Intensive Management—
Can the South Really Live Without It?

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Introduction

Over the past five years, the public and private sectors have debated the future of forest management and its implications for the next century. In the public sector, resource managers have debated the meaning and significance of "ecosystem management," a term coined in 1992 by then-Forest Service Chief F. Dale Robertson; he suggested that this approach to forest management would "blend the needs of people and environmental values in such a way that the National Forests and Grasslands represent diverse, healthy, productive, and sustainable ecosystems." Resource managers in the private sector have also debated among themselves and with their counterparts in the public sector about ecosystem management. The forest products industry's dominant view is that ecosystem management is a process with different meanings and applications, which are based on ownership and objectives (Owen 1995).

Within the private sector, debate also has focused on the traditional application of multiple-use forestry, using the principles of sustainable forest management. This is defined in the Sustainable Forestry Initiative (SFI) of the American Forest and Paper Association (AF&PA 1995) as "... [meeting] the needs of the present without compromising the ability of future generations to meet their own needs by practicing a land stewardship ethic which integrates the reforestation managing, growing, nurturing, and harvesting of trees for useful products with the conservation of soil, air and water quality, wildlife and fish habitat, and aesthetics." Thus, sustainability as defined by industry is about more than assuring a sustainable timber supply; it is also about sustaining the full spectrum of forest values.

Among the most prominent questions in these debates has been the role that intensive management plays as an element of a broader, nationwide forest management philosophy. The clearest advantages of plantations are immediate occupancy of a deforested site, rapid growth and high yield. For example, plantations of genetically improved loblolly pine (*Pinus taeda*) can produce 26 percent greater yields at 20 years than loblolly pines grown from unimproved wild seed (AF&PA 1997). Extensive use of plantations can therefore contribute significantly to the South's fiber supply over time.

Intensively managed plantations may provide most of the world's demand for wood pulp or construction material (Sedjo and Botkin 1997). The increasing importance of plantations in the South is likely related to technological improvements that have increased productivity and yields on intensively managed plantations, as well as to the increasing number of regulations and costs with harvesting second- and old-growth forests in other regions and nations. For example, a major forest industry in the West Gulf region recently sold or exchanged nearly a third of its land, because the demand of current and future mills can be met through a high-yield forestry program on just a portion of its land base.

However, intensive management has its detractors. There are major concerns about adverse environmental effects that result from harvesting, site preparation, use of herbicides, reforestation with a single species resulting in a "monoculture" using genetically improved seedlings and reliance on short rotation lengths. Concerns also exist about the effects of clearcutting a stand within the context of a larger area—a "forest fragmentation" effect.

Some suggest that the South can live without intensive management. In this paper, we will attempt to show that, in the context of southern forestry, intensive management is of great economic importance and can be applied in ways that have a sound ecological basis.

The Role of Intensive Management in Southern Forestry

Definition

Intensive management refers to the use of clearcutting as a primary reproduction cutting method, followed by site preparation and establishment of coniferous or hardwood plantations. Included in this definition is the use of planting as a tool to reestablish forest stands on open areas that had historically been forested, such as abandoned agricultural fields or pastures.

This is not to infer that other reproduction cutting methods cannot be considered intensive forest management. The preharvest inventories, preparation of marking tallies, marking, and establishment of natural regeneration

under the uneven-aged, single-tree selection method (cf. Baker et al. 1996) certainly require intensive attention by highly trained foresters. Nonetheless, we will restrict our definition of "intensive" to the establishment of plantations.

The intensiveness associated with clearcutting and planting has two elements. The first refers to the ecological changes that result. Clearcutting produces the greatest possible change in forest conditions that can occur during secondary succession. Removing the biomass of all trees of commercial size and value, and the mortality or suppression of much of the remaining woody biomass through site preparation (burning, mechanical cutting or removal, and/or use of herbicides), creates ecological conditions that are starkly different from those that existed prior to harvest. Continuous canopy cover is lost, the forest floor is broken up, biogeochemical cycling is completely changed, and solar radiation and other microclimatic effects reach all the way to the forest floor. Plantation establishment, whether on a recently harvested site or an abandoned agricultural field, represents additional change in ecological conditions, because the intention is usually to establish a single dominant woody species—and, moreover, to do so rapidly.

The second element of intensiveness is the considerable capital investment required for site preparation and planting. A typical prescription in the West Gulf Coastal Plain using site preparation with herbicides, broadcast burning and planting is on the order of $150 per acre; intensive site preparation using the shear-rake-windrow-burn and plant technique can cost about $200 per acre (Dubois et al. 1995). Natural stands can be established at much lower cost, although they have less immediate growth potential.

Scope

Source of data. Forest Inventory and Analysis (FIA) data provide the best means to evaluate the scope of intensive management in the South. FIA data are available in the Eastwide Forest Inventory database on the World Wide Web. The current extent to which intensive forestry is being conducted was determined by tallying the extent of artificially established forest area (whether in pine type, hardwood type or mixed pine-hardwood type) as a percentage of commercial forest area for 13 southern states (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, eastern Oklahoma, South Carolina, Tennessee, eastern Texas and Virginia). For the trend over time, eight states had two forest surveys in digital form (Arkansas, Florida, Mississippi, North Carolina, Oklahoma, South Carolina, Texas and Virginia). In these States, artificially established forest area was tallied as a percentage of commercial forest area for two inventory periods—the 1980s and the 1990s.

Current extent of intensive management in the South. According to 1990s FIA data, the 13 states in the South contain a total of 365,557,000 acres. Of this, 199,871,000 acres (58.7 percent) are in timberland (Table 1). Slightly more than 21.2 million acres of timberland (10.6 percent of timberland area) is in public ownership, 11.5 million acres (5.7 percent) of which is in national forests. Forest industry owns slightly more than 40 million acres (20.4 percent) of timberland in the South. However, most of the timberland in the South—more than 137 million acres, or 69 percent—is owned by non-industrial private forest (NIPF) landowners.

Table 1. Total land area and timberland area in total and by major ownership categories, for the 13 southern states, based on most recent Forest Inventory and Analysis data for each state.

		Timberland area[a]				
State	Total land area[a, b]	Total[a, b]	National forest[a, b]	Other public[a, b]	Forest industry[a, b]	NIPF[a, b]
Alabama	32,496	21,932	605	557	5,499	15,270
Arkansas	33,328	18,392	2,274	935	4,529	10,655
Florida	42,085	14,651	1,029	1,802	4,601	7,217
Georgia	37,702	23,631	752	894	5,870	16,116
Kentucky	25,227	12,347	699	376	204	11,068
Louisiana	26,265	13,783	568	743	4,422	8,049
Mississippi	30,025	18,587	1,107	844	3,314	13,322
North Carolina	33,708	18,711	1,082	920	2,420	14,287
Oklahoma	10,104	4,896	223	414	1,047	3,212
South Carolina	20,485	12,455	560	554	2,394	8,947
Tennessee	26,447	13,265	556	953	1,144	10,612
Texas	21,594	11,774	577	213	3,770	7,214
Virginia	26,091	15,448	1,468	515	1,555	11,910
All states	365,597	199,871	11,500	9,719	40,772	137,880

[a]Values are in thousand acres.
[b]Numbers in rows and columns may not add to totals due to rounding.

Southwide, 1990s FIA data show that plantations (pine type, hardwood type or mixed pine-hardwood type) occupy 34.7 million acres, or 17.4 percent of the timberland area in the South (Table 2). By state, the area in plantations varies from slightly more than 154,000 acres in Kentucky to slightly more than 5.5 million acres in Georgia. The amount of timberland in plantations varies

from 1.3 percent in Tennessee to 33.8 percent in Florida. Four states—Alabama, Florida, Georgia and Mississippi—account for nearly 19 million acres, or almost 55 percent, of total plantation area in the South.

Table 2. Timberland area of plantation origin (pine type, hardwood type or mixed pine-hardwood type), and percentage of timberland area in plantations (in parentheses), by ownership class and total, for the 13 states in the South.

	Timberland area[a]				
State	All[a, b]	National forest[a, b]	Other public[a, b]	Forest industry[a, b]	NIPF[a, b]
Alabama	4,411.2	35.7	39.8	2,264.6	2,071.1
	(20.1)	(5.9)	(7.1)	(41.2)	(13.6)
Arkansas	2,418.6	208.3	28.2	1,495.4	686.7
	(13.2)	(9.2)	(3.0)	(33.0)	(6.4)
Florida	4,945.1	319.7	267.7	2,628.1	1,729.6
	(33.8)	(31.1)	(14.9)	(57.1)	(24.0)
Georgia	5,502.5	77.4	52.5	3,154.7	2,217.9
	(23.3)	(10.3)	(5.9)	(53.7)	(13.8)
Kentucky	154.6	8.5	11.9	2.6	131.6
	(1.3)	(1.2)	(3.2)	(1.3)	(1.2)
Louisiana	2,645.8	121.8	29.6	1,756.4	738.0
	(19.2)	(21.4)	(4.0)	(39.7)	(9.2)
Mississippi	4,110.8	223.6	79.3	1,618.2	2,189.7
	(22.1)	(20.2)	(9.4)	(48.8)	(16.4)
North Carolina	2,289.7	28.8	71.5	1,224.8	964.6
	(12.2)	(2.7)	(7.8)	(50.6)	(6.8)
Oklahoma	610.2	50.3	0.0	515.5	44.4
	(12.5)	(22.6)	(0.0)	(49.2)	(1.4)
South Carolina	2,828.1	69.7	169.7	1,260.0	1,328.7
	(22.7)	(12.4)	(30.6)	(52.6)	(14.9)
Tennessee	518.5	3.6	33.3	265.7	215.9
	(3.9)	(0.6)	(3.5)	(23.2)	(2.0)
Texas	2,413.9	118.5	5.3	1,761.1	529.0
	(20.5)	(20.5)	(2.5)	(46.7)	(7.3)
Virginia	1,856.5	21.6	33.0	765.1	1,036.8
	(12.0)	(1.5)	(6.4)	(49.2)	(8.7)
All states	34,705.3	1,287.3	821.7	18,712.3	13,884.0
	(17.4)	(11.2)	(8.5)	(45.9)	(10.1)

[a]Table values are in thousand acres (percentage) for each combination of ownership category by state.

[b]Numbers in rows and columns may not add to totals due to rounding.

Public versus private ownership of plantations. Most plantations are on private lands. Southwide, 89 percent of the timberland base is under private ownership; private land accounts for 94 percent of the timberland of artificial origin.

Within the public sector, 11.2 percent of timberland area in the national forests Southwide is in plantations (Table 2). In five states (Florida, Louisiana, Mississippi, Oklahoma and Texas), plantations account for more than 20 percent of the national forest timberland base. Conversely, plantations account for less than 5 percent of the national forest timberland base in Kentucky, North Carolina, Tennessee and Virginia—where national forests are primarily hardwood forests.

In the other public sector (other federal, state, county and municipal lands), only 8.5 percent of the timberland base in the South supports plantations (Table 2). Two states stand out as exceptions—South Carolina, with 30 percent of the forest land in this sector in plantations, and Florida, with nearly 15 percent.

More forest industry land is in plantations than any other ownership. Nearly 46 percent of the timberland held by forest industry in the South is of artificial origin (Table 2). In four states, the proportion exceeds 50 percent (Florida, Georgia, North Carolina and South Carolina); in only three states (Arkansas, Kentucky and Tennessee) is the proportion less than a third.

In the NIPF sector, only 10.1 percent of the timberland base is in plantations, though that represents slightly more than 13.88 million acres of NIPF ownership (Table 2). Alabama, Georgia and Mississippi each contain more than 2 million acres of plantations in the NIPF sector; proportionally, Florida leads the southern states with 24 percent of NIPF timberland in plantations. Three states (Kentucky, Tennessee and Oklahoma) have less than 5 percent of NIPF forestland in plantations.

Changes over time for states with two inventories. Between the 1980 and 1990 FIA reports, the eight states with digital data analysis capability showed a 3.9-percent increase in the percentage of timberland in plantations (Table 3). This represents an increase from 16.5 million acres in the 1980s to nearly 21.5 million acres in the 1990s. The percentage change increased in all eight states, ranging from 1.4 percent in Oklahoma to 5.7 percent in Mississippi.

The largest increase was in the forest industry sector, where plantations occupied 7.1 percent more of the timberland in the 1990s than the 1980s. Again, all states showed an increase, ranging from 4.5 percent in Oklahoma to 11.9 percent in Texas. This represents a gain of nearly 1.1 million acres for these eight states alone (which together comprised 61 percent of the timberland area in all 13 states).

Table 3. Difference in the percentage of timberland of artificial origin between 1980s and 1990s, by ownership class and state, for states in the South with two digital Forest Inventory and Analysis reports.

	Timberland area				
State	All	National forest	Other public	Forest industry	NIPF
Arkansas	2.7	2.1	-0.6	5.7	2.1
Florida	5.6	7.7	2.5	7.0	8.7
Mississippi	5.7	4.6	2.7	6.3	6.8
North Carolina	2.9	0.1	-2.9	7.3	2.9
Oklahoma	1.4	4.9	0.0	4.5	1.0
South Carolina	4.9	2.4	5.1	8.8	5.5
Texas	5.0	5.1	-4.8	11.9	2.2
Virginia	2.2	0.3	0.7	8.1	2.7
All states	3.9	2.9	0.7	7.1	4.2

The NIPF sector showed the second largest increase; its plantations occupied 4.2 percent more of the timberland area in the 1990s than in the 1980s. The increase by state ranged from 1.0 percent in Oklahoma to 8.7 percent in Florida. However, this represents the largest absolute increase in plantation area of any of the four ownership sectors—from just more than 5 million acres in the 1980s to slightly more than 8.5 million acres in the 1990s, or roughly 70 percent of the total 5-million acre increase.

The smallest changes were in the public sector: national forest plantations increased by 2.9 percent and on other public lands by 0.7 percent. On the national forests, changes varied from a 0.1-percent increase in North Carolina to a 7.7-percent increase in Florida. Other public ownership was the only sector where decreases in the percentage of timberland in plantations were seen at the state level; changes in that sector's plantation area ranged from a decrease of 4.8 percent in Texas to an increase of 5.1 percent in South Carolina. This represents an increase of only 216,000 acres on the national forests and 110,000 acres on other public ownerships.

Summary. The scope of intensive forest management in the South can be summarized as follows:

- One out of six acres of timberland in the South is a plantation.
- The 34.7 million acres of plantations in the South represent an area slightly larger than the state of North Carolina.
- Of every 100 acres of plantations in the South, 94 are privately owned: 54 acres are on forest industry land and 40 acres on non-industrial private lands.
- Of every 100 acres of plantations in the South, only 6 are publicly owned: 4 are in national forests and 2 are on other public holdings.

In light of these data, the debate about whether intensive management has a role in southern forestry is moot. It has become an integral element of forest management, especially on private forestlands, and its importance is increasing.

Intensive Management in a Sustainable Forestry Context

Two elements are critical to sustainable forestry—management of forest stands and management of the patchwork of forest stands across a wider landscape. The importance of these two elements is reflected in the American Forest and Paper Association's (AF&PA) Sustainable Forestry Initiative (SFI). Of 13 objectives established in the SFI to implement sustainable forestry in the forest products industry, 7 are directly related to stand and landscape management concerns—5 apply to management of forest stands and 2 to forest landscapes (AF&PA 1995).

Management of Forest Stands

At the stand level, the use of intensive treatments to regenerate individual stands has strong ecological parallels in the dynamics of secondary forest succession and natural disturbance. Clearcutting imitates the severe natural disasters that occur in nature (Smith 1986, Bonnicksen 1994), such as Hurricane Hugo's devastation in South Carolina in 1989 or the wildfires in Yellowstone National Park in 1988. As such, clearcutting has a strong natural parallel—the intensive disturbance that removes all overstory and midstory vegetation from a site. But because silviculture is intended to improve on nature, foresters typically follow clearcutting by planting a chosen species—generally an intolerant, fast-growing species.

Therefore, the first indication that sustainable forest management is successful is whether prompt reforestation of forested areas occurs following harvest. Reforestation is the successful establishment of a new stand of desirable species adapted to the site, and among the most reliable ways to reforest an area is planting.

On AF&PA member-company land, for example, prompt reforestation is called for under the SFI. In 1997, member companies reported successful reforestation within two years of harvest on more than 97 percent of sites on which reproduction cutting had occurred (AF&PA 1997). Similarly, on National Forest System land, the National Forest Management Act of 1976 (NFMA) limits reproduction cutting only to those sites on which foresters can be assured of successful regeneration within a five-year period. However, there are no similar provisions or assurances for non-industrial land in the region.

Restoring abandoned agricultural land to productive forest is a second key element of forest sustainability, especially in the NIPF ownership sector. Afforestation of such land by planting provides a net addition of acreage to the timberland base. Aldo Leopold captured this ethic in his writings, noting that he acquired the Sand County property because he "wanted a place to plant pines" (Leopold 1991); he found "a curious transfusion of courage" in the view of his Sand County pine plantings on a desolate winter night (Leopold 1987). The Conservation Reserve Program and the Wetland Reserve Program of the Natural Resources Conservation Service, as well as various state agencies, promote such restoration.

Some stands in private ownership that have been highgraded in the past may have little potential for future development or for natural regeneration, especially if seed sources are not present or are of inferior phenotypic condition. In such cases, the best option for the timely establishment of a robust stand of suitable quality is by clearcutting and planting. Where there is neither a seed source nor any alternatives to rehabilitate an existing understocked stand, intensive management may be the landowner's best alternative.

The plant communities created by intensive management may be quite different from those that were harvested or than those that might result from using natural regeneration. Whether this is an advantage or disadvantage relates to the condition of the forest on a particular site and on the intentions of the landowner.

But not every plantation is the same. There are subtle differences between intensive management as practiced on public lands versus that practiced on private lands. NFMA requires that, in almost all circumstances, lands in the National Forest System must be reforested with native species within the natural range of those species. Thus, for example, if a clearcut was prescribed in a shortleaf pine (*Pinus echinata*) stand on national forestland in the Ouachita Mountains of westcentral Arkansas, only shortleaf pine can be planted, rather than loblolly or another southern pine, since shortleaf pine is the only pine native to the Ouachitas (Critchfield and Little 1966).

No such restrictions apply to private ownerships; private landowners can plant whatever they choose. For example, a major forest industry in the Ouachita Mountains plants loblolly pine rather than shortleaf on its clearcut sites. Differences also exist among ownerships in the intensity of site preparation. Site preparation and release treatments on national forestlands are often less intensive than associated with industrial forest management. The result is differences in the degree to which species that compete with planted species are suppressed. The net ecological result is subtle and largely unquantified, but apparent to the keen observer.

One might argue that with 94 percent of the plantations in the South on private land, the public land base should be managed only for late successional stages. However, this argument falls short on both legal and ecological grounds. The NFMA and its implementing regulations stipulate that the national forests provide diversity of habitat and maintenance of all native plants and animals, including those that typify early successional stages.

Intensive management using plantations is not the only tool to provide early seral habitat on federal lands; such habitat can also be provided by even-aged reproduction cutting methods that rely on natural regeneration. However, there are some ecological needs on public lands that are better or more efficiently met through intensive management. First, clearcutting and plantation establishment are used to reforest sites following natural disturbances such as wildfire or insect pest outbreaks. Second, some lands enter federal ownership after all commercial timber products have been removed from them; plantation establishment remains an effective tool for restoring the productivity of such sites. Even-aged management also helps achieve specific ecological objectives on federal lands. For example, national forests supporting red-cockaded woodpeckers (*Picoides borealis*) often use clearcutting to remove off-site plantings of slash pine and to plant longleaf pine—restoring a species to sites that originally supported it. Finally, planting is critical to ameliorate natural regeneration failures, such as might occur in a previously planted or naturally regenerated stand under abnormal microclimatic conditions.

On the other hand, private landowners in the South, especially forest products companies, use intensive management because of its productivity and economic advantages. Timber is the most important agricultural commodity in the South; in 1984, the $6.1 billion value of timber products (delivered to the mill or loading point) was double that of soybeans and cotton, and three times the value of tobacco, wheat or corn in the region (USDA Forest Service 1988). Plantation forestry is the most reliable method of ensuring an adequate flow of wood, not just for fiber production, but also for investment in mill capacity. Plantation wood tends to be uniform in diameter, length and taper, which contributes to harvest and milling efficiency. Plantations also create synergy among the public and private sectors; meeting the increasing demand for wood products through intensively managed plantations on private lands offers opportunities to reduce the extent and intensity of harvest on public forests (Sedjo and Botkin 1997).

Management of the Landscape

At the larger landscape level, the issue of scale becomes important when considering intensive management practices and sustainability. The spatial pattern and juxtaposition of plantations across a landscape may influence important ecological patterns and processes such as continuity of habitat. However,

these relationships are not yet clearly accepted in the literature and have not been translated into concrete recommendations that land managers can use to apply intensive management within a landscape. Research must focus on testing such hypotheses in operational landscape conditions (Turner 1989).

A primary concern about intensive management is its effect on biological diversity. The fragmentation of habitat has been a concern for more than a decade (Harris 1984). Fragmentation can refer to spatial fragmentation, such as when a new plantation breaks up a continuous forest canopy. It also can refer to discontinuities of vegetation within an area, such as when a mixed-species stand is replaced by a stand dominated by one species (Lord and Norton 1990).

Fragmentation effects are usually attributed to three factors: forest area, isolation and edge effects. It is sometimes argued that plantations reduce the area of native forest, isolate remaining patches of native forest, and create edges which attract predators and nest parasites; species associated with native forests might then decline in abundance. Such concerns arise because of the common assumption that stand-level habitat quality in plantations and native forests differs greatly for many species. Some (e.g., Terborgh 1989: 168) have even charged that southern pine plantations are "biological deserts."

However, research suggests that if the structure of vegetation is similar between plantations and native forests, wildlife communities can be similar as well. In North Carolina, for example, thinned plantations and unmanaged tall pocosins were found to be similar structurally (Karriker 1995). Both had tall trees and were vertically and horizontally diverse. As a result, bird communities were quite similar in both habitats.

Concern about edges has its origins in research projects investigating the permanent edges created by agriculture or urbanization. However, edges created by forest management do not always appear to function as permanent edges. One factor in this phenomenon may be that intensive management often occurs in the South within highly forested landscapes; landscape-scale habitat patterns greatly influence patterns of edge-related phenomena, e.g., nest predation and cowbird abundance (Donovan et al. 1997). Predator abundance and cowbird parasitism are most severe in landscapes highly fragmented by agriculture or urbanization. Cowbirds appear to have difficulty exploiting highly forested landscapes, even if managed by clearcutting (Thompson et al. 1992). Thus, at least in extensively forested areas, intensive management can be compatible with the goal of maintaining viable populations of many forest interior and Neotropical migrant birds (e.g., Thompson et al. 1992).

Maintenance of biological diversity requires maintenance of a variety of successional stages (Sharitz et al. 1992), from early successional to late successional stages. If intensively managed landscapes retain a diversity of successional stages, they can support many species, some of which are of conservation

interest. In South Carolina, for example, researchers from North Carolina state University (Richard A. Lancia personal communication: 1998) have identified 73 bird species within an intensively managed landscape chiefly composed of pine plantations of various ages. Other land types within the landscape are scattered "gum" ponds and native pine-hardwood and hardwood forests. Of the 73 bird species, 40 are Neotropical migratory birds, 11 are high-priority species (as designated by Partners in Flight) and 13 are often viewed as forest interior species.

It thus appears likely that intensive management practices on public and private lands can be modified to enhance structural diversity (Sharitz et al. 1992) at the stand and landscape level. But more research is needed to understand better which structural features are limiting and how to enhance them.

Discussion and Conclusions

It has been only six decades since H. H. Chapman (1942) initiated the forestry profession in the South by observing that second-growth loblolly pine stands in the West Gulf Coastal Plain could be profitably managed from establishment to final harvest. Since then, one out of six acres of timberland in the South now supports a planted stand. Intensive forest management has thus become one of the most important silvicultural tools in the toolbox of the forester. If the concept of forest sustainability is to have lasting importance in southern forestry, it must provide, as it did in the land ethic of Aldo Leopold, for the ecological attributes and economic values of the pine or hardwood plantation.

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