Restoration of White Pine in Minnesota, Wisconsin, and Michigan

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SUMMARY. White pine blister rust (*Cronartium ribicola* J.C. Fisch.) (WPBR) was discovered on *Ribes* L. in New York in 1906, although it was accidentally introduced from Europe on pine (*Pinus* L.) seedlings. The spread of this destructive fungus has changed the forests in North America. After decades of reduced planting because of the concern over the impact of WPBR, white pine (*Pinus strobus* L.) is now being restored in the lake states of Minnesota, Wisconsin and Michigan. Although the potential for growing white pine is high on many sites, the disappearance of a seed source because of logging and fires means that reestablishment of white pine to these areas will require active management. A series of plantings have been established on three national forests in Minnesota and Michigan to evaluate various silvicultural treatments intended to minimize the incidence of WPBR and to compare the performance of seedlings selected for disease resistance to nonselected planting stock.

The WPBR fungus is a long cycle, heteroecious rust that produces five types of spores and requires two hosts, alternating between five-needle pines and currants or gooseberries (*Ribes* L). Attempts to control this disease were the most extensive in time, labor and money in the history of forestry in the United States (Maloy 1997). Exacting moisture and temperature conditions are required for spore dispersal, germination, and infection of the two hosts by the various spores, and management strategies to avoid infection are based on these conditions (Van Arsdel, 1961). Local environmental conditions can influence WPBR incidence within rust hazard zones and may also have played a role in the effectiveness of local *Ribes* eradication efforts (Robbins and Jackson, 1988; Ostrofsky et al., 1988).

Materials and methods

Since 1989, a total of six research / demonstration plantings consisting of more than 5,000 trees have been established on the Hiawatha National Forest (NF) (1989), Chippewa NF (1998), and Superior NF (1997, 1999) in Michigan and Minnesota in areas of moderate to high risk for WPBR. White pine seedlings selected for resistance and good tree form and nonselected nursery seedlings are being screened under field conditions. We are comparing tree survival, pest incidence, and growth of seedling stock from the genetic improvement program of the USDA Forest Service in the lake states and stock from the former Minnesota Quetico-Superior Research Center to nonselected nursery stock in replicated plantings across a range of site conditions.

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Table 1. White pine height growth and blister rust (WPBR) incidence in the 1989 Hiawatha National Forest planting, June 1999.

Treatment	Live trees [no. (%)]	Mean ht [ft (m)]	Infected trees [no. (%)]	WPBR cankers (no.)
Clearcut	347 (58)	7.8 (3.2)[z]	20 (5.8)[y]	39
Shelterwood	445 (74)	5.7 (2.3)	48 (10.8)	69
Nonselected stock	401 (67)	6.0 (2.4)[z]	46 (11.5)[z]	66[y]
Selected stock	391 (65)	7.2 (2.9)	22 (5.6)	42
Unpruned	403 (67)	6.7 (2.7)	43 (10.7)[x]	83[z]
Pruned	389 (65)	6.5 (2.7)	25 (6.4)	25

[z]$P = 0.005$.
[y]$P = 0.025$.
[x]$P = 0.05$.

Treatments being compared include 1) growing white pine in clearcuts vs. under a recommended shelterwood to minimize conditions conducive for WPBR infection and attack by white pine weevils [*Pissodes strobi* (Peck)] and 2) pruning to remove lower branches most susceptible to WPBR plus corrective pruning for weevil-attacked trees (Katovich and Mielke, 1993). Increased shade under the closed canopy of a shelterwood may also suppress the growth of *Ribes* within a stand (Stewart, 1957).

The planting sites include paired clearcut and shelterwood treatments in a northern hardwood stand and in a paper birch (*Betula papyrifera* Marsh.) stand; a trembling aspen (*Populus tremuloides* Michx.) clearcut; and in small clearcuts in three mixed-conifer stands. The effects of different levels of competing vegetation on various ecological land types (ELTs) on tree growth and pest incidence are also being examined. Tree survival, heights, and incidence of damage from biotic and abiotic agents are recorded yearly.

The goal of this study is to determine best management practices for restoring white pine on various ELTs using silvicultural strategies and genetic improvement to minimize damage caused by WPBR, white pine weevil and browsing by white-tailed deer [*Odocoileus virginianus* (Boddaert)].

Results and discussion

The early results on the Hiawatha NF site in Michigan clearly showed that white pine height growth is greater but survival is lower in the clearcut treatment compared with trees in the shelterwood (Table 1), and the incidence of white pine weevil attack was greater (4.1% vs. 1.6%). Unexpectedly, WPBR incidence has been significantly greater in the shelterwood treatment. However, the majority of infected trees were in one plot nearest to the native *Ribes* growing on the site. WPBR cankers on the main stems of several pruned trees resulted from infection of needles directly attached to the bole, however, significantly fewer pruned trees are infected and they have significantly fewer cankers than the unpruned trees (Table 1). Trees from the USDA Forest Service improvement program were significantly taller and there were significantly fewer infected trees across all the treatments than the nonselected trees (Table 1). Armillaria root rot caused by *Armillaria* (Fr.:Fr.) Staude has killed more trees in the northern hardwood clearcut treatment (5.5%) than in the shelterwood (3.1%). Heavy snow and ice and extremely cold weather have also severely damaged trees at the Michigan site.

Although it is too early for meaningful results from the Minnesota sites, a few trends have become evident. Deer browsing has been severe at one of the sites on the Superior NF in Minnesota, requiring replanting of the plots and use of a protective bud-capping technique (stapling a folded piece of paper over the terminals) each fall to prevent damage to the terminal buds. Growing white pine in areas of high deer populations will require management to avoid planting failures as a result of heavy browsing. Competing vegetation, especially on the mesic sites will require much more effort to successfully establish white pine than on drier, nutrient-poor sites. In addition, since white pine is resistant to the shoot blight disease of understory red pine (*Pinus resinosa* Ait.) (Ostry et al., 1990), planting white pine under a red pine canopy will enable managers to maintain a conifer component on these sites.

Given the biological and economical restraints of restoring white pine using artificial regeneration techniques, we need to use silvicultural strategies and target sites that provide the optimum potential for success. Geographic location, topography, stand structure, soil, and climate are major factors that need to be considered when selecting planting sites for white pine and in managing this species to avoid damage from WPBR, white pine weevil, and deer. Successful restoration of white pine will require a sustained commitment to intensive management. The research described in this report is designed to serve as operational demonstrations to assist land managers in selecting the best prescription for establishing and growing white pine under their set of conditions.

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