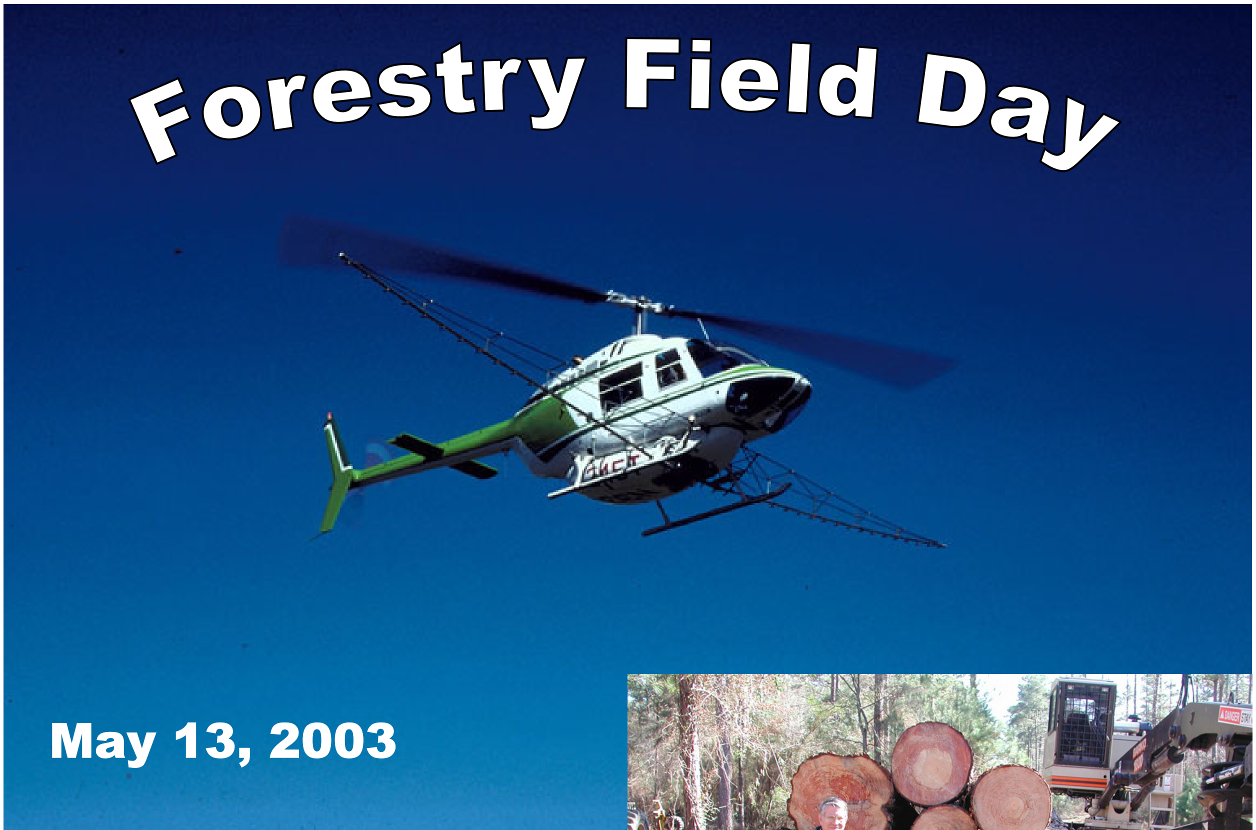
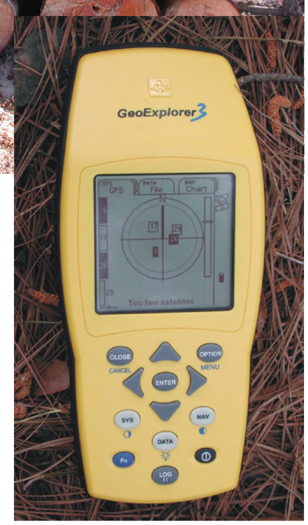
2003 Crossett

Forestry Field Day



May 13, 2003



Something Old
—Something New

Crossett Experimental Forest
Crossett, AR

Sponsored by:

USDA Forest Service,
Southern Research Station
University of Arkansas-Monticello,
Arkansas Forest Resource Center
Arkansas Cooperative Extension Service
Arkansas Forestry Commission

CROSSETT FIELD DAY

Something Old--Something New

May 13, 2003
Crossett Experimental Forest
Crossett, AR

Agenda

9:00-9:30 Welcome, Introductions, Overview

Time	Landowner Group	Forester Group
9:45-10:30	GPS/GIS Applications	Chemical site preparation
10:45-11:30	Natural reproduction cutting methods	Harvesting impacts
11:45-1:00	Lunch	Lunch
1:15-2:00	Chemical site preparation	GPS/GIS Applications
2:15-3:00	Harvesting impacts	Natural reproduction cutting methods
3:15-3:45	Open house at CEF headquarters	Open house at CEF headquarters

This field day is a cooperative effort of the USDA Forest Service, Southern Research Station; the Arkansas Cooperative Extension Service; Arkansas Forestry Commission; and the School of Forest Resources, University of Arkansas at Monticello. These agencies offer their programs to all eligible persons regardless of race, color, national origin, sex, age, or disability.

--Have a safe trip home--

Overview of the Historic Crossett Experimental Forest

In 1934, the Crossett Experimental Forest was established in Ashley County, Arkansas, from a donation of 1,680 acres of land by the Crossett Lumber Company (now Georgia-Pacific Corporation) to the Southern Forest Experiment Station (now the Southern Research Station). The Crossett Research Center was the first USDA Forest Service branch research station in the South. Previously, all field research had been conducted from station headquarters in New Orleans, LA. Research on forest management in second-growth loblolly and shortleaf pine stands was to be conducted and demonstrated to forest managers and landowners throughout the South. During the following six decades, Forest Service Researchers associated with Crossett have published more than 500 articles on forest management and silviculture. More than 45,000 foresters, students, landowners, and university staff have visited the Experimental Forest and benefited from its research.

The present day Research Work Unit (RWU), now located on the University of Arkansas campus at Monticello, continues the tradition of research on practical, low-cost silviculture in natural stands. This information is needed by private nonindustrial forest landowners, forest industry, and National Forests throughout the South. With personnel located throughout Arkansas, the RWU has extended its research to include silviculture and management of pine-hardwood and upland hardwood stands. A major achievement for the RWU has been the publication of a management guide to uneven-aged silviculture of loblolly and shortleaf pines. That capstone publication incorporates 60 years of research begun by the first researchers at Crossett and continued by their successors to this day.

Research Work Unit 4106 is responsible for administration of the Crossett Demonstration Forest. The Forest serves as a training center and outdoor classroom for various user groups. Activities include field days, workshops, and tours that demonstrate proven forest management techniques.

Research Work Unit Title: "Managing Upland Forest Ecosystems in the Mid-South"

RWU-4106 research problem areas:

- regeneration processes
- stand-level forest ecosystem dynamics
- landscape-level ecosystem dynamics

Mission Statement: To provide scientific information to understand, manage, and sustain the ecological processes, structures, and benefits of loblolly pine, shortleaf pine, mixed pine-hardwood, and hardwood forests in the uplands of the Mid-South.

USDA FOREST SERVICE
RWU-4106 PERSONNEL

Research Staff

University of Arkansas--Monticello, AR:
- Don Bragg, *Research Forester*
- Michael Shelton, *Research Forester*

Hot Springs, AR:
- James Guldin, *Project Leader/Research Ecologist*
- Martin Spetich, *Research Forester*

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- Daniel Marion, *Research Hydrologist*

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- Jim Whiteside, *Forestry Technician*

For more information about our unit, including addresses, phone numbers, and publications, visit our website at www.srs.fs.usda.gov/4106/index.htm or contact Project Leader Jim Guldin at jguldin@fs.fed.us

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SPEAKERS

GIS Technology and Forestry
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Arkansas Forest Resources Center

The "Comp" Study
Carroll Walls
Manager of Research and Development
UAP Timberlands
and
Dr. James Guldin
Research Ecologist
USDA Forest Service
Southern Research Station

The Methods of Cut Study
Dr. Michael Shelton
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Harvest Technology and Natural Stand Management
Dr. Don Bragg
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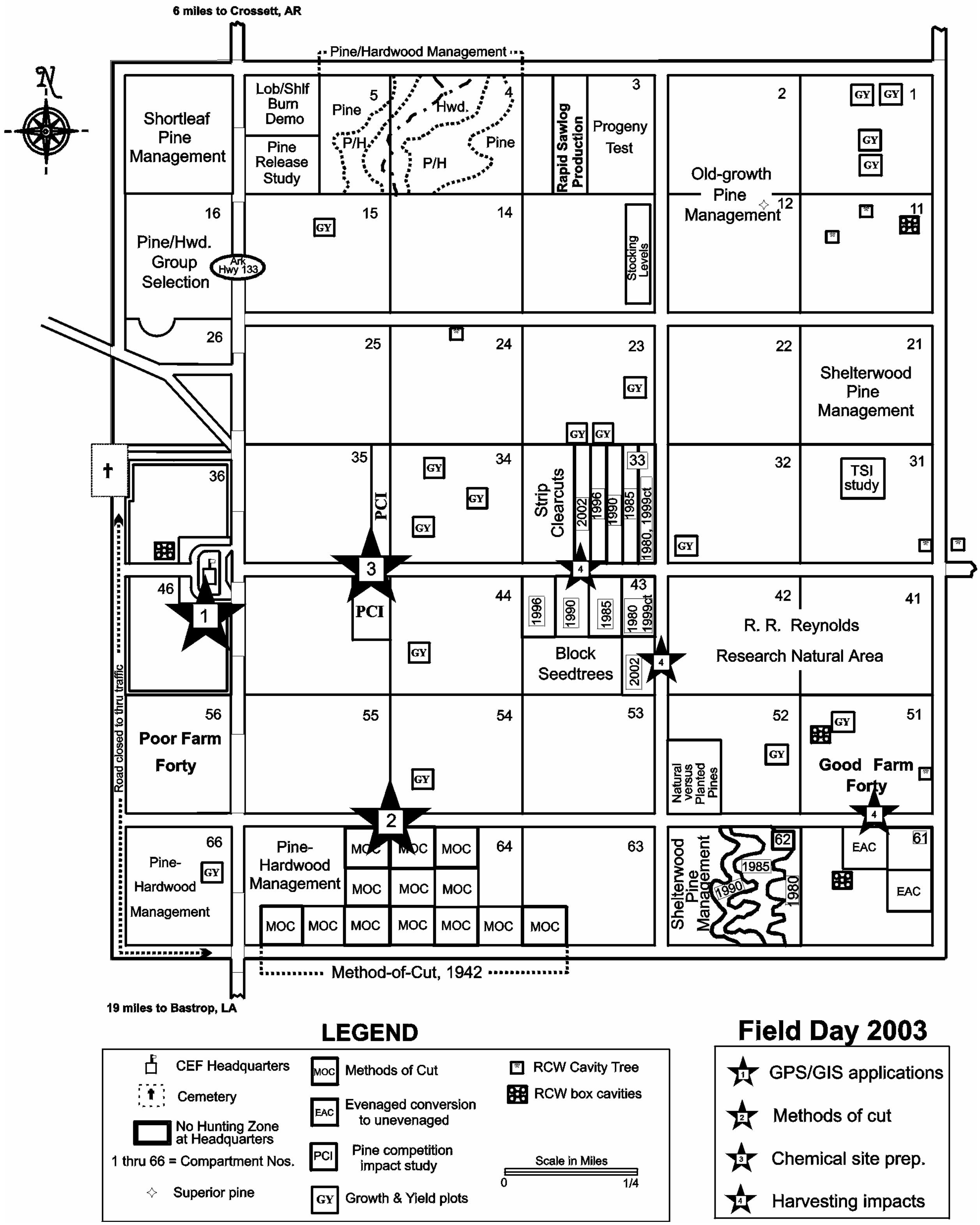
CROSSETT EXPERIMENTAL FOREST

Crossett Forestry Field Day, May 13, 2003



THE “COMP” STUDY:
18-YEAR RESULTS OF COMPETITION IMPACTS ON NATURAL STANDS OF LOBLOLLY AND SHORTLEAF PINES

Since most of the pine forests from which trees are being harvested in the southeastern United States originated from natural seedfall, this method of regeneration is still an important means of reforestation in this region. Even though loblolly and shortleaf pines are often principal components of the overstory in naturally regenerated forests, the understory is usually occupied by a dense mixture of shade-tolerant hardwood trees, woody shrubs, and herbaceous vegetation. When pines are harvested in natural stands, the forest floor is often exposed to full sunlight which promotes the invasion and growth of early successional vegetation. These herbaceous and woody plants can quickly overtop recently established natural pine seedlings and compete with larger pines for growing space, sunlight, soil moisture, and nutrients, thereby resulting in high mortality of pine regeneration and growth loss in pine saplings and trees.

An often-cited disadvantage for natural regeneration of southern pines is the inability to control density at the time of establishment. In the West Gulf Region, natural stands of loblolly and shortleaf pines can produce good seed crops (40,000 sound seeds per acre) in 7 out of 10 years. When these seeds are disseminated onto receptive sites, excessive pine density can result. In such situations, precommercial thinning is often recommended to shorten the rotation and reduce the risk of loss by fire, insects, diseases, and weather.

This study was conducted to investigate the interrelationships among woody and herbaceous competition components and to assess the impact of these components on establishment, survival, and growth of naturally regenerated loblolly and shortleaf pines.

Site description

The study is located within two 5-acre clearcuts located 300 feet apart on the Crossett Experimental Forest in southeastern Arkansas. Soil series are Bude and Providence silt loams. These soils have a site index of about 85-90 feet for loblolly pine at age 50 years.

Before study installation, the area was a 3-year old seed-tree stand, in which the seed trees had just been removed. However, this regeneration effort was abandoned so that the study could be installed. In August 1983, before study installation, the 3-year-old thicket of pines, hardwood sprouts, shrubs, brambles, and vines on both areas was mowed with a Hydro-ax® to create a uniform vegetation height of about 2 feet. During the fall and winter after mowing, the areas seeded naturally from mature pines that bordered the clearcuts. Pine seed production from this 1983-84 seed year averaged 1 million sound seeds acre. In the fall of 1984, pine regeneration averaged 13,200 seedlings/acre. It was estimated that over 90% of these seedlings were from the 1983-84 seed crop; the older seedlings were from previous seed crops but were too small to be mowed down.

Study design and treatments

Eight treatment plots were established within each 5-acre clearcut. Treatment plots were 0.25 acre with 0.10-acre interior subplots for measuring pine growth. Treatments were replicated four times in a randomized, complete block design with blocking based on pretreatment stocking of pine regeneration. Each interior subplot contained 10 permanent 0.001-acre circular plots that were systematically established for obtaining natural pine and woody rootstock densities and quadrat stocking by size class, plus ocular estimates of percent vegetative ground cover.

Three competition control treatments were initiated during the 1984 growing season and were maintained along with an untreated check as follows:

> **Check**. No additional treatment of herbaceous or woody nonpine vegetation was made after mowing in 1983.
>
> **Woody Control**. All hardwoods, shrubs, and woody vines were controlled annually by single-stem treatments with a herbicide (10% Garlon® 4E) for the first 5 consecutive years.
>
> **Herbaceous Control**. Forbs, grasses, semiwoody plants, and vines were controlled annually using multiple applications of pre-emergent and post-emergent herbicides (Oust® at 0.25 lb a.i./acre, Vantage® at 0.74 or 1.50 lb a.i. acre, and/or 2% Roundup®) for the first 4 consecutive years.
>
> **Total Control**. A combination of herbicides, as described in the woody and herbaceous treatments, was used to control all nonpine vegetation. Woody plants were controlled for the first 5 consecutive years and herbaceous vegetation was controlled for the first 4 consecutive years.

Other silvicultural activities

Precommercial thinning is often recommended when the pine density exceeds 5,000 stems per acre or if the live crown ratio drops below 40%. At 5 years, there was an average of 9,500 pine seedlings per acre across the study area. Before the sixth growing season, 500 crop pines per acre were selected for retention according to their dominant or codominant crown class, spacing, and absence of obvious defects. All other pines taller than 5 feet were precommercially thinned by hand on all plots. Across all plots, 90% of the crop pines were loblolly and the other 10% were shortleaf. Current costs of precommercial thinning are $50 to 100/acre depending on the method used and the existing stand conditions.

At 13 years, pines on the study area were commercially thinned to leave 200 crop trees per acre; all trees were harvested as pulpwood. This thinning removed the following volumes (cords/acre): 5 in Check, 7 in Woody Control, 9 in Herbaceous Control, and 12 in Total Control.

Competing vegetation at 5 years

After termination of herbicide applications, the coverage of competing, non-pine vegetation was as follows:

Treatment	Percent coverage	
	Herbaceous	Woody
Check	78	38
Woody	92	1
Herbaceous	7	38
Total Control	18	0

These results are as expected. In the Check, where no treatments were applied other than mowing, the competing vegetation consisted of both herbaceous and woody vegetation. Coverage of herbaceous vegetation was twice that of woody vegetation. Where Woody Control was conducted, the competing vegetation was virtually all herbaceous. In contrast, where Herbaceous Control was conducted most of the competing vegetation was woody. The Total Control plots had some herbaceous vegetation which had developed after applications were terminated, but these plots had no woody competition.

Production through 18 years

At 18 years, the stands had the following characteristics:

Treatment	D.b.h. (in.)	Height (ft)	Basal area (ft^2/ac)	Merch. vol. (ft^3/ac)	Saw. vol. (bf Int./ac)	Total vol. prod. (ft^3/ac)*
Check	9.0	52	89	1770	3500	2170
Woody	9.7	55	97	1960	4440	2510
Herbaceous	9.5	56	98	2090	5000	2820
Total Control	9.8	56	105	2280	5720	3210

* Total volume production is the merchantable volume at 18 years plus the volume harvested at 13 years.

At 18 years, the increased sawtimber volume over the Check was 27% for woody control, 43% for herbaceous control, and 63% for total control. The basal areas present at 18 years indicate that the plots that were treated with herbicides could be thinned for a second time–just 5 years after the first commercial thinning. Recommended post-harvest basal areas would be 75-80 ft^2/acre, and removals would be expected to be 6 to 8 cords/acre, which is an operable cut under most market conditions. The projected cut in the check plots (i.e., 4 cords/acre) is currently too low to be operable if harvested alone, but harvesting is possible in context with the entire study.

Modern advances in herbicide technology

The herbicides that were available for competition control when this study was installed in the mid 1980s were fairly limited in their selectivity. Recent advances in herbicides and their combination in tank mixes has allowed making prescription for specific stand needs. Chemical site preparation provides multiple benefits in regenerating natural pine stands by promoting seedling survival, increasing growth, and extending the receptivity of the seedbed. Some examples of chemical site preparation applications that have proven effective in natural pine stands on Coastal Plain sites follow:

Product	Application Period*	Product Rate/ac	Cost ($/ac)†
Velpar® ULW	Spring	5 to 6 lbs	110 to 128
Velpar® 75 DF	Spring	5 to 6 lbs	123 to 143
Velpar® L	Spring	7.5 to 9.0 qts	123 to 143
Arsenal® AC *plus*		16 to 20 oz	
Oust® *plus*	:	3 oz	:
Escort® *plus*	Fall	¾ oz	129 to 143
Timberland® 90	:	1 qt	:

* Spring: February 1 to May 15; Fall: July 15 to October 15.
† Costs include both the product and the application as a turnkey operation.

THE METHODS OF CUT STUDY

During the winter of 1943, four natural reproduction cutting methods for loblolly and shortleaf pines were imposed on twelve 4.4-acre plots in a 3-replicate, completely randomized design. Measurements were taken on interior 2.5-acre plots. Soils of the study area are Providence and Bude silt loams, having a site index of 85-90 feet at 50 years for loblolly pine. Before study implementation, the stand was an unmanaged, second-growth pine-hardwood stand that had developed following diameter-limit cutting the virgin forest to a 12-inch d.b.h. in around 1915. Preharvest stand conditions were fairly uniform, consisting of a mixture of loblolly and shortleaf pines intermingled with overstory and midstory hardwoods. The study was active from 1943 to 1968 with inventories and potential harvests being conducted every 5 years. There was no activities from 1968 until 1979 because the Experimental Forest was temporarily closed. The study was re-activated in 1979. The following treatments were randomly assigned to each of three plots:

Clearcut: All merchantable pines and hardwoods (trees larger than 5.5 inches d.b.h.) were harvested in January 1943. Plots were prescribed burned in the spring of 1943 to reduce logging slash, prepare the seedbed, and control small hardwoods. The seed source was pines in adjacent plots or in the uncut stand. In 1946 all hardwoods larger than 3.5 inches d.b.h. were cut to release pine regeneration. The plots were thinned from below about every 5 years beginning in 1980, and were burned the winter before each harvest.

Heavy seed tree: All merchantable pines and hardwoods were harvested in January 1943 except 15 dominant and codominant seed trees per acre. In addition, there were 16 pines per acre in the 4- and 5-inch d.b.h. classes, which were considered submerchantable at that time. In 1946 all hardwoods larger than 3.5 inches d.b.h. were cut to release pine regeneration. Pine seed trees were cut in 1958, 15 years after the study began. Plots were thinned from below about every 5 years beginning in 1980, and were burned the winter before each harvest.

Diameter limit: Pine sawtimber in trees larger than 11.5 inches d.b.h. and all merchantable hardwoods were harvested in January 1943. In 1946 all hardwoods larger than 3.5 inches d.b.h. were cut to release pine regeneration. Subsequent harvests were conducted when an operable volume existed (around 1,500 board feet Doyle per acre) with evaluations being made every 5 years. When conducted, harvests removed all sawtimber trees 12 inches d.b.h.. In addition, pulpwood was thinned in 1968. Herbicides were used when they became available in the 1950s and 1960s, but the frequency of use is not known. Since re-activation of the study: (1) the area was burned in 1980, (2) submerchantable hardwoods were injected in 1981 with Tordon, and (3) a broadcast application of Arsenal was made in 1990.

Uneven-aged management: Merchantable pines were harvested as single trees or small groups on a 5-year cutting cycle beginning in 1943. Merchantable hardwoods were harvested in January 1943, and all hardwoods larger than 3.5 inches d.b.h. were cut in 1946. Regulation of the pine harvest was by volume control. A fully stocked uneven-aged stand has 1,300 ft^3/acre or 6,700 board feet (Doyle) per acre in the sawlog component. Because the stand was understocked in 1943, only part of the periodic sawtimber growth (about two thirds) was cut until the stand reached full stocking. Thereafter, all of the sawtimber growth produced during a cutting cycle was harvested. Some pulpwood was also periodically harvested. Herbicides were used when they became available in the 1950s and 1960s, but the frequency of use is not known. Since re-activation of the study: (1) the area was burned in 1980, (2) submerchantable hardwoods were injected in 1981 with Tordon, and (3) a broadcast application of Velpar was made in 1986 and Arsenal in 1990.

Measurements and calculations: All pines with d.b.h. ≥ 3.6 inches were inventoried by 1-inch d.b.h. classes. Merchantable cubic footage (inside bark to a 3.5 inch inside-bark top) was calculated from a local volume equation. Sawtimber volume (board feet Doyle to a 7.5 inch inside-bark top) was calculated for pines ≥ 9.6 inches d.b.h. using a local volume equation.

Results

Figure 1 shows characteristics of the standing crop (the trees present at any given time) through 53 years of development. Each reproductive cutting method has a unique pattern. The clearcut begins at zero, because all merchantable trees were cut at the beginning. Then values increase rapidly through time; the increase with basal area and merchantable volume are quicker and steeper that of sawtimber volume because of the different merchantability standards involved. At 36 years, thinning was implemented in the clearcut, and standing volume showed decreases from thinning followed by increases from growth. The basal area and volume for the heavy-seed trees stands was initially above zero because of the retained seed-trees. They were cut at 15 years, which is why all values decreased at that time. After the seed-tree removal, the seed-tree stand looked very similar to the clearcut. The diameter limit cut shows irregular periods of increases and decreases. Sawtimber volume drops to zero following a cut because all trees of sawtimber sizes were cut. However, merchantable volume and basal area are always above zero because of trees in the pulpwood-size classes. The uneven-aged stand shows a "sawtooth" pattern; no value drops to zero because some sawtimber stocking is always retained. The large peak at 30-36 years was due to suspension cutting while the Research Unit was closed in the mid-1970s.

Total production at a particular time is the standing crop at that time plus the total cut through that time, and then minus the value present at 0 years. Total production is a good way to compare the reproduction cutting methods because it accounts for all growth elements: what's there now and what was previously cut, in addition to accounting for what was there initially. Values for total production are shown in figure 2. For total merchantable volume, there was not much difference in all four methods through 30 years, after which the clearcut, seed-tree and diameter-limit stands were about equal but exceeded the uneven-aged stand. However, a different pattern was displayed for sawtimber volume because this component is very sensitive to tree size. The uneven-aged stand was the top producer through 30 years, after which the uneven-aged stand, the clearcut, and the seed-tree stand converged and the diameter limit was the lowest producer. At 53 year, the top producer (the heavy seed-tree stand) grew about 5,000 board feet per acre more than the poorest producer (the diameter limit stand).

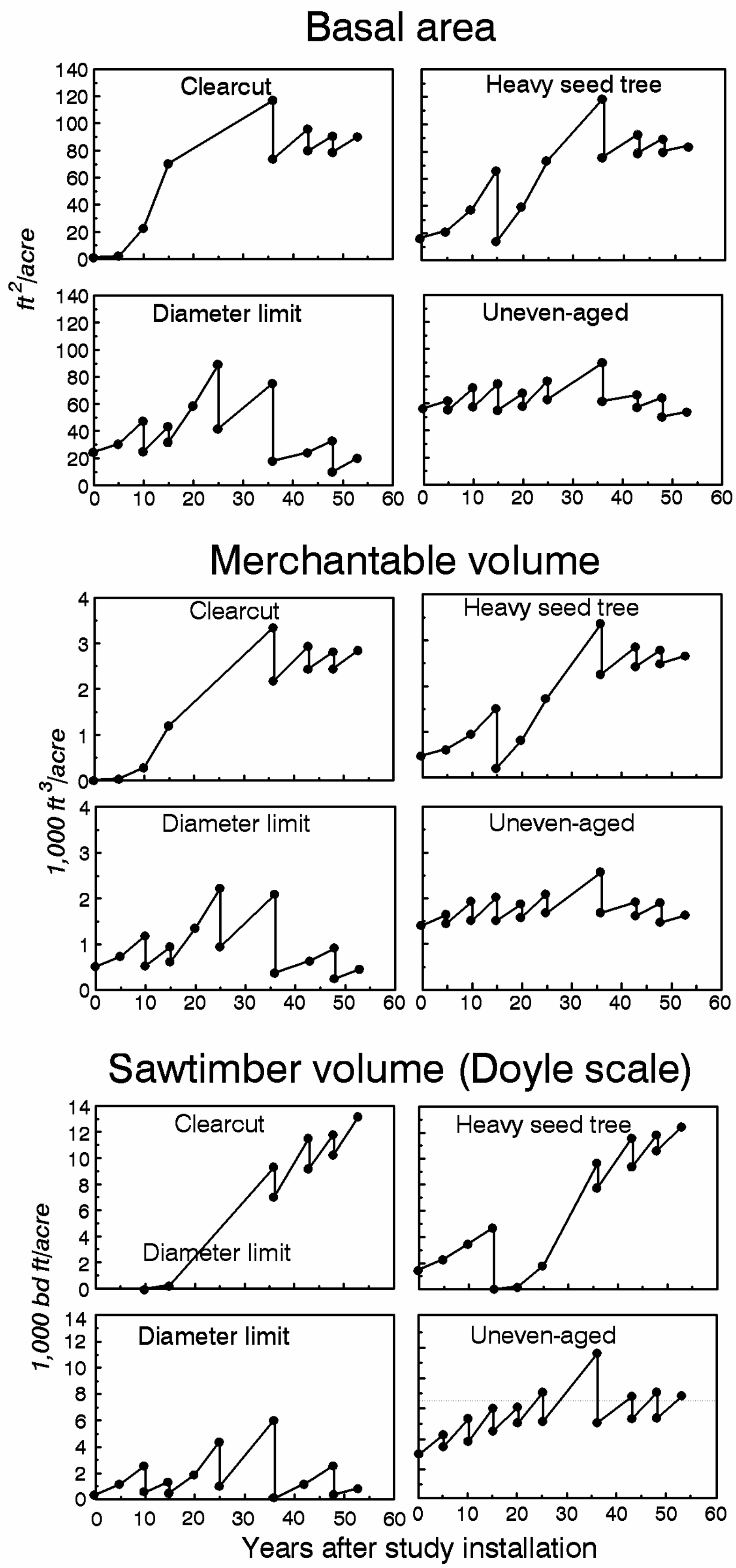


Figure 1. Values for the standing crop in the methods of cut study.

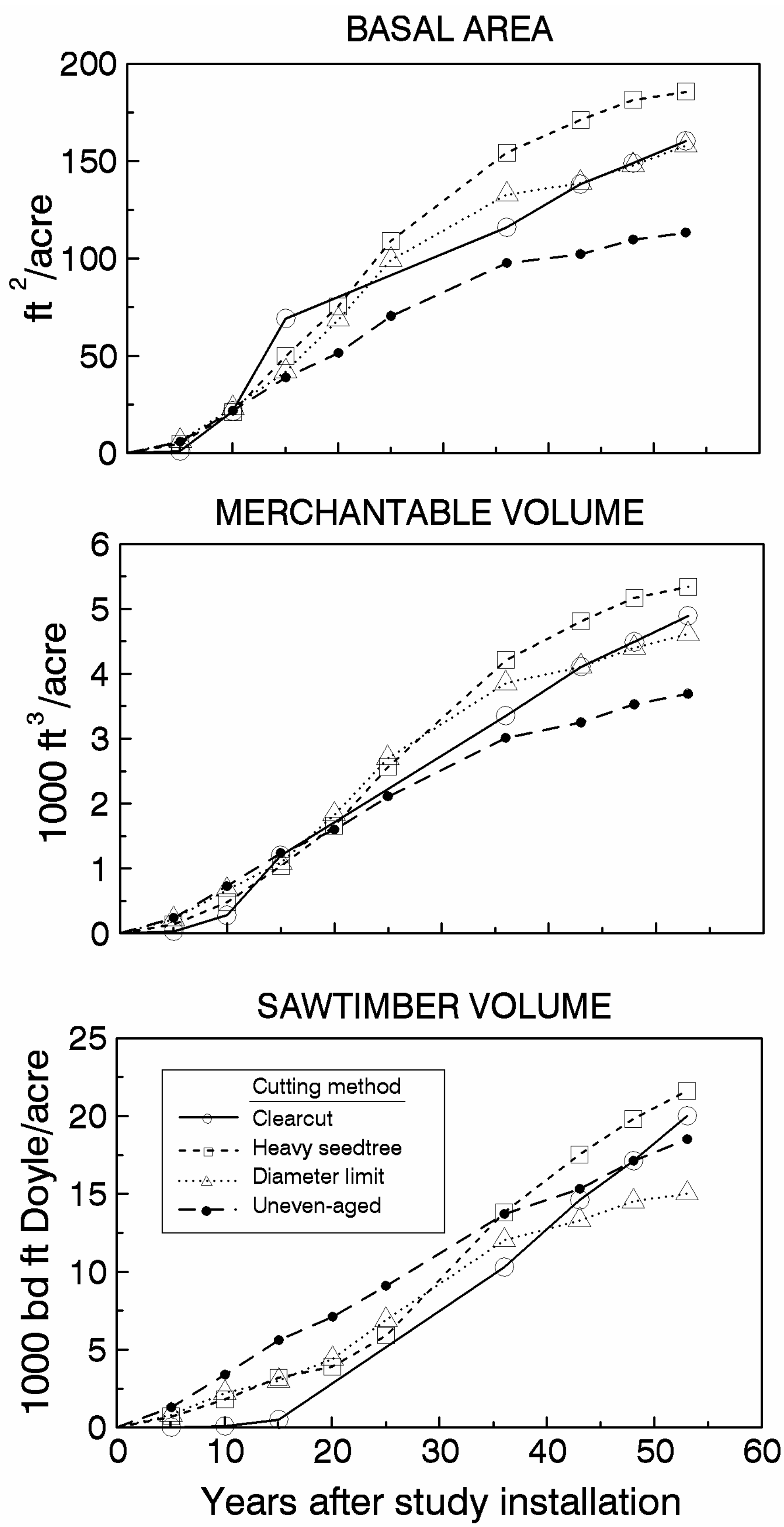


Figure 2. Total production (standing crop + cut - initial) for the methods of cut study.

The periodic-annual increment (PAI) for sawtimber production is shown in Figure 3a. The PAI for the clearcut begins at zero and then reaches a maximum of 600 board feet/acre/year at 40 years. Because of the retained seed trees, the heavy seed tree stand produced about 200 board feet/acre/year for the first 15 years, when the seed trees were removed. The PAI peaked at 30 years at 700 board feet/acre/year, and then declined more sharply than the clearcut. PAI for the diameter-limit stand was erratic, showing periods of high growth followed by periods of low growth. This results because stocking is not regulated as in the other stands. In contrast, PAI for the uneven-aged stand was fairly consistent through time, varying between 250 and 400 board feet/acre/year.

The number of pulpwood- and sawtimber-sized trees are shown in Figures 3b and 3c. Note that the pulpwood-sized trees in the clearcut and seed-tree stands reach a peak around 15 years and then decline to zero as all trees within the stand attain sawtimber sizes. In contrast, both the diameter-limit and uneven-aged stands have pulpwood-sized trees throughout their development. This occurs because of the stand dynamics associated with recurring regeneration and its development: seedlings grow in to saplings, saplings become pulpwood, and pulpwood becomes sawtimber. This dynamics is needed to maintain the multiple size classes characteristic of uneven-aged structure. In the diameter-limit stand, structure is a happenstance of the periodic cutting. In contrast, structure is an important silvicultural goal in the uneven-aged stand. Note for example that the number of sawtimber trees has been very uniform in the uneven-aged stand--about 35-40 trees/acre after harvest. This occurs because it is a goal of stand regulation. Compare this pattern to the wide fluctuations of the diameter-limit stand. Also note that the number of pulpwood trees in the uneven-aged stand was fairly constant at 80 to 100 trees/acre through 35 years and then declined to only 10 trees/acre at 53 years. For good uneven-aged structure there should be about 100 pulpwood-sized trees/acre. What happened? Several things. First, the stands became overstocked in the 1970s when the Research Unit was closed. Second, once cutting was reestablished to control stocking in the 1980s, there was no effective broadcast herbicide for controlling competing vegetation. Thus, structure continued to deteriorate. An important principle of uneven-aged silviculture is that it takes a long time to build back good structure once it is lost.

So what is the take-home message? The clearcutting, seed tree, and uneven-aged reproductive cutting methods are all viable options. The resulting stands will all have about the same productivity if they are carried long enough through time. There are different costs and benefits associate with each system. This allows landowners to pick the one which best meets their needs. By contrast, diameter-limit cutting should not ordinarily be practiced; its yield was about 20% below that of the other management systems.

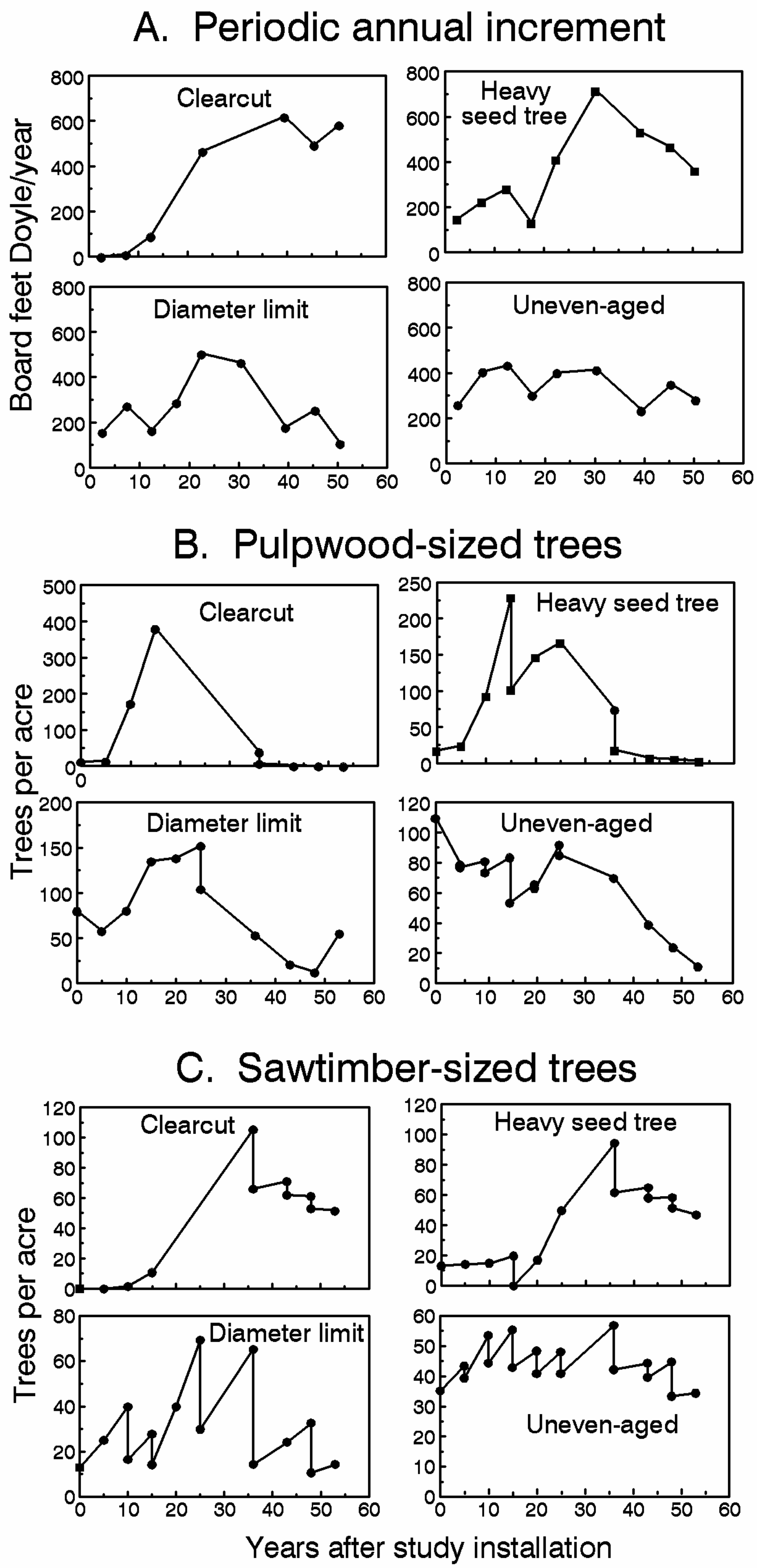


Figure 3. (A) Periodic annual increment and (B and C) trees per acre for the methods of cut study.

Comparing Reproduction Cutting Methods

Each natural reproduction cutting method has certain advantages and disadvantages. This allows prescribing different methods to meet the specific needs of the landowner and the stand. In addition, loblolly and shortleaf pines can be effectively regenerated using the full range of both natural and artificial methods.

Clearcut with natural regeneration:

Advantages

- Area regulation is simple to administer and operations are concentrated in both time and space.
- Logging method can be chosen without regard to protecting the residual stand.
- No trees are left on the regenerated area where they could be lost to wind, insects, lightning, etc.
- Timber marking is limited to defining the area to be cut.

Disadvantages

- Clearcut areas must be narrow to insure seeding from adjacent stands.
- Clearcut areas are visually unattractive to many people.
- No merchantable material can be harvested for 12 to 20 years.
- Weed and shrub competition is usually severe until the pine canopy closes.
- No overstory trees are present to protect soil amenities.

Seed-tree and shelterwood methods:

Advantages

- Large areas can be harvested in a single operation.
- Does not rely on seeding from adjacent stands.
- If weather or fire delays regeneration, the seed source remains to regenerate the area.
- Seed-tree removal can assist in precommercially thinning dense stands.
- More visually pleasing than clearcuts.
- Seed-trees continue to grow, producing high quality wood.

Disadvantages

- Careful logging and site preparation are required to protect seed trees.
- Residual trees may be lost to wind, lightning, insects, etc. before harvest.
- Seed trees may be difficult to sell because of low volume.
- Regeneration may be heavily damaged during seed tree removal.
- Multiple stand entries are needed to liquidate the original stand, compared to one for a clearcut.

Uneven-aged methods:

Advantages

- Cut-over, understocked stands can be quickly rehabilitated.
- Periodic harvest are provided without interruption for stand regeneration.
- The stand is upgraded if fast-growing, high-quality trees are favored.
- The stand is not as vulnerable to destruction by fire, biotic, or weather agents.
- Production is concentrated on valuable sawtimber trees.
- The stand is more aesthetically pleasing to some people and provides a varied wildlife habitat.

Disadvantages

- Intensive competition control is often required.
- Relatively frequent stand entry is required, perhaps every 3-10 years on good sites.
- Some area-efficient management practices, such as prescribed fire, are difficult to apply.
- Harvesting operations may be difficult and expensive; regeneration and retained trees may be damaged.
- The method requires considerable management skill and supervision.
- The stand is more aesthetically pleasing to some people and provides a varied wildlife habitat.

Diameter-limit cutting:

Advantages

- Simple, easy, and rapid to implement.
- Competition control is periodically required for regeneration.

Disadvantages

- Technically, neither recurring regeneration or sustained timber production are not provided for.
- The system is easily abused.
- No provision is provided for increasing tree quality; genetics may suffer.
- Unless a larger than standard diameter limit is selected (i.e., >12 inches dbh), seed production of the stand will be reduced.

HARVEST TECHNOLOGY AND NATURAL STAND MANAGEMENT

Some Basics

Whether even-aged or uneven-aged, regeneration is the bridge between the harvest of the original stand and the establishment of future crop trees. Successful regeneration and quality residual trees are critical for sustainable forestry practices. As with most forestry operations, natural regeneration holds certain risks that can be minimized by appropriate planning and execution. The following features are necessary to help ensure future productivity is maintained:

1. **An adequate seed supply.** Vigorous pine trees over 30 years old and over 12 inches in diameter at breast height (DBH) are the best seed producers, but considerable annual fluctuation occurs. Evaluations over the last 15 years on the Crossett Experimental Forest indicate that there will usually be 1 poor seed crop out of every 5 years; the other 4 years will have average or above-average seed crops. Seedfall begins in October, reaches a peak in November, and culminates in February.

2. **A favorable seedbed.** Exposed mineral soil and disturbed litter are the best seedbed conditions for establishing pine regeneration. Heavy litter accumulations are detrimental. Prescribed burning and the disturbance from logging generally improve seedbed conditions.

3. **Acceptable levels of limited resources.** Sunlight, soil moisture, and soil nutrients are critical for the successful establishment of pine seedlings. Sunlight intensity can be controlled by varying the density of overstory trees and size of the opening. However, little can be done to improve the soil moisture, which varies both annually and seasonally.

4. **Freedom from excessive competition.** Competing understory vegetation also robs pine seedlings of limited resources. Control measures used in natural regeneration include prescribed burning, mechanical treatments, and herbicide applications.

5. **Protection of residual overstory and advanced regeneration.** Damage to the individuals left for future crop trees is crucial in an uneven-aged forest. Unlike even-aged silviculture that establishes a whole new cohort at the same time, uneven-aged management relies upon individual saplings responding to available resources to gradually replace the stand.

6. **Match harvest technology to the silvicultural system being implemented.** Modern mechanized harvest technology can have an incredible impact on the success or failure of the silviculture being attempted.

The specifics of natural stand management depend on the characteristics of the targeted species and should be implemented well in advance of the actual harvest. Table 1 shows an effective schedule of events. As with any schedule, this one may be modified based on stand conditions, weather, and necessity, but modification may increase risk and the likelihood of remedial treatments. The site preparation method used can also be varied based on stand conditions, site quality, and seed supply. There are two-rules-of-thumb regarding site preparation: (1) the better sites usually require more intensive site preparation, and (2) less intensive site preparation is usually required when the seed supply is high. Seed supply can be anticipated by watching the 2-year pine reproductive cycle. The presence of abundant pine cones during mid summer usually indicates that there will be a good upcoming seed crop.

Table 1. An optimum schedule for naturally regenerating an even-aged pine stand.

Silvicultural practice	Schedule
(1) Hardwood control burn	6 years before clearcutting
(2) Hardwood control burn	3 years before clearcutting
(3) Site preparation burn	Winter/spring in year of clearcutting
(4) Eliminate nonmerchantable hardwoods	Spring in year of clearcutting
(5) Harvest all merchantable pines and hardwoods	Before October
(6) Stocking evaluation	Winter, 2 years after harvest
(7) Remedial treatments as needed	3 to 5 years after harvest

Natural regeneration has several distinct advantages over artificial regeneration for regenerating a small forest property. First, natural regeneration is usually less expensive than intensive artificial regeneration, which can easily run to over $300/acre. Second, small plantations located near a natural seed source usually have so much natural regeneration that it negates the density control and improved genetics which are the major advantages plantation culture. The use of competition control (e.g., controlled burns or herbicides), while increasing site preparation costs, can help improve natural pine regeneration if competition from hardwoods and brush is pronounced. Uneven-aged stands are rarely burned to control understory competition because the fire can heavily damage or outright kill pine seedlings. Herbicides can be effective in uneven-aged stands, especially if carefully targeted to release crop trees.

Harvest technology plays an important role in the success of both even-aged and uneven-aged pine management. In an even-aged system, like the seed tree harvest featured in this tour, extensive ground disturbance is a largely desirable attribute (so long as erosion or rutting aren't problems). Exposed mineral soil is a better seedbed for pine, and the competing vegetation is at least temporarily knocked back, improving pine establishment. If a good seed crop is available, achieving regeneration stocking goals is rarely a problem. Some sites may also benefit from a post-harvest burn to reduce slash, eliminate many non-pine competitors, and further improve the seedbed. If a number of hardwoods survive and appear to risk adequate pine stocking, an herbicide could also be applied after the harvest to reduce their impact. Later entries to apply herbicides or remove seed trees can also double as precommercial thinnings to increase residual pine growth.

Uneven-aged stands need to be treated differently, however. Since potential crop trees of all sizes are found in this silvicultural system, it is imperative to protect future generations from unnecessary damage. An uneven-aged stand is designed and managed to follow a "reverse J-shaped" curve

(Figure 1) with many more small diameter trees than big ones. Over the years, natural mortality and harvesting remove many smaller individuals, until (presumably) the largest

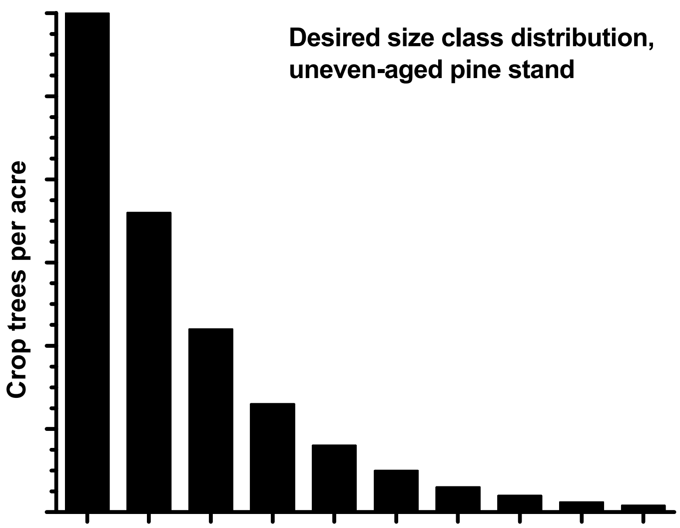


Figure 1. Good uneven-aged structure indicated by the reverse J-shaped diameter distribution.

size class is cut for sawtimber. If too few small trees are in any given size class range (Figure 2), then it becomes difficult to maintain the desired structure, and harvest patterns and cutting cycles may need to be modified to reflect this deficit.

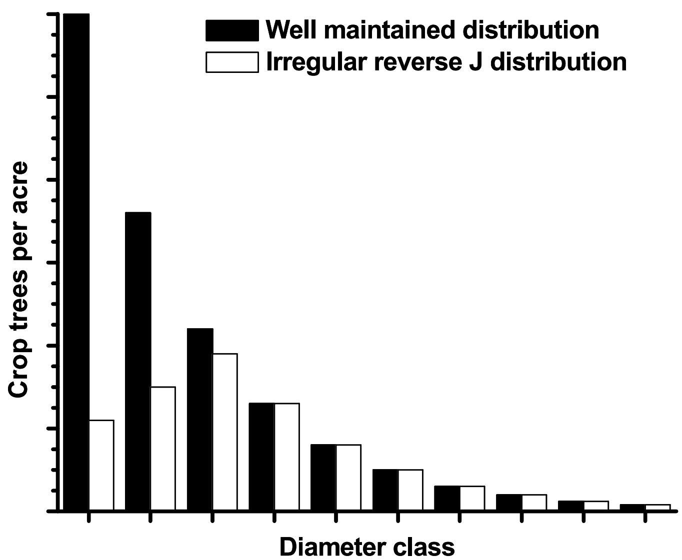


Figure 2. Poor uneven-aged structure (white bars) attributable to excessive removals and/or mortality in the smallest size classes. This deficit may eventually cause major problems in the largest (sawtimber) classes.

Tree-length harvest systems are particularly problematic in uneven-aged stands, especially if the branches are left on the log being skidded. Long logs are hard to drag through the woods without damaging the residual overstory and advanced regeneration. Keeping branches on the log extends the area of damage considerably. Logging with large diameter flotation tires, indiscriminately driving through the stand, and careless swinging of cutting blades also contribute greatly to the loss of advance regeneration (Figure 3). Operators frequently run their equipment to avoid damaging

Figure 3. Careless swinging of a cutting head felled these young pines needlessly. While most stands have more than enough advanced regeneration, too many episodes like this may affect future stand structure.

larger trees or to minimize rutting with little concern for the smallest size classes, often resulting in unacceptable losses to advanced regeneration and midstory pines (Figure 4).

Figure 4. Even large advanced regeneration can also be lost to damage from careless operators. These pulp-sized loblolly pine were simply run over and left on the site. Thus, future crop trees are removed from critical size classes.

Problems can also arise when skidders or other large ground-based equipment is used to apply herbicides or fertilizer. Getting equipment operators to appreciate the importance of the understory pines in uneven-aged stands is critical to the long-term success of this silvicultural regime. Some damage is inevitable, but it is possible to minimize losses, especially if unnecessary travel between trees can be avoided.

The Block and Strip Clearcut Demonstration Area

Two 40-acre compartments were selected in 1980 to demonstrate even-aged regulation using natural pine regeneration. Every 5 years, one-eighth of each area (i.e., 5 acres) will be clearcut as a block or strip (Figure 5). The original stand will be gradually harvested on each area, with

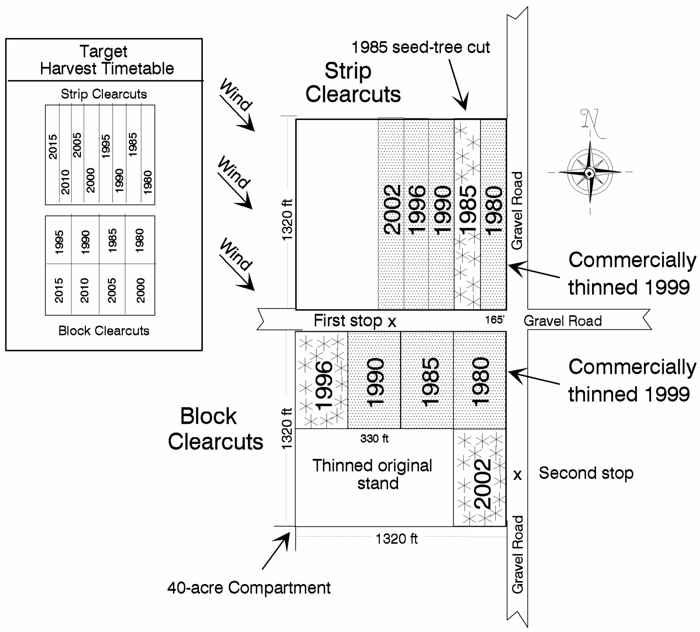


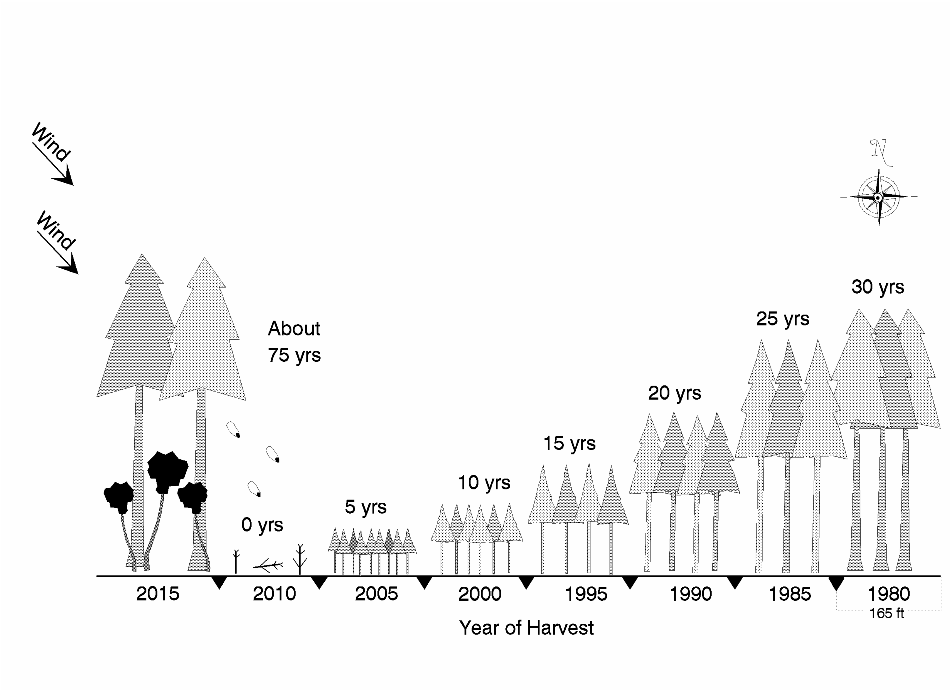
Figure 5. Implementation of block and strip clearcutting to demonstrate low cost natural stand management. This demonstration highlights the technique of area regulation, where a system of treatments are designed to produce a continuous yield of timber from a fixed area.

completion scheduled in 2015. The rotation length of the block and strip clearcuts is 40 years; thus, the first clearcuts made in 1980 will be clearcut for the second time when they are 40 years old in 2020. This regulation technique will eventually provide a sustainable and even flow of timber products throughout time. It is ideal for landowners who desire moderate, frequent incomes from their forest lands rather than large, infrequent incomes.

Studies have shown that loblolly pine seed, which are wind disseminated, will be adequately dispersed within 350 feet downwind from an adjoining stand. Thus, a clearcut must be relatively narrow when seeding is to come from the adjoining stand. This is why the strip and block clearcuts of this demonstration are no wider than 330 feet and are being cut in an east to west sequence. The length of each clearcut is irrelevant, as long as a suitable seed source occurs along the upwind edge. Figure 6 shows how the strip clearcuts might look in 2010.

The area was prescribed burned in March 1980 to top kill small hardwoods and to create favorable seedbed conditions prior to the regeneration cut. The harvest of all merchantable trees was completed just prior to the 1981 growing season. Residual hardwoods were injected with a herbicide, Tordon 101R, during the summer of 1981 at a cost of $40 per acre. A slash disposal burn was made in the fall of 1981 just before the onset of seedfall. The 1981-1982 seed crop was better than average, and both the strip and block clearcuts were successfully regenerated.

Figure 6. Future conditions of the strip clearcuts.



The second regeneration cut was made in November 1985 following a herbicide treatment for hardwood control in June 1984. Velpar, a soil-applied herbicide, was applied on a 3-foot by 3-foot grid at a rate of 1.5 gallons per acre and a cost of $90 per acre. The 1985-1986 seed crop was poor, and a slash disposal burn was conducted in November 1986 to enhance seedbed conditions for the upcoming seed crop. A bumper seed crop occurred in 1986-1987 that insured successful regeneration. Recent seed crops have been spotty in south Arkansas, although 2003 may be a good year. One of the main advantages to keeping seed trees is their ability to contribute seed for several years after the initial logging. This provides a buffer against poor seed crops or unexpected disasters like unplanned fires in young pine stands.

Twelve seedtrees per acre were retained on the second clearcut strip in 1985 to provide: (1) a demonstration of a different reproductive cutting method compared to clearcutting, and (2) a continued seed source to enhance regeneration on the 1980-strip clearcut. The 2003 seed tree cut left approximately 1000 board feet/acre in residual seed trees.

At the time of each reproduction cut, the residual stand was selectively thinned to leave about 80 ft^2/acre of pine basal area. These thinnings salvaged high risk trees and reduced overstory competition, which kept crop trees growing at high rates and increased their potential for seed production.

Area Regulation

Regulation is a forestry technique used to insure an even and sustainable flow of timber products. As the name implies, area regulation uses area to set the amount and schedule of reproduction cuts. In this demonstration, it simply means that one-eighth of the area or 5 acres will be regenerated every 5 years. The rotation length of each regenerated area is 40 years. Each 5-year harvest involves clearcutting a 5-acre area and thinning the rest of the 40-acre tract (if needed).

The original stand will gradually be harvested over the 35-year period from 1980 to 2015. The 1980 harvest was comparatively high, because the original stand was overstocked at that time (Table 2). Yields will decrease through time as the original forest is liquidated, but will eventually stabilize when the tract is fully regulated. When the first harvest is made under full regulation in 2020, the clearcut and thinning are estimated to yield 80 cords of pulpwood and 60,000 board feet (Doyle) of sawtimber every 5 years. Such yields will be sustained throughout time. The revenue from this harvest would be $1,253 in pulpwood and $21,420 in sawtimber for a total of $22,673, assuming $15.66 per cord for pulpwood and $357 per 1,000 board feet of sawtimber (spring 2003 prices reported by Timber-Mart South for southern Arkansas). This equals $4,535 annually for this 40-acre tract, or $113 per acre per year.

Table 2. The before-cut and cut volumes (in thousands of board feet Doyle) for the first four harvests of the block and strip clearcut demonstration areas. The numbers in parentheses are acreage by treatment.

Year	Before cut*	Cut		
		Clearcut	Thinning	Total
		Block		
1980	480 (40)	76 (5)	154 (35)	230 (40)
1985	311 (35)	60 (5)	53 (30)	113 (35)
1990	250 (30)	52 (5)	43 (25)	94 (30)
1996	206 (25)	37 (5)	27 (20)	64 (25)
	Totals:	**225**	**277**	**501**
		Strip		
1980	496 (40)	67 (5)	142 (35)	209 (40)
1985	348 (35)	32 (5)	60 (30)	92 (35)
1990	308 (30)	74 (5)	53 (25)	127 (30)
1996	231 (25)	42 (5)	30 (20)	72 (25)
	Totals:	**173**	**255**	**428**

* Estimated from the 1980-preharvest cruise, the marked cut, and predicted growth rates.

Pine Regeneration

Natural loblolly-shortleaf pine regeneration is generally considered to be acceptable if 60 percent milacre stocking and 700 seedlings per acre are present 3 years after harvest. Based on these guidelines, all four of these areas are adequately stocked with pine regeneration (Table 3). Most of the pines are considered free-to-grow, that is, they are not overtopped by competing hardwoods. Precommercial thinning is often recommended when the pine density exceeds 5,000 stems per acre. However, the future crop trees of these stands will most likely come from the sapling component, where density is well below the recommended guideline. If warranted, some precommercial thinning could be accomplished by skidding the trees harvested in subsequent clearcuts across previously regenerated areas. Otherwise, precommercial thinning would typically cost the landowner $78/acre.

Table 3. The status pine seedlings (< 1 inch DBH) and saplings (1 to 3 inches DBH) in the four clearcuts during March 1989.

Year and Method	Density (stems/acre)*			Milacre stocking (%)	Milacres not overtopped by hardwoods (%)
	Seedlings	Saplings	Total		
1980 Block	2,960	2,840	5,800	90	69
1980 Strip	5,690	2,900	8,590	92	78
1985 Block	4,520	560	5,080	91	100
1985 Strip	8,070	410	8,480	95	83

* Based on 100 milacre plots per clearcut. A milacre plot is 0.001 acres in area and has a radius of 3.72 feet.

The "Good Forty" Demonstration Area

The Good Forty Demonstration Area was established in 1937 to help convince landowners that appropriate forestry practices could sustain long-term timber growth and yield. One of two uneven-aged demonstration compartments established, the Good Forty was know as "good" not because of differences in site quality, but because the original stocking of the stand (about 5,000 board feet/acre) was considered adequate. Now entering its 66th year as a demonstration, the Good Forty has been harvested about once every five years over this entire period, growing 409 board feet (Doyle) of sawtimber and 0.2 cords of pulpwood per acre per year, while maintaining good stocking in most size classes. We manage the Good Forty to keep the stand at approximately 7,500 board feet/acre, and we'll cut 1,500 to 2,500 board feet per acre every cutting cycle (about 95% of growth).

However, in recent years some new challenges to using single tree selection management have become apparent. For most of its history, the Good Forty was logged by individuals using chainsaws cutting relatively short sawlogs hauled to landings using fairly small pieces of equipment. The last couple of harvests have been done with fewer people in the woods, utilizing large harvesting machines (Figure 7) and skidders that haul longer logs or even whole trees to a merchandizing machine that can delimb and buck the logs and load them onto trucks for transport.

MGS 3/95 (modified and updated 4/03, DCB)

Figure 7. More pictures of recent logging of the Good Forty.

GIS TECHNOLOGY AND FORESTRY

Links of Interest

Many excellent web sites offer information on the subject of GPS. The following are recommended:

http://www.esri.com

http://www.esri.com/library/brochures/pdfs/forestry.pdf

http://www.gisday.com/cd2002/whitepaper/geography-matters.pdf

http://sal.uamont.edu/

http://www.trimble.com/gps/

FORESTRY FIELD DAY EVALUATION

MAY 13, 2003

1. I am a ____ private landowner, ____ forester, ____ other (please specify) ________________________
2. Was the field day helpful to you? ______ In what way(s)? _____________________________________

   ____

   ____
3. Have you learned something today that you can use on your own land ____Yes ____No? If yes, on approximately how many acres might you apply what you learned? __________ acres.
4. What could be done to improve field day? ____

   ____
5. The following are possible themes for future forestry field days. Please rank the following eight themes from 1 to 8 in order of your interest? (1 = most interested, 8 = least interested)

   ____ Rehabilitation and management of understocked stands

   ____ Low-cost management systems

   ____ Integrated land resource planning, management, and assistance

   ____ Selection (uneven-aged) management

   ____ Density control (thinning) in pine stands

   ____ Vegetative competition control

   ____ Importance of forest management

   ____ Forest economics and investments
6. Do you have any themes to suggest for future field days that are not mentioned in item 5?

   ____
7. Our unit has research in other locations. Would you attend a field day like this one but held on:

   the Ouachita National Forest near Hot Springs? ____Yes ____No

   the Ozark National Forest near Russellville? ____Yes ____No
8. How were you informed that there would be a Forestry Field Day this year? _______________________

   ____
9. Would you be interested in attending other forestry workshops at the Crossett Experimental Forest? ____Yes ____No If yes, what subjects? ____

9\. If you have other comments or suggestions, please make them on the reverse side of this page.

Thank you for your comments. Have a safe trip home!