SILVICULTURE SETS THE SCENE FOR THE NEXT SOFTWOOD FOREST STAND

Maxwell L. McCormack, Jr.[1]

Abstract.--Silvicultural components for establishing softwood stands in northeastern North America are summarized. Harvesting systems, early stand establishment, and management of competing vegetation are emphasized.

The interaction of silviculture with the regeneration, establishment, and development of softwood stands in northeastern North America is summarized in Figure 1. Over a large part of the region there is strong dependency on natural regeneration. In some locations, especially across the Province of New Brunswick, there are extensive artificial regeneration programs. Both pathways to stand establishment have their own particular needs and characteristics as well as common factors.

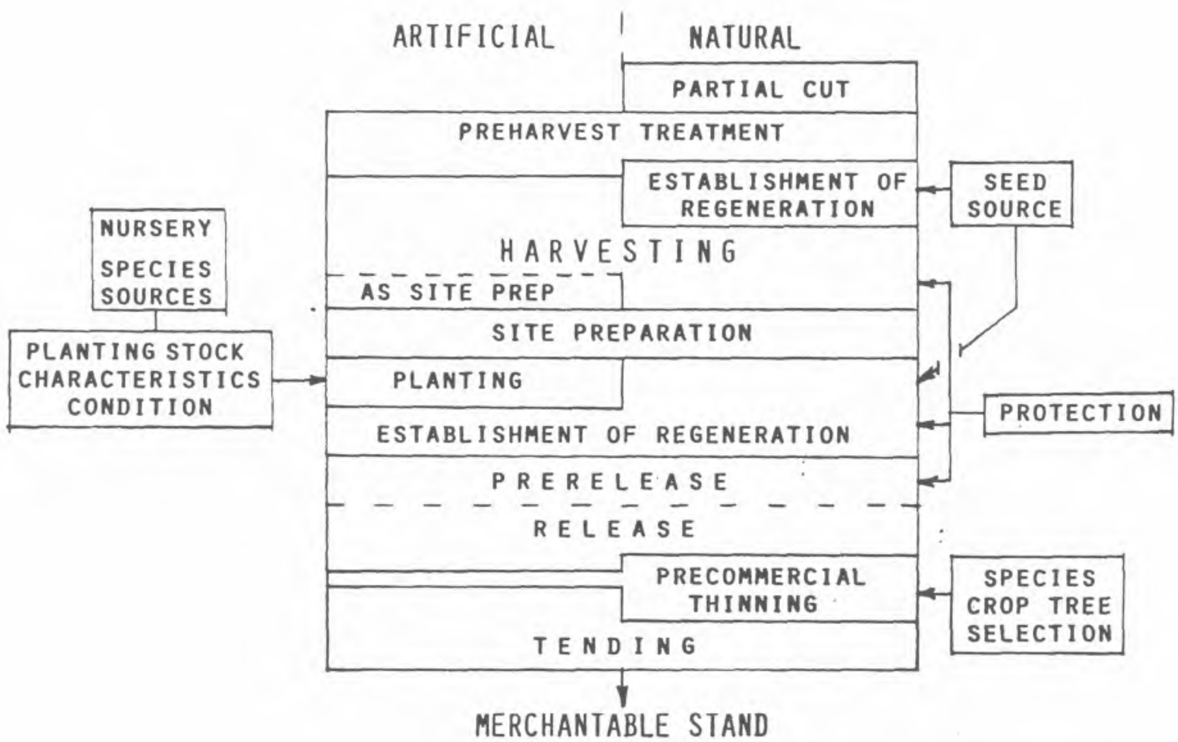

Figure 1.--Schematic diagram of the silvicultural components of softwood stand establishment and development. The partial partitioning down the center recognizes plantations (left) and natural regeneration (right).

[1]Research Professor of Forest Resources, Cooperative Forestry Research Unit, Univ. of Maine, Orono.

PARTIAL CUTTING AND PREHARVEST TREATMENTS

There is a dichotomy of harvesting entries in merchantable softwood stands; clearcutting or partial cutting. The former is common because of its efficiency and simplicity, but properly timed partial cuts provide a means of managing some future seed sources and subsequent vegetation development. Damage from harvesting activity and wind are risks to the residual stand which can counteract potential benefits. Development of undesirable understory vegetation and some species composition can be manipulated with preharvest treatments. Ground application and stem injection of herbicides (Ostrofsky and McCormack 1986), as well as selected seed bed preparations, are silvicultural opportunities which are usually overlooked.

HARVESTING

Harvesting operations form the leading edge of silviculture. They determine the conditions for regeneration, and establish the character of the developing stand. Furthermore, in commercial operations the final harvest is the only time managers are sure they will be on the site to influence the next stand. Hopefully, there will be additional entries, but we never can be sure. A complication in evaluating past harvests and anticipating post-harvest conditions is the continuing changes in harvesting technology (Table 1).

Table 1.--Development of Harvesting Technology[2/]

Time	Equipment	Method	Residues
Pre 1940	Ax, Crosscut Horses, Oxen Water	Logs & Bolts	Tops, Limbs Bark, Etc.
1960	Chainsaw Crawler (Skidder) Trailers (Forwarder)	Logs, Bolts Some Treelength	Tops, Limbs
1970	Chainsaw, Shears Skidder Feller-Buncher Feller-Forwarder	Treelength Full-Tree	Some
1980	Feller-Buncher Grapple Skidder Feller-Forwarder Chippers	Treelength Full-Tree	Not Much To None

2/ Adapted from B. Hoffman, College of Forest Resources, Univ. of Maine, draft manuscript April 1988.

In the past, harvesting operations have tended to be separated from other forest management activities. In addition, landowner accounting procedures can pass on harvesting-caused detrimental conditions to the regeneration program. Therefore, it is important to consider harvesting and regeneration in a coordinated management package that considers biological components equally with economics and harvesting system productivity (Ross 1984).

Recent trends toward intensive mechanical and biomass harvesting result in conditions which are distinctly different from those of the past. For instance, large amounts of non-merchantable biomass (i.e., limbs and tops) are no longer distributed across a site (Mann et al. 1988, Smith et al. 1986, Smith 1985). Instead, they are concentrated in roadside piles or chipped for use as fuel. Soil disturbance patterns from mechanical harvesting are important considerations (Martin 1988, McCormack 1984). Observations across a variety of mechanical harvesting systems (McCormack 1984) illustrate that harvesting residues are valuable. They (1) provide desirable microhabitat and protection for regeneration, (2) add green organic matter to the soil, and (3) compose an important part of the nutrient cycle. Microhabitat and organic matter additions are difficult to evaluate, but observations in the field consistently show better distribution of desirable natural regeneration where logging residues have been distributed across a site. Whole-tree harvesting of red spruce (Picea rubens Sarg.) and balsam fir (Abies balsamea [L.] Mill.) has removed two to four times the amount of nutrients that would have been removed by a bole-only harvest (Smith et al. 1985). Growth measurements in Scandinavian studies have shown benefits of logging residues to residual stand increment following partial cuts (Bjorkroth 1984, Andersson 1984). However, importance of nutrients from residues can vary with site quality (Weetman and Algar 1983).

Observations over several years of mechanical harvesting show differences in amounts of ground disturbance and slash distribution relates to equipment characteristics (McCormack 1984). For example, feller-forwarders leave different patterns than feller-bunchers supported by grapple skidders. Among feller-bunchers there are different disturbance patterns between those which travel on tracks as compared to those on tires. Selected comparisons of winter and summer mechanical harvesting over a ten-year period show almost twice as such disturbance from summer operations (McCormack 1984). These types of considerations could be planned and coordinated into appropriate site preparation.

The origin of natural regeneration often depends on the character of a harvesting system. Patterns of travel and amounts of disturbance affect how the next stand develops. Although harvesting disturbance can provide good seed beds for pines (Pinus L. spp.), spruce and fir regeneration are almost always derived from seedlings which are in place (Westveld 1931). Figure 2 shows typical development of red spruce regeneration in a stand which had been lightly disturbed by spruce budworm (Choristoneura fumiferana [Clemens]). The fact that spruce-fir regeneration is in place at the time of harvest increases the importance of potential damage from mechanical systems, but also provides for early assessments of regeneration. Excessive disturbance can increase competing undesirable vegetation (Newton et al. 1987, McCormack 1985).

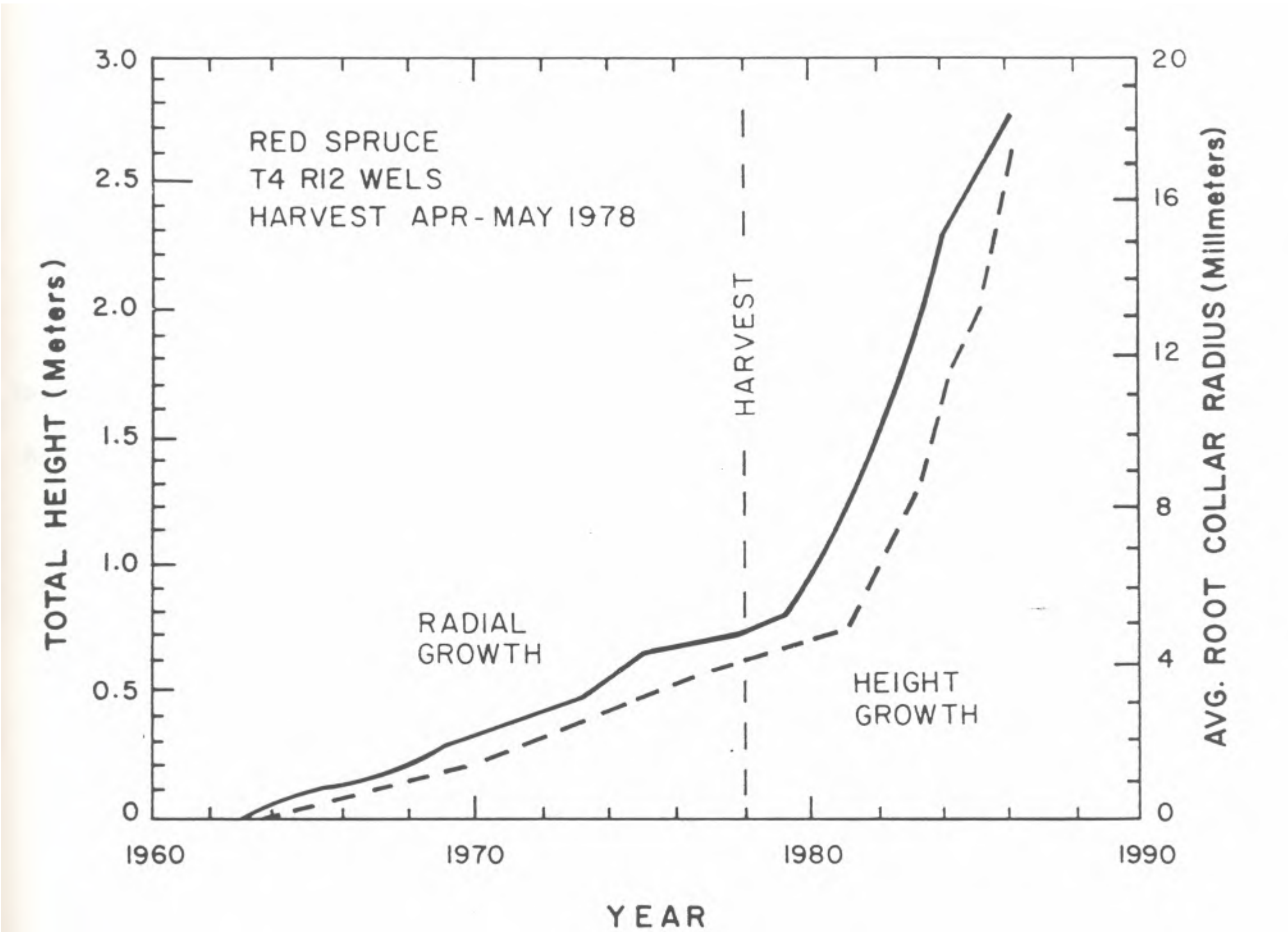

Figure 2.--Growth curves for a red spruce seedling which was 15 years old at harvest. Spruce budworm defoliation probably helped the seedling reach its 12-year height of 0.5a. Radial growth response to harvest preceded that of height growth (Strauch 1988).

SITE PREPARATION AND REGENERATION ESTABLISHMENT

Where post-harvesting conditions do not provide an adequately prepared site, supplemental treatments are often necessary to assure regeneration establishment. Site preparation is usually a separate step involving mechanical treatment; although a herbicide application sometimes is used alone or in combination with a mechanical treatment. Murray (1984) has summarized the extensive experience in the Maritimes. Site preparation primarily provides organized access for planting crews but also may improve microsites for planted trees. However, excessive mechanical disturbance can stimulate the development of competing vegetation.

Plantation success is highly dependent on planting stock quality and characteristics. Specific nursery practices, therefore, are very important (Hallett 1984). Size and vigor of stock planted play an important role in overcoming competition and adverse site conditions. Planting methods also affect results (West 1984) and early monitoring of plantation establishment is essential (Speer 1984) for best development and timely remedial treatment of pest problems.

Artificial regeneration should be carried out by prescriptions which involve a multitude of interacting site, species, and economic considerations (Coffman 1982). Kotar and Coffman (1982) have shown that early establishment, defined as number of years to reach breast height (4.5 ft), is very important in determining mean annual increment of red pine (Pinus resinosa Ait.). Field experience has shown that early establishment of dominance is also important for spruces and critical for larches (Larix Mill. app.).

Fungi and insects also can interfere with establishment. Some common ones in recent years seem to relate to planting stock condition and disturbance as well as disposition of logging residue and length of time after harvest. One example, is root rot (Armillarea mellea [Vahl. ex Fr.] Kummes) which has killed good quality black spruce (Picea mariana [Mill.] B.S.P.) and white spruce (Piceal glauca [Moench] Voss) stock which had been carefully planted on productive sites. An insect, the seedling debarking weevil (Hylobius congener), has caused up to 40% mortality in a white pine (Pinus strobus L.) plantation (Houseweart 1982). Seedlings in older cuts are less susceptible to this damage and studies show removal of duff from around seedlings results in reduced damage (Welty and Houseweart 1985).

PRERELEASE AND RELEASE

The term prerelease is used here to emphasize the importance of well-timed suppression of competing vegetation to maintain dominance and growth momentum of desirable regeneration. Perala (1982) summarized data for the Upper Great Lakes indicating averages of 43% greater survival, 120% greater height growth, and 814% greater weight growth when released from weeds. He emphasized that best responses were achieved with treatments early in stand development. Similar responses are reported for the Maritimes (Bailey 1984) and for natural regeneration in Maine (Newton et al. 1987). Experience shows that release treatments are effective even after conifers have been overtopped, but are best when carried out within the first ten years after disturbance (harvesting or site prep). Another interaction of herbicide treatments which may provide an additional benefit to planted conifers is a release of nutrients into the soil solution following application (Smith et al. 1988).

The importance of release treatments is evidenced by a steady increase of conifer regeneration areas being treated aerially with herbicides (McCormack 1985). Personal surveys by the author indicate that over 500,000 acres will be treated in 1988 from Ontario through Maine to Newfoundland.

Herbicide treatments are not without complications. Considering conifer species listed by Fowler (1984), there is a general species hierarchy of tolerance to operational herbicide treatments. In order of increasing susceptibility to injury, the following is the general rule: black spruce, red spruce, balsam fir, red pine, white spruce, jack pine (Pinus banksiana Lamb.), and larches. Actually, there are no operational herbicide treatments which will not cause serious injury, or mortality, to larches. Consequently, proper, effective site preparation is essential when planting larches. Recent personal observations, in Maine and Newfoundland, of glyphosate injury to upper portions of individual balsam firs indicate this may be related to differential hardening off in late summer which, in turn, may be related to time of flushing in the spring.

Herbicide treatments can also result in enhanced development of resistant undesirables. For example, applications of 2,4-D can foster development of 2,4-D-resistant clones of trembling aspen (Populus tremuloides Michx.). In the process of suppressing pin cherry (Prunus pensylvanica L.f.), 2,4-D treatments have encouraged red maple (Acer rubrum L.) and raspberry (Rubus idaeus L.) on better sites. Glyphosate use across large areas can result in subsequent invasion by light-seeded and buried seed species (e.g., Epilobium and Polygonum).

PRECOMMERCIAL THINNING AND TENDING

Precommercial thinning is primarily a concern in natural regeneration. However, some recent informal references to overstocking in plantations indicates a need for more thorough assessment and understanding (Figure 2) of volunteer seedlings. Most precommercial thinning is done motor-manually with spacing saws. This requires individual tree choices by the operators. These choices modify species composition and also reflect decisions based on tree vigor and the presence, or absence, of live branches near the ground. Herbicide treatments prior to thinning reduce burdens on the thinning crew, provide better choices of vigorous crop trees, and result in less hardwood sprouting to interfere with stand development. From an academic silviculture standpoint further tending of conifer stands might be possible, but where applied, precommercial thinning is the last entry.

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