type of residue, the number of times residue fell across the plot circumference was recorded as well as the cumulative diameter of the individual residue pieces.

Position of the microsite in relation to the immediate surroundings was recorded with respect to location—on ground level, above ground level, or below ground level. A "first impression" of the microsite was recorded to describe three general surface conditions—litter, mineral soil, or rocky soil.

After the microsite description was completed, each seedling that served as the plot center was dug up with a shovel. Care was taken to keep the root system intact and minimize stripping of the new roots. Seedlings were placed in plastic bags inside an ice chest and transported to the Forestry Sciences Laboratory in Moscow, Idaho. The root system was carefully washed to remove any soil particles. Both the root system and the shoot were oven dried at 140°F for 24 hours and then weighed to obtain the total weight of the seedling.

RESULTS AND DISCUSSION

Seedling survival was 85% at the end of the first growing season. The dry 1986 summer created ideal conditions to test seedling survival. The weather during the planting operation was optimal, but by late October an early winter with temperatures below freezing had set in. Seedlings may not have

Published in proceedings of "Interior Douglas-Fir: The Species and Its Management" held February 27 – March 1, 1990 in Spokane, WA, USA.
Compiled and edited by D.M. Baumgartner and J.E. Lotan, Washington State University Extension, Pullman, WA.
(Bulletin Office, WSU, PO Box 645912, Pullman, WA 99164-5912.) MISC0230. 301 pp.

had time to acclimate to the lower soil temperatures. The issue of spring planting versus fall planting may have a bearing on survival. When stock performance comparisons were made between containerized and bareroot seedlings, Hahn and Smith (1983) found that containerized seedlings maintained higher survival rates on both a warm south slope and a moist, cool north slope than bareroot seedlings.

To assess seedling performance in relation to various microsite conditions, we divided the seedlings into four performance groups based on their total weight. Total weight was used as the measure of seedling performance. Groups one and two represented the best performing seedlings and groups three and four represented the poorest performing seedlings.

Once the performance groups were determined, a two-way frequency procedure was used with performance compared to each of the individual microsite surface conditions.

Using the results from the frequency tables, a subjective ranking was assigned to each microsite condition. If a condition described a microsite of a seedling in one of the two highest performance groups, the descriptor was given a + rank. If it described a microsite of a seedling in one of the two lowest performance groups the descriptor was given a - rank. Neutral ranks were assigned if a descriptor was evenly distributed in all performance groups (Table 1). The most desirable surface conditions were burn, soil wood, and shade (cast by a log), while the undesirable surface conditions were rocky soil, moss, grass, shade (cast by stumps or shrubs), and a microsite position on the ground level. As one might expect, grass was not a desirable condition most likely because of the competition it provides for soil moisture. Because the broadcast burn was of a moderate intensity, it created more favorable microsite conditions than a high intensity burn which would have resulted in more vegetative competition especially from *Ceanothus*. The moderate intensity burn did not destroy the surface organic layers which have been shown to be important for microsite activities and nutrient cycling (Harvey *et al.* 1987). Table 2 summarizes the most desirable, least desirable, and neutral microsite conditions based on the +, -, and neutral ranks.

Harvey *et al.* (1987) have observed that despite prolific rooting of conifers in soil wood, few roots of other plants are found. This fact led them to believe soil wood may provide a selective substratum for conifer roots. Both mineral soil and decayed wood rooting substrates have important physical characteristics. Mineral soil acquires and loses moisture rapidly, has low moisture and nutrient storage capacity, and changes temperature rapidly. In contrast, decayed wood acquires and loses moisture slowly, has high moisture storage capacity, and changes temperature slowly (Harvey 1982).

The microsites above ground level were usually high in organic matter which provided nutrients and a favorable rooting environment, but they had a tendency to dry out because of the unconsolidated nature of the material. The sites below ground level were caused by logging activities and often had displaced soils.

Mean number and mean diameter of the woody residue pieces were calculated for the three woody residue categories. To evaluate the merits of woody residue, a volume figure was calculated by multiplying the mean number of residue intercepts along the plot circumference times the mean diameter (Table 3). For both new and incipient residue, the most volume was found in the best performance groups (groups one and two combined) compared to the poorest performance groups (groups three and four combined). As far as advanced decay residue was concerned, little of the residue had decayed to that stage yet, but the new and incipient decay residue will eventually fall into the advanced category.

The descriptors that were ranked + and - from the 1986 data were used as predictors in a model to see if data collected in 1987 and 1988 had the same characteristics for desirable microsites (Table 4). In 1987, all performance groups had a larger percentage of desirable microsites than undesirable microsites. The same trend held true in 1988. When comparing within performance groups, the highest percentage of desirable sites in 1987 were in the best performance groups. The comparison of the 1986, 1987, and 1988 results reveals that microsites become less important in the second and third growing seasons.

Table 1.—Rankings of microsite surface conditions, based on seedling performance.

Surface condition	Rank
Cover (%)	
Soil wood	+
Moss	-
Grass	-
Shrubs	N
Burn	+
Shade	
Log	+
Stump	-
Shrub	-
Position	
On ground level	-
Above ground level	N
Below ground level	N
General Description	
Rocky soil	-
Litter	N
Mineral soil	N

Table 2.—Microsite predictors, based on surface conditions.

Desirable	Undesirable	Neutral
Burn	Moss	Litter
Soil wood presence	Grass	Shrubs
Shade (log)	Rocky soil	Mineral Soil
	Shade (stump)[1]	Position (above ground level)
	Shade (shrub)[1]	Position (below ground level)
	Position (on ground level)	

[1]Shade from stumps or shrubs cast over the seedling from outside the microsite plot.

Published in proceedings of "Interior Douglas-Fir: The Species and Its Management" held February 27 – March 1, 1990 in Spokane, WA, USA.
Compiled and edited by D.M. Baumgartner and J.E. Lotan, Washington State University Extension, Pullman, WA.

(Bulletin Office, WSU, PO Box 645912, Pullman, WA 99164-5912.) MISC0230. 301 pp.

Table 3.—Residue volume for microsite plots.

Seedling performance[1] group	Mean no.	Mean diameter (cm)	Volume
		New Residue	
1	0.52	0.91	0.47
2	0.75	2.17	1.63
3	0.66	1.63	1.08
4	0.56	1.41	0.80
		Incipient Residue	
1	0.10	1.41	0.14
2	0.08	0.37	0.03
3	0.05	0.17	0.01
4	0.05	0.36	0.02
		Advanced Residue	
1	0.00	0.00	0.00
2	0.00	0.00	0.00
3	0.02	0.08	0.002
4	0.03	0.07	0.002

[1]Based on total seedling weight.

Table 4.—Distribution of 1987 and 1988 seedlings by performance group in desirable and undesirable microsites as defined by 1986 criteria.

Seedling performance[1] group	Desirable	Undesirable
	——————percent——————	
	1987	
1	87	13
2	73	27
3	67	33
4	57	43
	1988	
1	58	42
2	75	25
3	58	42
4	82	18

[1]Based on total seedling weight.

CONCLUSIONS

Even though these results are from the first field growing season, there is an adequate data base to provide some useful rules to reinforce some previous theories. After the first growing season, the microsites that were the most desirable, based on seedling biomass, were burn, presence of soil wood, and shade cast by a log. Any one of these conditions alone or in combination would provide Douglas-fir in northern Idaho with a favorable microsite.

When soil wood is available, it is desirable to plant near it. Forest land managers should keep in mind Harvey's (1982) recommendation "when planting, place seedlings near a source of organic matter (decayed wood). Because of the difficulty of getting the seedling properly 'heeled in' do not plant directly in deep layers of organic matter."

Some schools of thought hold that microsites suited for early survival and performance may not be best for later development and that a seedling may outgrow its original microsite. While there is a strong possibility that a seedling will outgrow its original microsite, in many cases a prime concern is to provide the seedling with optimal conditions in its first year in order to ensure survival.

LITERATURE CITED

Barber, H. W., Jr. 1984. Effects of site preparation on survival and moisture stress of interior Douglas-fir seedlings planted in grass. Tree Planters' Notes. 35(4):7-10.

Coffman, M. S. 1975. Shade from brush increases survival of planted Douglas-fir. J. For. 11:726-728.

Cooper, S., K. Neiman, R. Steele and D. Roberts. 1987. Forest habitat types of northern Idaho. Gen. Tech. Rep. INT-226. Ogden, UT: USDA Forest Service, Intermountain Research Station. 135 pp.

Finklin, A. I. and W. C. Fischer. 1987. Climate of the Deception Creek Experimental Forest, northern Idaho. Gen. Tech. Rep. INT-226. Ogden, UT: USDA Forest Service, Intermountain Research Station. 76 pp.

Flint, L. E. and S. W. Childs. 1987. Effect of shading, mulching and vegetation control on Douglas-fir seedling growth and soil water supply. For. Ecol. and Manage. 18:189-203.

Greaves, R. D. 1978. Planting and seeding. *In:* Cleary, Brian D., R. D. Greaves, R. K. Hermann, eds. Regenerating Oregon's forests. A guide for the regeneration forester; Corvallis. Oregon State Univ. Extension Service. p. 99-134.

Gutzwiler, J. R. 1976. Mechanical site preparation for tree planting in the inland Northwest. *In:* Baumgartner, David M. and R. J. Boyd, eds, Proceedings—tree planting in the Inland Northwest: February 17-19, 1976: Pullman. Washington State Univ. Cooperative Extension Service. p. 117-133.

Hahn, P. F. and A. J. Smith. 1983. Douglas-fir planting stock performance comparison after the third growing season. Tree Planters' Notes. 34(1):33-39.

Harvey, A. E. 1982. The importance of residual organic debris in site preparation and amelioration for reforestation. *In:* Baumgartner, David M., ed. Proceedings—site preparation and fuels management on steep terrain; February 15-17, 1982, Spokane. Washington State Univ. Cooperative Extension Service, Pullman. p. 75-85.

Harvey, A. E., M. F. Jurgensen, M. J. Larsen and R. T. Graham. 1987. Decaying organic materials and soil quality in the Inland Northwest: A management opportunity. Gen. Tech. Rep. INT-225. Ogden, UT: USDA Forest Service, Intermountain Research Station. 15 pp.

Hite, W. A. 1976. Selecting an optimum planting microsite. *In:* Baumgartner, David M. and R. J. Boyd, eds. Proceedings—Tree planting in the Inland Northwest: February 17-19, 1976, Pullman. Washington State Univ. Cooperative Extension Service. p. 177-184.

Newton, M. 1973. Environmental management for seedling establishment. Res. Pap. 16. Oregon State Univ., Forest Research Laboratory. 5 pp.

Published in proceedings of "Interior Douglas-Fir: The Species and Its Management" held February 27 – March 1, 1990 in Spokane, WA, USA.
Compiled and edited by D.M. Baumgartner and J.E. Lotan, Washington State University Extension, Pullman, WA.
(Bulletin Office, WSU, PO Box 645912, Pullman, WA 99164-5912.) MISC0230. 301 pp.

Rainville, S. C. 1987. Effect of microsite preparation on the development of conifer seedlings in northern Idaho. MS Thesis. Univ. of Idaho, Moscow. 67 pp.

Roy, D. F. 1955. Don't plant close to unbarked logs! Forest Research Note 101. Berkeley: USDA Forest Service, California Forest and Range Exp. Sta. 1 pp.

Ryan, K. C. and N. V. Noste. 1982. Evaluating prescribed fires. *In:* J. E. Lotan, B. M. Kilgore, W. C. Fischer, R. W. Mutch (tech. coord.), Symposium and workshop on wilderness fire. Symposium proceedings, Missoula, MT, November 15-18, 1983. Gen. Tech. Rep. INT-182. Ogden, UT: USDA Forest Service, Intermountain Research Station. p. 230-238.

Schopmeyer, C. S. 1940. Survival in forest plantations in the Northern Rocky Mountain Region. J. For. 38:16-24.

Selter, C. M. and W. D. Pitts. 1986. Site microenvironment and seedling survival of Shasta red fir. The American Midland Naturalist. 115(2):228-300.

Shaw, C. G., III, R. C. Sidle and A. S. Harris. 1987. Evaluation of planting sites common to a southeast Alaska clearcut. III. Effects of microsite type and ectomycorrhizal inoculation on growth and survival of Sitka spruce seedlings. Can. J. For. Res. 17:334-339.

Weadick, M. E. 1976. Contract planting. *In:* Baumgartner, David M. and R. J. Boyd, eds, Proceedings—tree planting in the Inland Northwest: February 17-19, 1976, Pullman. Washington State Univ. Cooperative Extension Service. p. 267-273.

Wellner, C. A. 1976. The reforestation situation. *In:* Baumgartner, David M. and R. J. Boyd, eds, Proceedings—tree planting in the Inland Northwest: February 17-19, 1976, Pullman. Washington State Univ. Cooperative Extension Service. p. 1-9.

Authors

Jonalea R. Tonn
Forester
Intermountain Research Station
Moscow, ID 83843

Russell T. Graham
Research Forester
Intermountain Research Station
Moscow, ID 83843