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TWO YEARS NECESSARY FOR SUCCESSFUL NATURAL SEEDING IN NONBRUSHY BLACK SPRUCE BOGS

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ABSTRACT.—Natural seeding in a strip-cut black spruce bog was adequate, averaging 1,800 stems per acre and 80 percent milacre stocking. Natural seeding in a completely cut bog was inadequate, averaging 630 stems per acre and 40 percent milacre stocking. Slash was removed to expose sphagnum seedbeds in both cases. Progressive cutting every other year is recommended.

OXFORD: 231.3:372:174.7(776) *Picea mariana.*
KEY WORDS: *Picea mariana,* direct seeding, swamp conifers, conifer reproduction, peatlands, Minnesota.

Guidelines for black spruce (*Picea mariana* (Mill.) B.S.P.) regeneration are well established from studies on the Big Falls Experimental Forest in north-central Minnesota—an area of extensive peatlands on the bed of glacial Lake Agassiz (Johnston 1977). Clearcutting and slash removal is all that is required for black spruce to reproduce rapidly and abundantly if (1) the peatland is not brushy, (2) *Sphagnum* spp. moss seedbeds are well distributed, and (3) natural seeding is ample. However, the success of these conditions has not been documented for small, isolated, lake-filled peatlands in glacial moraine country, nor has the success of natural seeding been measured where the entire stand is harvested and no standing seed source remains. We had the opportunity to measure natural seeding success on a 20-acre black spruce bog on the Marcell Experimental Forest in the Marcell Hills country 50 miles south of the Big Falls Experimental Forest.

PROCEDURE

The study area was a nonbrushy black spruce bog about 2,000 feet long and 500 feet wide oriented approximately north-south along the major axis. The bog had two stands with the following characteristics in 1968:

Stand characteristic	*Older stand*	*Younger stand*
Age (years)	73	62
Site Index (feet at 50 years)	40	31
Basal area (square feet/acre) (Stems > 0.5 inches d.b.h.)	157	122
Volume (cords/acre)	20	14

Apparently the southern half of the bog burned and black spruce seedlings were re-established in 1906. Both stands had practically a continuous ground cover of lush sphagnum moss with clumps of Labrador-tea, leather-leaf, and fine-leaved sedges scattered throughout.

Both black spruce stands were partially harvested in February 1969 by clearcutting 100-foot-wide, east-west strips and leaving 150-foot-wide uncut strips. All slash was put into a few piles, thus exposing practically all of the ground in the clearcut strips. Three growing seasons later (August 1971) seedlings were counted on 25 ¼-milacre plots in the clearcut strips of each stand and advance reproduction was similarly counted in the uncut strips.

The remaining 150-foot-wide strips were harvested in January, 1974, and all slash was progressively piled and burned. In November, 1975 (seven growing seasons after harvesting), reproduction in the 100-foot-wide strips was resampled on 38 milacre plots in each stand. In November, 1976 (three growing seasons after harvesting), reproduction in the 150-foot-wide strips was counted on 51 milacre and 51 ¼-milacre plots in each stand. All regeneration data were converted to number of stems per acre and percent milacre stocking. Between densities of 500 and 2,000 stems per acre, ¼-milacre stocking times 2.63 equals milacre stocking in each stand.

RESULTS AND DISCUSSION

The 100-foot-wide strips regenerated successfully. Three growing seasons after cutting there were about 1,800 seedlings per acre in each stand (table 1). Although these densities are only 8 to 15 percent of those reported for similar conditions in black spruce stands on the Big Falls Experimental Forest (Johnston 1975), milacre stocking is about 80 percent for each stand on the Marcell Experimental Forest. Therefore, we conclude that the new black spruce forest is adequately stocked. Seven growing seasons after cutting (5 years with a standing seed source), seedling numbers increased to about 2,300 per acre, and milacre stocking remained about 80 percent.

One reason for the lower densities on the Marcell study area may be the lush sphagnum growth which is typical on small, nonbrushy, acid bogs. Measurements for 3 years showed that sphagnum moss grows about 4 inches each spring and 2 inches each fall during periods of cool temperatures and high humidities. Therefore, some young seedlings may have been smothered by the moss and those that survive typically produce adventitious roots in the new moss growth (fig. 1).

The 150-foot-wide strips had a nonbrushy, well-distributed sphagnum seedbed, but the only seed source was seed dispersed before or during cutting. Advance reproduction in the younger stand survived the logging, but the larger advance reproduction in the older stand was either cut or crushed. Both stands had about 225 stems of advance reproduction after harvesting (table 2).

About 400 new seedlings per acre were present after cutting with 30 percent milacre stocking in each stand. When new seedlings and advance reproduction are combined, they total about 625 stems per acre and 40 percent milacre stocking for each stand (table 2). Sixty percent milacre stocking is considered necessary for an adequately stocked stand (Johnston 1977); therefore, harvesting the entire seed source and relying on previously dispersed seed will not result in adequate, rapid regeneration. Black spruce seed remains viable for only about 12 months on upland

Table 1.—*Black spruce reproduction 3 and 7 growing seasons after strip cutting with slash removed on a nonbrushy, medium site with well-distributed* Sphagnum *moss*

Growing seasons after strip cutting	Stems per acre		Milacre stocking	
	Older stand	Younger stand	Older stand	Younger stand
	Number		*Percent*	
3	1,770	1,770	81	76
[1]7	2,380	2,220	81	81

[1]Remaining 150-foot wide strips (seed source) were harvested after 5 years.

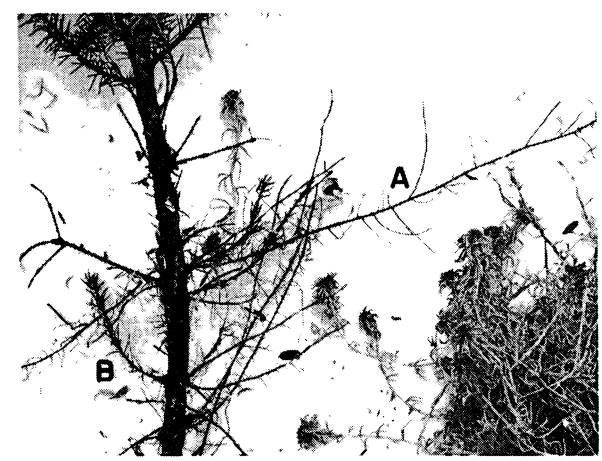

Figure 1.—*Seven-year-old black spruce seedling that grew in* Sphagnum *moss. Note adventitious root (A) at old stem node and above branch (B) smothered by lush* Sphagnum *growth.*

Table 2.—*Black spruce reproduction 2 years before and 3 years after clearcutting with slash removed on a nonbrushy, medium site with well-distributed* Sphagnum *moss and no adjacent seed source*

Time of reproduction establishment	Stems per acre		Milacre stocking	
	Older stand	Younger stand	Older stand	Younger stand
	Number		*Percent*	
Advance reproduction				
2 years before cutting	790	200	29	5
3 years after cutting	230	220	17	14
New reproduction				
3 years after cutting	450	360	30	30
Total reproduction				
3 years after cutting	680	580	40	42

or peatland seedbeds (Fraser 1976), thus seed storage in the moss cannot be relied on to increase milacre stocking in subsequent years.

Overall, our data show about 40 percent milacre stocking after one growing season, with only the previous fall's seed, and about 80 percent milacre stocking after three growing seasons with 2 years of standing seed source and the fall seed prior to harvesting. Interpolating, we might assume a 60 percent milacre stocking after two growing seasons with a continuous seed source. Since 60 percent milacre stocking is the lower limit of adequate stocking, we suggest that two years of seed (the fall before cutting and the fall after cutting) are required to secure the minimum stocking level in black spruce stands on small, nonbrushy bogs. To secure stocking levels greater than the minimum we suggest that three years of seed (the fall before cutting and two falls after cutting) are needed.

MANAGEMENT IMPLICATIONS

Nonbrushy, black spruce bogs can be regenerated successfully if they have a well-distributed sphagnum seedbed and if slash is removed to expose it. Full-tree skidding, with slash burning at the landing, has been recommended as a practical method for achieving these conditions (Johnston 1975). Though much of the slash removal was done by hand in our study, it closely simulates a full-tree skidding operation. However, completely harvesting black spruce bogs of 5 to 50 acres during one season will not leave sufficient seed to regenerate the stand rapidly.

Areas larger than 50 acres should be progressively strip-cut no more frequently than every other year in order for the clearcut area to reach 80 percent milacre stocking. Although risky, it is possible that the cutting could be done every year if only the minimum stocking level (60 percent) is desired. Some wind mortality will occur along exposed edges of stands that are left but most trees can be salvaged every other year. Strip widths should not exceed natural seeding distance (about 400 feet). After the last cut, direct seeding may be necessary if a natural seed source is not available.

Bogs of 50 acres or less can also be progressively cut although only two cuts may be feasible. Entire bogs can be harvested with full-tree skidding to expose the seedbed and then be direct seeded. If slash removal and direct seeding are not done the regeneration will have less than full stocking (probably less than 40 percent), and it will take about 15 years for the new trees to begin to provide seed to fill in the nonstocked or understocked areas.

The choice will depend on management goals, the cost of direct seeding, and the presence of dwarf mistletoe. If dwarf mistletoe is abundant, slash should be broadcast and burned (Johnston 1977). Most small bogs can be seeded by hand with a cyclone seeder at the recommended seeding rate of ¼-pound per acre (Johnston 1977). Seed cost is about $50 per pound, thus regeneration costs for seeding alone should be about $15 per acre. Skidding and slash burning will add to costs. Usually natural seeding can be relied on if sale areas in nonbrushy black spruce peatlands are laid out skillfully, but some small areas will need direct seeding to provide full and rapid stocking.

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