MANAGING LONGLEAF PINE UNDER THE SELECTION SYSTEM-- PROMISESAND PROBLEMS[1]

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Abstract. Six- and ten-year results are reported on group-selection management of two small tracts of longleaf pine (*Pinus palustris*) in south Alabama. One stand is managed via volume control in the sawtimber component, the other is managed via a structure target, and both are prescription burned on a 3-year cycle. Information is given on structure changes, volume production, and reproduction establishment and development. Comparisons are made with an adjacent tract managed and prescription burned for decades under an even-aged shelterwood system. Advantages and disadvantages of the group-selection system for longleaf pine, both observed and anticipated, are discussed.

Introduction

Longleaf pine (*Pinus palustris*) is generally regarded as a species best managed in natural stands using even-aged silvicultural systems and is specifically well suited to a shelterwood system (Croker and Boyer 1975). Due principally to seedling intolerance to competition, it is not ordinarily thought of as being suited to an uneven-aged or selection system. However, we have evidence that the species can be managed under a group-selection system that includes cyclic prescribed burning for seedbed preparation and control of unwanted vegetation. The following paper briefly describes the first 6- and lo-year results from two stands managed under such a sys tern.

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Methods

Study Areas

Two tracts of natural longleaf pine forest, 30 and 36 ac in size, were surveyed and established as selection management demonstrations on the Escambia Experimental Forest (EEF) in southern Alabama (Table 1). One area, designated the "volume/ guiding-dbh-limit" (V/GDL) stand, was inventoried and first cut during 1977-78. The other area, designated the "basal area-maximum dbh-q" (BDq) stand, was inventoried and first cut during 1981-83. Both were chosen because they contained irregular, patchy areas of mature longleaf pine and some groups and patches of seedlings and saplings. Neither had received significant cutting during the decade before selection as demonstrations, but both had been periodically burned for decades, treated once for hardwood control (Table 1) , and were relatively free of woody competition.

Table 1. Stand data for **longleaf** pine demonstration stands.

Item/operation	V/GDL stand	BDq stand	Farm 40
Location	EEF Cpts. 147-148	EEF Cpt. 65	EEF Cpt. 156
Area	36 ac	30 ac	40 ac
TSI	1980	1965-66	1948-49-50
Prescribed burns	1948	1951	1954
	1954	1953	1957
	1957	1961	1963
	1963	1963	1968
	1968	1965	1973
	1971	1968	1974
	1974	1972	1976
	1976	1976	1978
	1979	1978	1981
	1982	1981	1985
	1985	1984	1988
	1988	1987	1989

Regulation

The V/GDL stand is regulated under the system developed by Reynolds (1959, 1969) and Reynolds and others (1984) for uneven-aged loblolly-short-leaf pine (P. taeda and P. echinata) stands in southern Arkansas. Simply stated, the-stands regulated under volume control in the sawtimber component using a guiding dbh limit to help allocate the allowable cut. A desired volume in the sawtimber component at the end of a cutting cycle is adopted as a target, the sawtimber volume growth rate is estimated, a cutting cycle (dependent on the sawtimber growth rate) is adopted, and a sawtimber volume is left after cutting (A-C) that will grow at the determined rate to give the desired standing volume at the end of the cutting cycle. The GDL is the dbh class in the upper portion of the stand table in and above which all the cut could be taken, if desired. However, if this were done, a diameter-limit cut would result and some good, fast-growing trees above the limit might be prematurely cut while some poor, slow-growing trees below the limit might be left. Hence, the term "guiding-dbh-limit" is a guide, and in fact, good trees above the limit are left and poor trees below the limit are cut to result in the allowable cut.

Specifically, the V/GDL prescription was to leave a volume of about 4,000 FBM Doyle rule, or 6,500 FBM International 1/4-inch rule (Int.1/4) which, with an assumed growth rate of 200 FBM Doyle (300 FBM Int.1/4), would grow in 5 years to obtain about 5,000 FBM Doyle or 8,000 FBM Int.1/4.

The Bdq stand is managed under structure control in which the entire merchantable stand table is treated -- not just the sawtimber. Thus, management is more complete and, as we shall see, more objective. Simply stated, an A-C target structure (stand table) specified by stand basal area, maximum dbh of trees to be left, and a l-inch q (the fixed ratio of the numbers of trees in succeeding l-inch dbh classes) is adopted. Then the before-cut (B-C) inventory stand table is compared with the A-C target and surplus trees in excess of the target stand table are then harvested. If there are deficits between the A-C target and the B-C inventory, then enough basal area in trees above the target is left to ensure that the prescribed A-C basal area remains. [See Farrar (1981, 1984) and Farrar et al. (1989) for more information and other references on both V/GDL and Bdq regulation.]

The BDq prescription was to leave 50 ft^2 of merchantable basal area (in trees over 3.5 inches dbh), assume a residual maximum dbh of 20 inches, and use a l-inch q of 1.2.

Inventories

The merchantable pine stand in each area is given periodic loo-percent inventories by l-inch dbh classes. These inventories include those to determine the B-C stand table, to mark the trees to be cut, and to tally any logging or other damage for salvage. At the time of each B-C inventory, a sketch map is made of the stand to show any features such as roads or streams and any concentrations or scarcities of timber sizes (e.g., sawtimber, pulpwood). Volumes are determined by use of local volume functions and custom inventory summary software' for the EEF (Farrar 1986). At the time of the B-C volume inventory, pine reproduction is also sampled and 100 nested temporary sample plots are systematically inventoried on each tract. The nested plot consists of a central circular milacre, on which seedlings (over 0.5 to 4.5 ft in height) are tallied, within a circular 1/100-ac plot, on which saplings (l-, 2-, and 3-inch dbh classes) are tallied.

Marking

The marking rules to obtain the allowable cut for both V/GDL and BDq methods are basically simple. The poorer trees with respect to vigor, stem form, and spatial position are removed in the allowable cut, and the better trees are left, while also adhering to the following group-selection rules: (1) Enlarge any existing group of reproduction by cutting merchantable border trees that are candidates for removal but only if reproduction exists beneath these trees; (2) Start a new group of reproduction by removing those trees in and above the GDL or maximum dbh class that need to be cut and have reproduction beneath them; and (3) Remove the rest of the allowable cut in trees taken singly in thinnings in the closed remainder of the stand. The main logistical problem is to mark all of the allowable cut in one pass through the stand. This can be practically achieved by dividing the stand into, say, quarters; allocating about one-quarter of the cut to each quarter ; trying to hit the cut quotas in each quarter; and adjusting the cut up or down as required from quarter to quarter to mark the allowable cut. [See Marquis (1978) for more details on this operation.]

Note that there is no attempt to allocate any certain area to any tree size class and we do not keep records on the area occupied by any size (age) class. The application of the group-selection marking rules is depended upon to eventually create the desired uneven-aged structure. That this will probably occur is intuitively seen in the BDq system but is not so apparent in the V/GDL system.

Since growth on these medium sites was less than anticipated, cutting cycles were lengthened to 10 years to provide an adequate operable cut. Thus, the V/GDL stand was cut initially in 1977 and not again until 1987; and the BDq stand was cut only initially in 1982-83 and not in 1987.

Treatments

Both stands have received treatment to reduce unwanted woody vegetation that cannot be effectively controlled by prescribed fire. All undesirable stems l-inch dbh and larger were injected with herbicide. The V/GDL stand was treated in 1980 (Tordon 101-R) and the BDq stand in 1965-66 (2,4-D amine).

Once the unwanted woody vegetation is brought under control, as above, continued control is by periodic prescribed fire. Both stands are winter burned on a 3-year cycle. Occasionally, 2-year spring burns may be imposed for a few cycles if the 3-year winter burns do not effectively keep hardwoods small. Because burns are prescribed to give complete coverage of the demonstration areas, they are not necessarily best for all timber sizes. Burns are most effective in the groups of closed timber, from large sapling to mature sawtimber in size, and are somewhat less effective in the groups of reproduction where fuels are principally grasses rather than pine needles . They also kill varying amounts of fire-susceptible reproduction beneath parent trees but since regeneration is cyclically re-established and these fires also prepare seedbeds, the net effect so far, as we will see, is that regeneration is regularly established and much of it retained.

Results And Discussion

Structure

The structure of the V/GDL merchantable stand has not yet assumed the classic reverse-J dbh distribution generally associated with balanced uneven-aged stands (Fig. 1) because: (1) the stand has been under selection management for only 10 years; (2) it had one initial cut that was essentially an improvement cut/low thinning; and (3), more importantly, there is nothing inherent in the V/GDL regulation method to ensure a reverse-J distribution. However, it may eventually result in such a distribution but not as soon as BDq. Some loblolly-shortleaf pine stands managed for decades in south Arkansas under this system did not necessarily create reverse-J dbh distributions in the process (Murphy and Farrar 1981). It remains to be seen if the V/GDL group-selection system employed here will, of its own, result in a classic reverse-J distribution or if this condition is indeed necessary for successful uneven-aged management in longleaf pine.

The structure of the BDq merchantable stand is approaching a reverse-J dbh distribution because the cutting specifically tailors the stand toward such a distribution. Note in Figure 2 that above the lo-inch dbh class, the structure assumes a reverse-J distribution more or less parallel to the

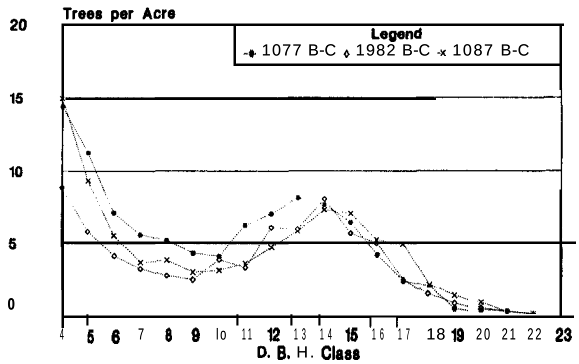

Figure 1. Frequency by merchantable l-inch dbh classes—V/GDL stand.

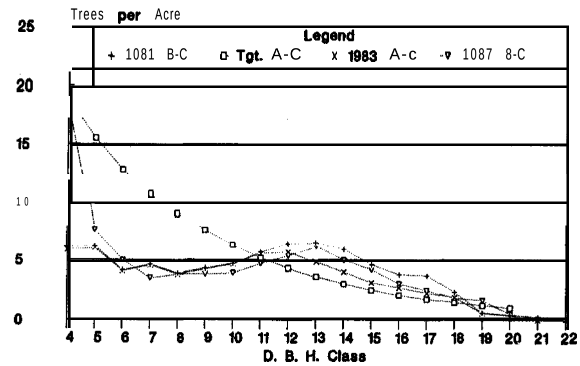

Figure 2. Frequency by merchantable l-inch dbh classes- BDq stand.

A-C target distribution for this reason and that there has been considerable ingrowth into the smaller dbh classes; particularly into the 4-inch class. As management and recruitment from reproduction continues, the stand should more completely approach such a distribution.

Growth

The merchantable stand periodic growth for 10 years is shown for the V/GDL stand in Table 2 and for 6 years for the BDq stand in Table 3. Growth has not been outstanding in either case, amounting to about 30 ft^3/ac/yr, or about 140 FBM/ac/yr Doyle, which is considerably less than the 200 expected. At this rate, a 5-year cutting cycle results in about 700 FBM Doyle available for cut which is not economically operable, assuming 1,000 FBM Doyle to be operable. With this sawtimber growth rate, a lo-year cutting cycle results in growth of about 1,400 FBM Doyle growth, which is economical to cut.

The poor growth during the first growth period in each stand resulted from volume loss caused by mortality. In the V/GDL stand the actual causes of the unsalvaged mortality are unknown, but they were most likely lightning strikes and associated bark beetle attacks; possibly some was from logging damage. In the BDq stand the negative volume change is thought to be for the same reasons plus mortality from a 1983 windstorm. Although the latter was largely salvaged and captured in the cut, it did cause the cut to be about 300 FBM Doyle/ac above the amount marked and reduced the base for growth. During the second period in the V/GDL stand, the relatively large positive change in volume suggests minor mortality and a growth rate that we think is more normal for such stands.

Sub-merchantable Stand

Regeneration appears to be adequate and sustainable in both the V/GDL and BDq stands (Fig. 3 and 4). In each case, during the management period, the numbers of trees in each sapling dbh class has increased. If the number of seedling and sapling trees dictated by the adopted A-C target BDq structure is taken as an absolute minimum, then the reproduction amount appears to be more than adequate (Fig. 4). In both cases, a decrease in seedlings during the management period occurred. However, the seedling

Table 2. Teu-year production history- **V/GDL** selection stand.

	Merchantable stand/ Trees	Basal area	Volume	Sawtimber stand/ Volume	Doyle	Int.1/4"
	(no./ac)	(ft^2/ac)	(ft^3/ac)	(ft^3/ac)	- (bd	ft/ac) -
B-C inventory 1977	98	62.0	1,576	1,274	4,808	7,988
B-C inventory 1982	72	53.7	1,394	1,177	4,532	7,414
Change 1977-82	-26	-8.3	-182	-97	-276	-574
Cut 1977-78	30	12.3	288	205	846	1,319
Growth 1977-82	4	4.0	106	108	570	745
PAI 1977-82	1	0.8	21	22	114	149
B-C inventory 1982	72	53.7	1,394	1,177	4,532	7,414
B-C inventory 1987	88	62.4	1,613	1,357	5,437	8,637
Change 1982-87	16	8.7	219	180	905	1,223
Cut 1982-83	0	0	0	0	0	0
Growth 1982-87	16	8.7	219	180	905	1,223
PAI 1982-87	3	1.7	44	36	181	245
Cut 1987	13	11.2	297	261	1,126	1,694
A-C inventory 1987	75	51.2	1,316	1,096	4,311	6,943

Table 3. Six-year production history- **BDq** selection stand.

	Merchantable stand/ Trees	Basal area	Volume	Sawtimber stand/ Volume	Doyle	Int.1/4"
	(no./ac)	(ft^2/ac)	(ft^3/ac)	(ft^3/ac)	- (bd	ft/ac) -
B-C inventory 1981	74	54.3	1,404	1,154	4,404	7,254
B-C inventory 1987	81	49.2	1,244	1,012	3,893	6,375
Change 1981-87	7	-5.1	-160	-142	-511	-879
Cut 1982-83	10	11.9	323	293	1,222	1,888
Growth 1981-87	17	6.8	163	151	711	1,009
PAI 1981-87	3	1.1	27	25	119	168
Cut 1987-88	0	0	0	0	0	0
A-C inventory 1987	81	49.2	1,244	1,012	3,893	6,375

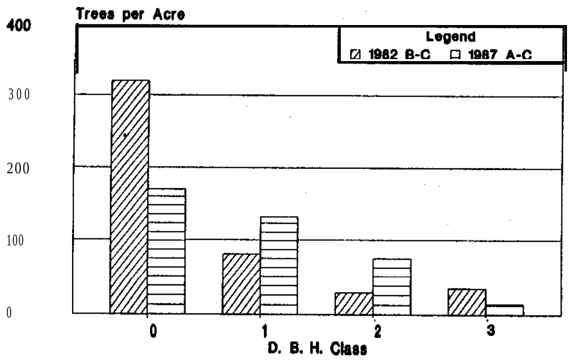

Figure 3. **Seedling** and sapling **1**-inch dbh class **frequencies—V/GDL** stand.

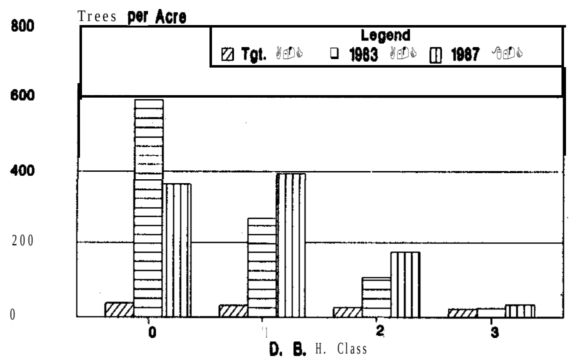

Figure 4. Seedling and sapling **1**-inch dbh class **frequencies—BDq** stand.

numbers are likely to fluctuate due to repeated burning, intermittent seed crops, logging damage, and recruitment into the sapling classes. In both cases, for these periods there was no logging so the change is attributable mostly to burning and recruitment. We might add that for a lo-year period prior to BDq management of the stand, its irregular stand of mature natural longleaf had similar basal area density, sustained periodic light cutting, and received burns on a 3-year cycle as was the subsequent case. During this period, sapling frequencies also increased in this stand with time (Fig. 5). This observation suggested that longleaf could be managed and reproduced under a selection system that included the cyclic prescribed burning required for seedbed preparation and control of hardwood competition.

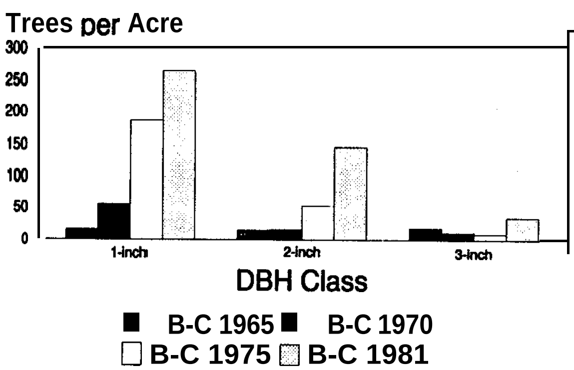

Figure 5. Sapling l-inch dbh class **frequencies— EEF compartment 65.**

Observations

Thus far we have found no serious problem to suggest that natural stands of longleaf pine on longleaf pinelbluestem (Andropogon spp.) sites on the rolling lower Gulf Coastal Plain cannot be managed and sustained under a group-selection system. This system, for longleaf pine, requires regular burning for the multiple purposes of seedbed preparation, unwanted vegetation control, and hazard reduction. However, successful management for 10 years or less does not prove a system. Proof will require practice and monitoring for several more decades.

Further, the growth of such stands is not likely to reach the optimum that may be achieved under an even-aged shelterwood system using large blocks (> 40 ac) in each age class. The difference is probably due to the competition exerted by large timber on adjacent smaller trees, particularly seedlings and saplings. The competitive effect of large timber root systems extends for about the height of the large timber (or about 1 chain) into adjacent seedling and sapling stands or groups and retards their development, with the effect decreasing with distance. Thus, a circular opening of about 1/3 ac is entirely under competition from adjacent large timber. The effect is reduced at an exponentially decreasing rate as opening size increases. For example, a 5-ac circular opening has about 2.8 ac, or 56 percent of its central area free of competition from adjacent mature timber; while a 40-ac opening would have about 31 ac, or 83 percent of its central area similarly free.

How much more efficient in wood production such a system of large even-aged stands will be is unknown, but it appears that a forest of small even-aged stands (about 5 ac each) grows no better than our group-selection stands so far (Table 4). In Table 4 the periodic growth for the past 10 years is shown for our longleaf pine Farm 40 demonstration (Table 1) on the EEF. It has been managed for more than 40 years under an even-aged system of shelterwood in small blocks of fractions of an acre to a few acres in size and with periodic prescribed burning. This stand is managed toward area regulation with an 80-year rotation and a lo-year cutting interval. It is growing at rates comparable to those of our V/GDL and BDq stands. A set of fully-regulated even-aged stands under area control has not yet been achieved in the Farm 40, but their composite is beginning to reflect the classic reverse-J dbh distribution expected under regulation (Fig. 6). Thus, it appears that there will be little volume production difference between a longleaf stand managed and regulated under group-selection and a similar area managed and regulated under an even-aged system that creates a balanced set of age classes in small stands of a few acres each.

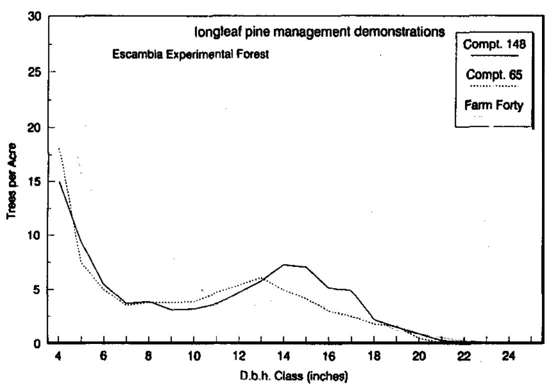

Figure 6. The 1988 merchantable 1-inch dbh class frequencies—Farm 40, V/GDL (compt. 148), and BDq (compt. 65) stands.

In addition to the necessary increase in the cutting cycle from 5 to 10 years dictated by the growth rates, further changes in the management of both selection stands are planned. In the V/GDL stand, we expect to gradually increase the residual sawtimber volume to 4,500 to 5,000 FBM Doyle (7,000 to 8,000 FBM Int. 1/4) to improve the growth base, growth, and allowable cut. For the same reason, the residual basal area in the BDq stand will gradually be increased to 55 to 60 ft^2/ac. Both are feasible targets that can be sustained as management continues and structure improves.

Good data on stem frequencies were obtained in the reproduction inventories but there was no information on the competitive or "free-to-grow"

Table 4. Ten-year production history-Farm 40 even-aged stands.

	Merchantable stand/			Sawtimber stand/		
	Trees	Basal area	Volume	Volume	Doyle	Int.1/4"
	(no./ac)	(ft^2/ac)	(ft^3/ac)	(ft^3/ac)	- (bd ft/ac) -	
B-C inventory 1977	119	50.8	1,200	857	3,376	5,437
B-C inventory 1982	96	48.0	1,170	844	3,424	5,393
Change 1977-82	-23	-2.8	-30	-13	48	-44
Cut 1977-82	33	8.2	164	90	286	542
Growth 1977-82	10	5.4	134	77	334	498
PAI 1977-82	2	1.1	27	15	67	100
B-C inventory 1982	96	48.0	1,170	844	3,424	5,393
B-C inventory 1987	119	57.8	1,401	1,002	4,106	6,417
Change 1982-87	23	9.8	231	158	682	1,024
Cut 1982-83	0	0	0	0	0	0
Growth 1982-87	23	9.8	231	158	682	1,024
PAI 1982-87	5	2.0	46	32	136	205
Cut 1988	6	5.3	141	121	460	757

status of these seedlings and saplings. In future reproduction inventor: ies, this information will be obtained so we can better assess the portion of the reproduction likely to contribute to ingrowth into the larger sizes.

Advantages And Disadvantages

To summarize our short-term experience with the group-selection system in longleaf pine, a set of the major advantages and disadvantages encountered, with annotations, are listed below. Some are specific to longleaf pine and longleaf is mentioned in them. Others generally apply to a selection system in loblolly, longleaf, or shortleaf pine. They are not necessarily in any order of importance because this will vary with the objectives, experience, and skill level of the practitioner.

Advantages

* It provides a possible alternative to even-aged management in longleaf pine stands on medium sites where competing unwanted vegetation can be largely controlled by cyclic prescribed burning, including

growing-season burns (the comparative resistance of longleaf pine seedlings and saplings to fire damage allows regular burning of entire units, a practice generally deemed too dangerous for use with other southern pines under selection management).

* A constant high-forest cover is maintained; no large areas are ever laid bare.

* Regeneration is more or less continuous (not confined to one short, risky period as in even-aged systems).

* Full regulation is relatively easily, quickly, and automatically achieved if the selection system is properly applied to somewhat irregular stands (conversely, a full rotation is required to regulate a forest of even-aged stands).

* Small areas (e.g., about 40 ac) can be economically managed for regular, essentially even-flow, cuts within a relatively short period, depending upon the initial age/size class distributions (economic cuts from a small forest of even-aged stands may be irregular and not optimally applied until near the end of the first rotation).

* Volume yields of a small selection stand of longleaf pine (e.g., about 40 ac) will likely be as good as that from a similarly-sized small forest comprised of many small even-aged stands, due to large zones of inter-stand competition in both cases.

* The diversity of age (size) classes found within a selection stand may be more aesthetically appealing to some.

* In longleaf pine, it may provide better habitat for some rare and/or endangered species of wildlife [e.g., red-cockaded woodpecker (Picoides borealis), gopher tortoise (Gopherus polyphemus), indigo snake (Drymarchon corais couperi)] due possibly to concentration and maintenance of suitable varied habitat within an appropriately sized total stand area without the disruption caused by final harvest and regeneration of relatively large even-aged stands.

* Within limits, smaller (younger) or larger (older) trees can be grown under regulation with simply a change in cutting cycle and/or maximum dbh and no change in stand area [in even-aged systems such a change would require a change in rotation length, a change in the number of cutting intervals, a change in the number of stands, re-division of the fixed area (or annexation of additional area), and another rotation to achieve regulation].

Disadvantages

* Regular prescribed burning in group-selection stands of longleaf pine does not do the best job for all tree size classes and is not currently a viable option for other southern pines [burning in even-aged stands can be better tailored to individual age (size) class needs].

* Some timber stand improvement work other than burning (e.g., tree injection with herbicide or mechanical cutting in spring) may be required in longleaf pine stands about every 20 years (even-aged stands probably need to be so treated only once in a rotation, at the time of the shelterwood preparatory or seed cut).

* Volume yields in longleaf pine group-selection stands will likely be less than that from a forest of large even-aged stands (in the latter situation the zone of competition between different size classes of timber is minimized).

* Selection management requires more time and attention, with attendant costs, especially in early stages of adoption when personnel knowledge and experience are at their lowest.

* Significant stand inventory data (i.e., stand and/or stock table) are required at each cutting cycle to guide proper cutting and can be a significant added cost.

* A lo-year cutting cycle is probably the shortest practical one for most longleaf pine sites (most even-aged stands on the same sites and less than about 50 years old can 'probably be economically thinned at a 5-year interval).

* A selection system in longleaf pine may not be best for some wildlife species, such as bobwhite quail (Colinus virginianus), although it may be entirely suitable for others such as white-tailed deer (Odocoileus virginianus), turkey (Meleagris gallopavo sylvestris), and fox squirrel (Sciurus niger bachmani, S. n. niger).

* A selection system may not work well for longleaf pine on very poor, dry, sandy sites, wet flatwoods sites with dense palmetto (Serenoa repens) understories, or very good mesic sites because effective prescribed burning for competition control and/or seedbed preparation may be difficult to achieve.

* In this system it is difficult to economically and logistically apply area-wise mechanical or chemical control of unwanted vegetation.

* The time required to grow longleaf pines of a given size will be longer in selection than even-aged stands due to extended periods of varying partial suppression before reaching the upper canopy. Thus, it may take several decades to convert a classical even-aged stand to a regulated selection stand.

Acknowledgment

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