North Central Forest Experiment Station 2.02

CENTRAL HARDWOOD NOTES

Genetic Principles

Tree growth is a function of both environment and genetic makeup. All forest management activities during a rotation from establishment to harvest affect the genetic composition and the environment of a stand. Silvicultural practices which fail to take both of these factors into account will reduce forest productivity.

Moderate to strong genetic control has been demonstrated in several central hardwood species for quality characteristics such as growth rate, stem straightness, branch size and angle, response to wounding, pest resistance, and heartwood formation rate. Forest management affects the genetic makeup of the forest primarily through the process of selection that allows trees with certain traits to contribute more offspring to succeeding stands than trees with different traits. The type of trees you select to reproduce the stand can improve or reduce future forest productivity and timber quality.

Many stands throughout the central hardwood forest have been highgraded several times. This practice is dysgenic. It can reduce genetic quality by removing larger, higher quality trees, which may also be of higher genetic quality. Small, poor quality, and probably genetically inferior trees are left to produce future stands. Continued highgrading can produce stands that are genetically incapable of reaching the productive capacity of the site.

Fortunately, we have opportunities to maintain or even increase the genetic quality of central hardwood stands. Artificial reforestation with genetically improved planting stock is the fastest way to obtain genetic improvement. Natural stands can also be improved. Although slower than using artificial regeneration, genetic improvement of natural stands will have a greater overall impact on central hardwood forest productivity because 95 percent or more of all central hardwood stands are being and will be regenerated naturally.

Artificial Regeneration

At present, artificial regeneration of central hardwood species is limited to a few high value species. Black walnut is the only species being managed in plantations on any significant scale. Red oak is being underplanted or interplanted to a limited extent to supplement natural regeneration in clearcuts and shelterwoods.

Plantation productivity can be improved most rapidly using a combination of genetically superior planting stock and good cultural practices. Seedlings from seed orchards of proven genetic superiority are the most desirable planting stock for artificial regeneration. Black walnut seed orchards are being developed by state forestry agencies in the central hardwood region, but these orchards presently produce limited amounts of seed.

Significant genetic improvement can also be obtained quickly by using seed from the best available sources of a species for artificial reforestation. Geographic seed source (provenance) tests for a number of central hardwood species have shown the following: (1) seedlings from local sources, those from near the location of the test site, are usually average or above average in survival or growth, but are seldom the very best seedlings in the tests: (2) seedlings from nonlocal sources, often originating a considerable distance from the test site, frequently outperform those of local origin; and (3) seedlings from other nonlocal sources, again often originating a considerable distance from the test site, are poorly adapted and exhibit poor survival and slow growth. Therefore, use seedlings from good local stands or above average individual trees to establish plantations unless seedlings from nonlocal sources are proven superior in long-term tests. Nonlocal, unproven seedlings for reforestation can lead to severe growth losses and plantation failure.

Natural Regeneration

General Considerations

Genetic improvement in naturally regenerated stands mainly exploits the genetic differences among individual trees within a single stand. Opportunities for genetic improvement during natural stand regeneration are greatest when potential parent trees are selected in advance, either by being favored as crop trees in an intermediate treatment, or by being selected to leave standing in seed tree, shelterwood, or selection harvests.

Stands arising from advanced regeneration established prior to the parent tree selection or established after overstory removal from seed stored in the forest floor (e.g., black cherry, yellow-poplar, and white ash) will likely have a genetic makeup similar to the preceding stand. Opportunities for genetic improvement of these stands occur during weeding and release operations after stand establishment and during thinning before the reproduction cut.

Dense stands of natural regeneration increase your opportunities for selection. You can secure abundant reproduction by preparing optimum seed beds and by timing regeneration cuts to coincide with good seed crops of desired species to increase chances for selection in subsequent treatments. For example, sugar maple can produce over 2.5 million seeds per acre in a single season. Typically, about 50 percent of these germinate, but only 5 percent of the germinants survive to the end of the first growing season. Mortality over the following year reduces the population to less than 0.5 percent of the seed originally produced. However, this still leaves 10,000 to 15,000 seedlings per acre for subsequent selection.

Regeneration Systems

Clearcutting is usually genetically neutral. Depending on the species being harvested and the season of the harvest, stands may originate from advanced regeneration, from seed or sprouts produced by the trees being removed, or from seed produced by trees surrounding the cleared area. Since no parental selection is imposed during the reproduction cut, little if any change in genetic quality will occur between generations. Genetic improvement can be obtained by selection during release and thinning before clearcutting and by securing abundant regeneration to increase selection opportunities in later stages of stand development.

The shelterwood system can be used to advantage in stands with mixed species to make genetic improvement within species and to improve the proportion of desirable species in the new stand. Remove poorly formed or diseased trees in a preparatory cut and leave the best individuals for seed production. Resistance to disease and the ability to recover from damage (such as logging injury) are moderately to highly heritable in central hardwood species. Give these traits priority along with growth rate, form, and seed production ability when selecting trees to leave for the shelterwood.

The selection system permits continual genetic upgrading of uneven-aged stands if applied conscientiously. However, most central hardwood stands are relatively even-aged, or have at most only two or three age classes; so the mixture of tree sizes often represents differential growth rates as well as different age classes. If only large trees are continually removed in the name of selection silviculture, genetic decline is the inevitable result. Poorly formed, diseased, and weak trees of all size classes must be removed in each cutting cycle, along with mature trees. Illegitimate 'selection systems' such as diameter-limit cuts and highgrading are systematically dysgenic.

Intermediate Stand Culture

Intermediate treatments from the earliest cleaning/weeding operations through commercial thinnings can genetically improve all stands, natural or planted, whether they originate from seedlings or sprouts. Eliminate poor quality trees before they can contribute to the next generation either by pollen, seed, or sprouts. This will enhance both the economic and genetic quality of the residual and subsequent stands. As a general rule, thin from below. Thin from above only to favor desirable but slow-starting species overtopped by less desirable species or to eliminate previously unharvested cull trees.

Summary

The genetic principles applicable to manage central hardwoods are easy to put into practice. Indeed, good silviculture is good forest "germplasm management." Modern forest practices designed to maintain diversity and discriminate against obviously inferior individual trees will result in genetically improved central hardwood stands.

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