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Warnell School of Forestry & Natural Resources
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Renovating Poor Pine Stands: Putting Land Back to Work

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Well managed stands of pines produce many values for a forest landowner. At the other end of the management continuum lie those pine stands which produce few values and may approach being a liability to the landowner. There are many stands of pines that do not fully utilize inherent site productivity to generate value. These pine stands have been abused, unmanaged, or poorly managed over a number of years.

Major renovation treatments are required to bring these poor pine stands back to productivity, minimize resource loss, and facilitate future management. Several aspects of pine stand renovation are presented here. Complete stand conversions from hardwoods to pines, and other possible management alternatives such as pine/hardwood mixes or hardwood management, are not reviewed. The primary management objective covered within this discussion will be pine timber production and marketing.

Reproductive Ecology

Management manipulations on forest land amplify natural processes (competition, disturbance, stress, and succession) to meet landowner objectives. The successful colonization and growth of the chosen crop species on the site over time is the goal. Open sites are usually colonized by tree species which require plenty of light for food production and mineral soil for seed germination. As these trees grow, they shade the understory plants and produce litter that covers the ground. These "early-successional" trees create an understory in which few of their own seedlings can become established.

Late-Successional Species

When the understory cannot be colonized by overstory trees, other species become established which tolerate partial shade and have seeds which germinate well in organic litter. These tree species begin to form an incomplete secondary canopy layer below the overstory trees. As secondary canopy trees grow, their canopies rise, eventually interfere with and push-out overstory species. As early successional species die and cannot replace themselves, the forest stand becomes dominated by new site / shade tolerant species.

New species will succeed in the stand if their:

1) seeds can germinate;
2) young seedlings can survive in the understory; and,
3) stems can grow quickly into overstory openings.

An additional feature of these "later-successional" species is some sprout from established root systems or stumps. This gives a tree a head-start over any interference. For example, young oak seedlings may have stems two years old and root systems 12 years old. Oak continues to sprout until an opportunity exists for a sprout to grow into a canopy gap.

Pine Emphasis

Pine is an early-successional species. Conditions that are similar to open, newly harvested sites favor pine, if the disturbance area is large enough to minimize interference, to open-up mineral soil for seeds, and to provide full sunlight. Later-successional species like oak, maple and other hardwoods sprout back after disturbance or harvesting, survive more shading, require less exposed soil, and are more tolerant of site stress.

To maintain pine, management activities must create conditions favorable to pine and unfavorable to its competition. By periodically damaging or ecologically stressing hardwoods, pine will continue to dominate a site. This type of species management will inhibit the normal progression of ecological processes which would eventually lead to a hardwood stand or a low density pine / hardwood stand.

Without proper management, or with poor management, pine sites will eventually be dominated by hardwoods. Good management holds the site at an early-successional stage which is prime for pine. Prescribed burning, herbicide use and cutting are means to hold a forested site in a pine stage condition.

Crown Management

Managing stands of trees involves holding long-term site changes back and managing final crop trees (best 50-250 trees per acre) by controlling tree crowns. A tree's crown is composed of leaves and supporting branches which help tree trunks (wood product) grow. Without a healthy crown to produce food and control space, there would be no product to sell or values to accumulate.

Trees make food by capturing sunlight in their leaves. Energy from sunlight is used to produce food using components from air, soil and water. Leaves must be exposed to adequate sunlight in order to function. When trees cannot capture enough sunlight, they decline and die. Larger and healthier tree crowns result in more food production, which leads to increased wood production.

Raise Crop Trees

Because light and other resources needed for tree growth are limited, managers must decide which trees should be favored. Emphasize trees with rapid, high-quality growth with few structural problems and ecological risks. A great market exists for pine species. For example, allowing trees with no economic value, or with highly variable markets or ecological risks, to use site resources and survive prevents favored trees from using those same resources for growth.

To maximize economic returns, pines must grow as big as they can in the shortest amount of time. Concentrate site resources (light, water and essential elements) onto a few crop trees.

Resources can be shared by hundreds of trees and weeds, or concentrated onto a few crop trees which generate values and income. Ensure crop trees grow big and fast by keeping their crowns large and eliminating neighboring tree interference.

Control Weed Trees

It is critical site resources not be wasted on non-crop species. Alternatively, site resources which can not be reasonably captured and controlled by growing crop trees should not be wasted or lost through erosion and other site damaging agents. A productive site will always have other species of plants present and clearing to bare soil, mowing, and other highly intensive activities for controlling interference are not cost effective nor ecologically wise.

Trees must have large crowns to make food and to react well to any stand treatments. Crop trees need to be spread across a site. Leave crop trees well distributed across a site and free to grow, or use planting to establish new seedlings to assure crop tree species can fully occupy a site.

Pine Stand Problems

There are four common forest stand problems associated with abused and poorly managed pine stands:

A) Domination by hardwoods with pines greatly understocked;
B) Severely highgraded;
C) Harvested and not replanted; and,
D) Too many stems and growth stagnation.

Solutions must be carefully considered because these problems are the result of decades of abuse, no management or poor management. Managerial patience is required. Instant, radical solutions may not be possible and may destroy future site productivity. Solutions presented here are not "quick fixes." Proper treatments will yield positive results.

Before prescribing a treatment for a poor pine stand, clearly define the problem:

- If the stand is understocked with pine, how many pines are present?
- If the stand was harvested and not replanted, what is growing on the site now?
- Should a stand be liquidated to start over, or left to harvest the few remaining stems?
- In stagnated pine stands, how dense are the stems?

These questions and others must be answered as accurately as possible to ensure prudent, cost-effective and timely treatments. An inventory of the site and trees is essential.

Inventory

A basic site inventory must be developed to provide data and maps including:

- number, distribution and commercial volume of crop trees per acre;
- basal area of crop trees versus total basal area of trees on the site;
- quality of crop trees;
- site quality and productivity estimate;
- major competing tree species;
- amount of advanced pine regeneration in the understory; and,
- pattern / distribution of problem areas across the site.

Mapping overstocked crop tree areas, areas without crop trees, and well-stocked crop tree areas are important. Treatments must be applied to specific problem areas to be cost effective. Only with an accurate inventory and identification of problem areas can renovation begin.

For this decision, a five-acre renovation block will be used (467-feet sides of a square or 263-foot radius of a circle). This will be the minimum size of an applied renovation treatment. Renovation can occur over an entire forest, or in small blocks or patches. Five-acre units are an easy way to plan and keep track of treatments, because they are a reasonable size for providing resources for an early-successional species like pine. Designate problem areas and treatments in any scale, but the smaller the treatable unit, the higher per-crop-tree costs can become.

The minimal size of an economically viable pine stand management unit is usually around 40-50 acres for it to be attractive for loggers, site preparation and planting contractors. Five acre areas can be ecologically renovated, but economically will not be large enough for most loggers, site preparation and planting contractors to work on unless there are other similar aged stands adjoining which can be managed collectively to provide adequarte harvest volumes and large enough areas for site prepartaion and planting treatmensts.

Total Stand Renovation

The first option in renovating stands often appears to be a complete harvest (liquidate stand) and to start over. This may or may not be the best financial option. Only by proper inventory and informed projection of future value can a decision be made.

A key point is to determine where a stand is located within a normal harvest rotation cycle. Is the stand just starting out (one to seven years old) with crop trees not well developed, or is the stand nearing the end of a rotation (within five years of harvest) with few crop trees present? In these cases, a start-over with the current stand eradicated with a site preparation perscription in stands 1-7 years old, or a complete harvest, site preparation and plant, might be a cost-effective alternative. For most stands in the middle of a rotation period, liquidation would not be economical if a sufficient number of crop trees with good growth rates exist.

Liquidation Interest Rates

Generally, the higher discount (interest) rates for acceptable management alternatives, the more costly mid-rotation liquidation becomes (Figure 1). Early in stand life, little rotation time and site resources are invested in a new stand, so losses from a total eradication to start again are relatively low. Near the end of a rotation, when trees are close to harvest, a total harvest does not involve large additional costs.

Many stands in the middle of a rotation cycle with few crop trees per acre can still be carried to full rotation age with fewer costs and more returns than completely harvesting the site and starting over.

Renovation Tools

There are a number of ways a forest manager or landowner can move a stand back to pines as well as keep a stand productive. These means include controlling interference with chemicals, using prescribed burning once advanced pine regeneration or planted pines are 10 years old, cutting unwanted stems and species within the stand, and removing trees of the crop species which are poorly growing, in poor health, poorly formed, or too densely planted. Plant-

ing can be used to establish new pine stands and provide genetic improvement and pest-resistant trees on a site. Each of these processes has advantages and disadvantages, and all can be misused.

The purpose of renovation is to thin pines which are too dense, or to push ecological processes back to an earlier stage. Holding a site at an early ecological stage minimizes interference, assists with natural reproduction, and ensures future stands will be easier to manage. The level of treatment needed to allow pines to dominate a site is limited by the additional economic returns a specific treatment yields at harvest time. The most effective and efficient level of treatment per acre, at the lowest cost over time, determines what treatment to use and to what extent.

Herbicides -- Modern chemicals are becoming more specific, less costly and pose less of an environmental impact than earlier chemicals. Their use, following label specifications, is a tremendous aid in controlling competition and unwanted species. Chemicals can be sprayed by helicopter, ground units or backpack sprayers or hand injected. Single trees, small areas, or blanket applications can be prescribed for specific management objectives.

Prescribed Burning -- One of the most useful and least expensive forest management tools is careful application of fire. Fire removes interfering vegetation and destroys dense litter with little damage to pines of the desired age and height. Care must be taken so fire does not destroy young pines or disfigure marketable pines.

Fire pushes ecological processes back to an early stage and, if used periodically, can build a pine stand. A single prescribed fire in a stand needing renovation does little long-term good, but a series of prescribed burns two to three years apart will destroy new sprouting hardwoods and help pines.

Timber Stand Improvement (TSI) -- Removal of unwanted hardwood stems by cutting or chemicals allows more site resources to be used by crop trees. Dead, dying, pest-filled, decayed, malformed or suppressed trees should be removed and kept from reproducing in the stand. Eliminate undesirable and poor trees before any release treatments, since these trees will respond to any resulting increase in growing space. Large hardwoods can be effectively controlled by herbicide application. TSI can be expensive and contractors may be difficult to find.

Thinning -- Thinning removes marketable pines which are flat-topped, damaged, poorly formed, pest-attacked, decayed, declining or suppressed. Thinning is also used in renovation work to cut "wolf" trees. Wolf trees are: large and limby with little merchantable value; over-consume resources such as light, water, space and essential elements out of proportion to their value; and, prevent new pines from growing. Thinning is also used to remove marketable pines growing too close together.

Thinning operations must be carefully applied to prevent residual stand damage to young and mature trees. In some areas it may be difficult to find professionals to thin stands of pines. With low pulpwood demand, long hauling distances to pulpwood mills and/or low pulpwood price markets, it will be difficult to find contractors who thin stands. In addition, without merchantable stems, all costs and no present revenues will occur.

Planting -- Planting establishes new trees in large areas where few pines exist. Single tree planting or interplanting in small patches are not cost-effective. Planting can replace stands in which high-quality stems have been cut out and only poor stems exist. Planting allows pines with improved genetic attributes such as pest resistance, and growth and form improvements, to become established on a site. The current pine stand must be clearcut with proper site preparation performed before pine seedlings can be planted because pines are site/ shade intolerant.

Renovating Hardwood Dominant -- Pine Understocked Stands

One type of renovation is designed for stands dominated by hardwoods and greatly understocked with pines. These stands require hardwood removal and pine regeneration. Financial, pine growth rates, and site considerations must be carefully examined when treating this type of stand.

Remove hardwoods with periodic fire and/or chemical treatments. Most hardwoods less than three inches in diameter have bark susceptible to fire damage. The first fire kills the main stem and later periodic fires kill sprouts. Repeated prescribed burns are necessary for hardwood control. Larger hardwood trees not killed by fire can be chemically injected. If advanced regeneration of pine develops in the understory after the first prescribed fire, wait several years for a second fire to prevent seedling pine damage. Individual or group release of existing young pines from interference is usually needed.

Large areas that are at least one to five acres in size, devoid of crop trees, and have had vegetation controlled (such as with a herbicide treatment) are suitable for planting. Plant across the site with 12-foot by 6-foot (605 trees per acre) spacing. Control herbaceous and woody plant interference around seedlings and eliminate any overtopping neighboring hardwoods. Plant pines in full sun and delay further fire until seedlings are seven to ten years old. Release pines from surrounding interference with chemicals in two to five years if needed. Prescribed burning done just before heavy pine seed crops can help establish new pine seedlings with a low-cost natural regeneration system.

Renovating Severely Highgraded Stands

Many poor pine stands have been severely highgraded. Diameter-limit cutting, selective cutting, and aesthetic / development cuts are forms of highgrading. Highgrading is cutting the best trees and leaving the pest-infested, decayed, damaged, crooked, dying, declining and suppressed trees to grow and reproduce. After several cycles of highgrading, stand productivity for timber values will decline to where there is little value in a stand and few expectations of producing value through tree growth.

This type of stand requires enrichment plantings, heavy TSI, and hardwood control to prevent hardwood dominance. Because stands are abused by different means of highgrading, careful examination and treatment application are required. Plant in areas completely harvested or opened by vegetation control to establish high-quality pines on the site. Plant in blocks with about 300 seedlings per acre on a 12-foot by 6-foot grid (605 trees per acre) so that each pine is in full sun and free to grow.

Remove interfering plants and weed trees by a pre-planting prescribed burn, wait seven to ten years for pines to grow, then begin a periodic cycle of prescribed burning. Interference can be removed and pines released by herbicides within two to five years. If large pines can act as

seed trees (six to thirty mature trees per acre with large crowns, depending upon the species), burn in late Summer before good seed crops.

A problem with highgraded stands is not from ecological processes moving to hardwoods, but from limited biological productivity. Reverse this process by eliminating all unwanted or unacceptable stems, and by favoring good pines already on the site. Several TSI treatments and harvest / plantings may be needed for full recovery.

Renovating Harvested Sites Without Regeneration Present

One of the most prevalent and costly mistakes made with pine stands is harvesting with no regeneration plan or delaying regeneration. Every year a site is not producing pine wood represents income lost and potential site productivity lost.

Regeneration delays cause the next pine forest, when established, to suffer greater interference problems, be more costly to establish and take longer to grow to harvest. If regeneration is not planned at all, a site usually follows a natural ecological pattern dominated by hardwoods. The more hardwoods present, the more expense and time needed to recapture the site for pine production.

These types of stands require vegetation control by fire and chemicals to minimize hardwoods, site preparation on some areas, and planting. If naturally regenerated pines do not exist on the site, the stand should be liquidated and burned. The site can then be regenerated by low-cost site preparation and planting methods. Pine release after two to five years will probably be needed.

If more than 150 stems of advanced pine regeneration (greater than one inch in diameter) or more than 300 stems of established pine seedlings exist, use pine release. Clumps of seedlings create spacing problems and should be thinned out. If little natural pine regeneration exists, the site is still young enough in the harvest rotation to be started over. Additional chemical, brush cutting / control, and prescribed burning will be needed to ensure pine dominance.

Renovating Stagnated Stands

Just as stands with no pine regeneration are a problem, so are young stands which have 1,200 or more stems per acre. These stands suffer from severe interference which slows growth and stagnates young stands. Whole stands can be lost when stagnated. Stagnation resulting from too many stems is usually apparent by the second to fifth year. Many pest populations are more successful in dense stands and can destroy many trees.

Young stands can be precommercially thinned. This method is expensive, but is one of few remedies for crowded seedlings. Poorly formed, poorly positioned or diseased stems should be cut about six to 12 inches above the ground. Crop trees should be left at levels of 300 (12- by 12- foot spacing) to 500 (9.5-by 9.5- foot spacing) stems per acre. If left untreated, the entire stand could be lost to pest or interference problems, or have slow growth for decades.

Older stands over 130 square feet of basal area can stagnate and be prone to pest attack and stress problems. These stands were planted too densely and never thinned, or arose from dense natural regeneration. Older stands require more care in thinning than young stands. Some species, such as slash pine, do not respond well to thinning after stagnation. Wind blow-down and ice damage can become problems for remaining trees in newly thinned older stands. In addition, residual tree damage from thinning is difficult to prevent in a dense stand. Thin stands back to 70 to 80 square feet of basal area for the first thinning in a stagnated older stand.

Be Aware Of Problems

Table 1 and Table 2 provide general guidance for forest landowners with poor pine stands. These two tables provide decision points for understanding existing problems, and helping develop viable solutions tuned to your special circumstances and specific sites. This review of general management solutions to poor pine sites should not be used alone as a management tool, but does provide an awareness and educational tools to help forest landowners consider ecological, financial, and land use choices over time.

Conclusions

Bad stands can be a result of bad management, bad site history, and/or poor quality sites. Site quality can not be corrected in the short-run, but existing management mistakes and poorly stocked stands can be corrected. Good sites can have many bad management decisions, mistakes or unexpected acts of nature appear as poor tree stocking and growth. Renovating these stands will keep them productive.

Renovating pine stands does require investments of time and money to make up for years of neglect, abuse or ignorance. Seek professional assistance from foresters to properly manage your forest resources. Invest in the future by renovating non-productive sites.

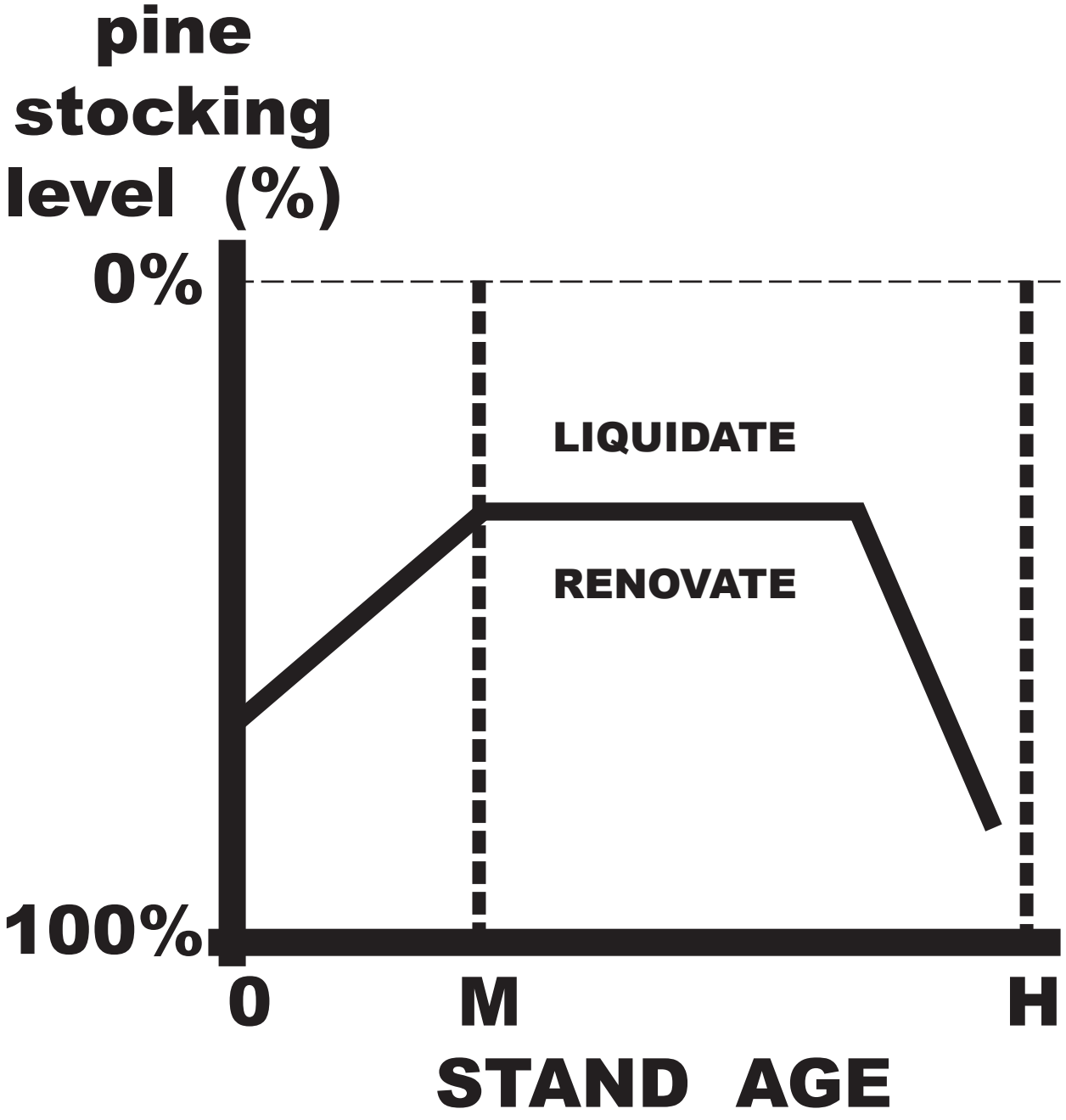

Figure 1: Example decision guide for total liquidation of a pine stand at a given interest rate. This decision line is different for every forest landowner situation and interest rate.

If a stand is below the line then renovate. If a stand is above the line liquidate. M = stand becomes merchantable. H = expected harvest age.

Table 1. General decision table based upon stand conditions under average circumstances.

Items Measured	"Manage Existing Stand"	"Harvest & Regenerate Stand"
A) Total Basal Area	over 65 sq ft	under 65 sq ft
B) Average merchantable pine age	middle-aged	< 5 years old OR closer than 5 years to harvest
C) Pine growth rate & crown size	medium to fast/ greater than 1/3 live crown	slow/ less than 20% live crown
D) Percent pine BA of total site BA	greater than 60%	less than 40%
E) Advanced pine regeneration per acre (> 1 inch diameter)	more than 150 stems	less than 100 stems

Table 2: Decision points from Table 1.

Decision I:

If all items (A - E) in the "harvest and regenerate" (right) column are true for your stand, completely harvest and replant, provide competition control and expect to use pine release. Once pines are large enough, use periodic prescribed burns.

Decision 2:

If conditions D & E in the "manage existing stand" (left) column are true for your stand, advanced and natural regeneration can be used to help regenerate the site as harvest approaches, or uneven-aged or group management can be used.

Decision 3:

If conditions A - D in the "manage existing stand" column are true for your stand, use prescribed fire and TSI to push the stand back to pine domination.

Decision 4:

Do nothing regardless of stand conditions. Stand risks, productivity losses and monetary losses can be great.

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