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Container Seedling Planting With Manual Microsite Preparation for Species Restoration

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Difficulties in achieving good soil-root contact when planting container seedlings in undisturbed forest soils containing living roots resulted in the adaption of a manual microsite preparation technique using heavy tree-planting spades. Microsites that were an admixture of mineral and organic soils, were produced on boot-screefed spots by repeated vertical insertion of the spade at various angles. Shortrooted container seedlings planted in these microsites on hardwood strip cuts resulted in good survival and growth. Tree Planters' Notes 47(2):58-61; 1996.

Human activities combined with natural disturbances have altered the species composition of large areas of eastern Canada's forest; for example,

- Harvesting practices have resulted in the conversion of red spruce *(Picea rubens* Sarg.)– balsam fir *(Abies balsamea* (L.) Mill.)– eastern hemlock *(Tsuga canadensis* (L.) Carr.) forests into balsam fir forests that are subject to massive destruction by spruce budworm (Blais 1983; Weetman 1994).

- Fires in the stem-exclusion phase of post-harvest succession often result in hardwoods such as white birch *(Betula papyrifera* Marsh.) and red maple *(Acer rubrurn* L.) dominating the site for over a century (Seymour 1992).

- Forest plantation programs on well-drained, upland, fertile, Acadian mixedwood sites have emphasized pioneer conifer species such as black spruce *(Picca mariana* (Mill.) B.S.P.) and jack pine *(Pinus banksiana* Lamb.), which cannot regenerate themselves on these sites after harvest because of intense competition from various early successional species; the resulting forest often has lowered species diversity and decreased management options.

Restoration programs have been implemented to rebuild original species assemblages and increase future management options. Restoration programs in forestry have recently included ecosystems in which only some species are missing; the goal is the reestablishment of biodiversity and the level of heterogeneity inherent in undisturbed systems (CCFM 1995; Harrington 1995). Restoration strategies may include planting to reintroduce missing species and should provide the conditions for heterogeneity to develop without predetermining which species will predominate (Noss 1994; Trombulak 1996).

Fill planting, underplanting, and gap planting have been dealt with from the standpoint of light availability for planted seedlings (Helgerson 1990) and size of planting stock (Needham and Clements 1991; St-Amour 1995); however, very few published studies deal with the mechanics of planting seedlings in these situations, where soil preparation by tillage equipment is not possible.

There has been some experimental work with rakes mounted on tracked excavators and mixing attachments for small tractors to prepare plantable microsites in forest stands that have been partially cut or treated as shelterwoods (FERIC 1996).

Planting in the absence of mechanical site preparation can be accomplished by **dughole methods** (Gordon and others 1995), however, these are laborious and very time-consuming. More common are **compression methods** (Smith 1986) by which planting slits are produced by pushing soil aside using sharp tools such as dibbles, shovels, and planting guns and **extraction methods** (Cormier 1994) by which a soil core, equivalent in size and shape to the container seedling root plug (StAmour 1996), is removed; both these methods run the risk of compacting or glazing and smearing soil on the walls of the planting hole and deforming the roots' growth and form (Balisky and others 1995).

Operational fill planting in New Brunswick cutovers, stocked at less than 60% with natural softwood regeneration, increased from 10% of the total reforestation effort in 1991 to 30% in 1993. This technique is believed to protect natural regeneration, avoid site disturbance, and increase commercial species stocking at reduced cost. However, planting has been done exclusively by compression methods in unprepared soils to produce planting holes and survival, growth, root form, and tree stability have not been assessed for this fill-planting methodology.

Evolution of a Technique

During our studies involving restoration plantings of shade-tolerant and intermediate species in areas where they had been eliminated by unsustainable harvesting practices, fire, or intensive plantation culture, most of the candidate planting sites were either too small to accommodate heavy tillage equipment or were in areas such as municipal watersheds where the use of such machinery was not allowed.

Our main experience has been in planting container seedlings with dibbles, spades, and planting guns in friable, freshly disturbed, mineral soil resulting from the use of various plows and scarifiers. We tried using these tools on undisturbed soils after boot-screefing off most of the organic horizon, but the presence of living roots of brushy vegetation and adjacent trees, as well as undecomposed roots attached to freshly cut stumps, made for problems in achieving good contact between soil compressed against the sides of the hole and the rooted plugs.

Our solution has been the use of heavy plug spades. Light boot-screefing is done so that the level of mineral soil at the base of the humus layer can be identified. The long (135 cm) wooden-handled spade is plunged through the remaining humus into mineral soil 5 to 8 times to a depth of approximately 15 cm. The blade (measuring 19 x 11.5 cm) is heavy enough (1.46 kg) that this operation is not overly tiring. The blade is rotated about 45/ at each insertion so that organic and mineral soils are mixed together to produce a patch of friable material about 15 cm in diameter. Most of the living roots in the patch are severed by this "cultivation." On the final insertion, the blade is left embedded in the mixed soil and moved back and forth in a 30/ arc to open a hole for inserting the rooted plug. Short-rooted plugs (6 to 8 cm long) from PANTH and Jiffy container systems are easier to insert than longer rooted plugs from various multipot container systems. Loose soil is pulled around the rooted plug by hand and pressed in place by the palm of the hand or a boot. Finally (and this is recommended with any container seedling planting method), loose organic material (leaves, needles or organic horizon materials) is swept over and around the base of the planted seedling to diminish the wicking of moisture from the exposed organic-mineral soil mixture.

Disadvantages

The planting rates achieved by people using a variety of tools on mechanically prepared soil microsites are not possible when producing spade-mixed microsites. A minimum of 30 seconds is required to find (probing with the planting spade) an area free enough from large subsurface rocks and to "cultivate" a 15-cm-diameter patch and then plant the seedling. This is in contrast to approximately 10 seconds of actual planting time when a variety of tools are used on mechanically prepared sites. Mechanical site preparation usually provides slash-free travel lanes for planters as they move from one spot to the next; this ease of movement is not possible when moving across debris-strewn cutovers.

Advantages

Manual microsite preparation can be used when planting steep slopes and partial harvest situations such as shelterwoods where tillage equipment is difficult or impossible to use. The costs of capital and energy-intensive tillage are avoided. There is little destruction of natural regenerants as manual microsite preparation produces soil disturbance on less than 1% of the ground surface at the highest planting densities. Discretionary planting is facilitated in the absence of regular planting lines produced by tillage equipment; planting spots can be chosen far enough to the south of major light competitors, such as sprouting stumps, to enhance the chances of survival and adequate growth rates. Proximity of nutrient-rich humic material and uninhibited root extension (Balisky and others 1995) is facilitated by a mixed planting spot many times the diameter of the rooted plug. Frost heaving of the seedlings, which is a problem on the large planting spots of bare mineral soil produced by mechanical tilling, can be diminished by the production of small microsites that are an admixture of mineral and organic soils (BCMF 1994).

Trial Plantation

We planted winter greenhouse-reared Jiffy '96' seedlings in July 1994 and summer greenhouse-reared seedlings, which were hardened-off and freezer-stored over winter, in May 1995. The Jiffy system uses dry mesh-enclosed peat pellets that are expanded by water soaking before seeding. The round peat plugs when fully expanded are capable of supporting free-standing seedlings that are completely air-pruned because the plugs are held together by mesh. Expanded size is 38 mm diameter and 68 mm high, with a rooting volume of about 80 cm^3; growing density is 590/m^2. Seedling characteristics at the time of field planting are shown in table 1.

Planting was done in strip cuts of several widths in white birch-red maple stands on a municipal watershed forest. The planting intervention was extensive on a very wide grid (5 by 5 m) and was designed to facilitate the study of competitor-influenced light regimes on the

Table 1— *Container seedling characteristics at planting on manually prepared microsites and field measures after several growth seasons*

Species	Strip width	Planting date	Planting height. (cm)	Planting volume (cm^3)	% Survival 8/96	Volume 8/96 (cm^3)
Red spruce	10	7/94	20.4	0.66	97	11.8
	20				83	10.1
	30				96	11.5
	10	5/95	21.4	0.86	94	5.9
	20				75	6.8
	30				83	7.0
White spruce	10	7/94	18.1	0.72	100	9.4
	20				100	10.3
	30				89	22.1
	10	5/95	22.3	0.89	100	11.5
	20				100	11.6
	30				94	13.1
White pine	10	7/94	9.5	0.50	100	14.2
	20				79	19.2
	30				100	13.0
	20	5/95	7.15	0.14	79	4.2
	30				100	9.0

growth of shade-tolerant and intermediate species. This trial will complement similar work with planted pioneer species in large clear-cuts (Salonius and others 1991). Planting in the north to south-oriented strips included positions 5 m within the uncut leave strip, the edge of the cut strip, and at 5-m intervals across the strip. The long-term goal was to reintroduce species to the Acadian mixedwood site that would ultimately produce regenerants capable of being managed by some form of partial harvest silviculture.

Preliminary Results

Field measures of seedlings, after several growing seasons, are shown in table 1. Growth of container seedlings planted on manually prepared microsites has been encouraging. Survival is similar to that achieved by the largest planting program in Canada (Johnson 1994). Growth has generally been more vigorous in the wider strips, which offer both competing vegetation and planted seedlings access to greater amounts of direct sunlight during the growing season. We are especially interested in the growth of red spruce in the wider strips. Red spruce tends to suffer from exposure and winter drying when planted in the open and we surmize that the orientation of the cut strips, perpendicular to the most damaging winter winds, has produced this result.

Conclusions

Manual mixed microsite preparation, coupled with the planting of short-rooted container seedlings, has been successful. Controlled experiments are necessary to compare the growth and survival of seedlings planted in slits produced by compression methods with growth and survival of seedlings planted using the method developed in this study.

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Literature Cited

Balisky AC, Salonius PO, Walli C, Brinkman D. 1995. Seedling roots and forest floor: misplaced and neglected aspects of British Columbia's reforestation effort? Forestry Chronicle 71(1): 59-65.

Blais JR. 1983. Trends in the frequency, extent and severity of spruce budworm outbreaks in eastern Canada. Canadian Journal of Forest Research 13: 539-547.

BCMF [British Columbia Ministry of Forests. 1994. Planter screefs may increase frost heaving. Regen. Note 4 (February). Victoria, BC: Silviculture Branch.

Canadian Council of Forest Ministers. 1995. Defining sustainable forest management: a Canadian approach to criteria and indicators. Ottawa, ON. 22 p.

Cormier D. 1994. In-fill planting with large planting stock. Silvic. Field Note 62. Pointe-Claire, QC: Forest Engineering Research Institute of Canada.

FERIC [Forest Engineering Research Institute of Canada. 1996. Understory site preparation. FERIC Silvicultural Operations Newsletter 9:1.

Gordon AM, Simpson JA, Williams P 1995. Six-year response of red oak seedlings planted under a shelterwood in central Ontario. Canadian Journal of Forest Research 25: 603-613.

Harrington CA. 1995. Forests planted for ecosystem restoration. In: Planted forests: contributions to sustainable societies; Proceedings of a meeting at the Oregon Convention Center, Portland, Oregon; 1995 June 28-July 1; Portland, OR: 67.

Helgerson OT. 1990. Response of underplanted Douglas-fir to herbicide injection of sclerophyll hardwoods in southwest Oregon. Western Journal of Applied Forestry 5: 86-89.

Johnson CM. 1994. Field performance of container systems in British Columbia. Forestry Chronicle 70 (2): 137-139.

Needham T, Clements S. 1991. Fill planting to achieve yield targets in naturally regenerated stands. In: Simpson CM, ed. Proceedings, Conference on Natural Regeneration Management. Fredericton, NB: Forestry Canada: 213-224.

Noss RE 1994. Wilderness recovery: thinking big in restoration ecology. In: Filarski M, ed. Restoration forestry: an international guide to sustainable forestry practices. Durango, CO: Kivaki Press: 92-101.

Salonius PO, Beaton KP, Murray TS. 1991. How to estimate future competition stress to better spend herbicide dollars. Tech. Note 251. Fredericton, NB: Forestry Canada-Maritimes Region.

Seymour RS. 1992. The red spruce-balsam fir forest of Maine: evolution of silvicultural practice in response to stand development patterns and disturbances. In: Kelty MJ, Larson BC, Oliver CD, eds. The ecology and silviculture of mixed-species forests. Dordrecht, the Netherlands: Kluwer Academic Publishers: 217-244.

Smith DM. 1986. The practice of silviculture. 8th ed. New York: John Wiley and Sons. 527 p.

St-Amour M. 1995. Planting large seedlings: preliminary studies in Quebec. Silv. Tech. Note TN-228. Pointe-Claire, QC: Forest Engineering Research Institute of Canada.

St-Amour M. 1996. Development of a planting tool for large seedlings. Silvic. Field Note 87. Pointe-Claire, QC: City: Forest Engineering Research Institute of Canada.

Trombulak SC. 1996. The restoration of old growth: why and how. In: Davis MB, ed. Eastern old-growth forests: prospects for rediscovery and recovery. Washington, DC: Island Press: 305-320.

Weetman GE. 1994. Silviculture systems in Canada's boreal forest. In: Bamsey CR, ed. Innovative silviculture systems in boreal forests. Proceedings of a meeting, 1944 Oct. 2-8; Edmonton, AB. Edmonton, AB: Clear Lake, Ltd.: 5-16.