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Temple-Inland FOREST

THE HARDWOOD FOREST

Management Plan

2001

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EXECUTIVE SUMMARY

New objectives associated with TIFPC's hardwood resources have necessitated the need to revise the current (1990) Hardwood Management Plan. Initially the objective of the hardwood management program was to provide a sustainable domestic short-fiber source to the bleached liner board plant in Evadale, Texas. At that time, projections indicated a potential future shortage of hardwood fiber. The initial plan called for the establishment of even-aged patches to be managed on a 40-year pulp rotation. Since 1990, however, substantial improvements in grade log merchantability and associated price increases have allowed TIFPC to realize higher returns from natural hardwood resources. In addition, the recent sale of the Evadale Mill to Westvaco provides an opportunity to further improve revenues through the production of extended rotation hardwood sawtimber and expand markets associated with these products.

Presently, there are 150,000 acres of fee land designated as southern hardwood forest. Of this acreage approximately 120,000 acres have been determined suitable for management. This forest is composed of approximately 141,676 acres of bottomland hardwoods, 1,861 acres upland hardwoods, and 6,463 acres in coastal flatwood hardwoods *(Figure 3)*. They occur mainly in the flood plains along the Neches River and to a lessor extent the Angelina and Sabine Rivers, and in creek bottoms.

Approximately 194,000 tons of hardwood and 46,000 tons of pine roundwood products are removed from the hardwood forest annually. Grade logs currently account for approximately 13% of the total volume, 18% tie logs, and 48% is hardwood pulpwood. These products are sold on the open market to local, in state, and out of state

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manufacturing facilities. Pine sawlogs make up about 16% of the total volume removed, while the remaining 5% is pine pulpwood *(Figure4).* Internal facilities utilize the majority of the pine products generated.

Past and present management practices administered by the Hardwood Department have carefully taken into consideration social, as well as, economic conditions of the hardwood resource. Persons responsible for harvesting/regeneration will continue to be ever mindful of the potential environmental impacts and aesthetic quality when planning. Temple-Inland's Forestry Principles will continue to provide as a guide for responsible stewardship of the hardwood resource.

Sound silvicultural practices shall be implemented to meet resource needs. They shall be the driving forces, the means to achieve the desired end. The silvicultural system will be the process by which we grow the hardwood forest stand to meet our objectives. This process shall include all practices over a rotation—harvest or regeneration cuttings intermediate cuttings, and other cultural treatments necessary for replacement and development of the hardwood forest stand. A site-specific prescriptive approach will be utilized to develop forest management plans.

Maintenance of sustainable value within Temple-Inland's operational hardwood forest on a site-specific basis will require the integration of several accommodating systems, their typical application, and a scientific evaluation of each method with regard to its utility within forested wetland ecosystems. With the current age, condition, and composition of Temple's even-aged domestic hardwood resource, the even-aged silvicultural system provides the most appropriate method of ensuring the continuation of current species composition through subsequent rotations and will be utilized on the

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majority of hardwood stands. An uneven-aged system will be utilized in areas such as SMZ's and AMZ's where compositional shifts are desirable or in Special-Use areas where even-aged harvest methods are not appropriate.

Currently, there is no formal monitoring system in place to evaluate forest health and dynamics of the hardwood forest. The high cost of conventional Continuous Forest Inventory (CFI) systems, along with the time and manpower necessary to conduct data collection on an ongoing basis, has led current management to explore new remotely sensed data technologies. This technology, once developed, should enhance our ability to more efficiently identify forest health and dynamics related issues as well as provide a means to prioritize harvest scheduling.

Presently, there are no known rare, threatened or endangered species in the hardwood forest owned by TIFPC. However, it is acknowledged that this forest type, as a whole, is considered unique. Therefore, we will remain mindful of this fact and shall diligently strive to maintain the functions and values this forest inherently possesses.

Harvest scheduling each year will be determined using the area-based regulation principle. The planned rotation age for the hardwood forest is 60 years. In order to achieve a fully regulated forest by the year 2050, successful regeneration harvests must average approximately 2,000 acres annually. Additionally, roughly 4,000-5,000 acres will be scheduled for partial cutting. A 5-year harvest schedule is in place and will be updated once a year.

Sustained harvesting of the hardwood resource is necessary for several reasons: to maintain forest health and forest productivity, to meet silvicultural objectives, to generate revenue, and to develop wildlife and social benefits. Harvesting in the hardwood forest

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shall be performed by experienced contract logging professionals. These professionals shall be handpicked based on their knowledge and expertise of site conditions and product types removed from the forest. Harvesting staff within the Hardwood Department has worked diligently to locate and develop a reliable logging force that understands the challenges prevalent in this forest. The continued success of the hardwood program centers on retaining a viable hardwood contract logging force. In order to protect and maintain water quality during harvesting operations, the Hardwood Department will continue to endeavor to meet and/or exceed BMP's.

Temple-Inland has periodically conducted research on its hardwood forests since 1982. However, in 1997 a hardwood research department was established to develop knowledge associated with Temple-Inland's hardwood resources. Initially, the program was geared toward development of cost-effective domestic short fiber production through fertigation and intensive hardwood plantation systems. Though, with the sale of the Evadale, Texas Mill in 1999, the focus of hardwood research shall be shifted toward long-term management with an emphasis on grade log production.

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MANAGEMENT STRATEGY

Introduction

Temple-Inland Forest Products Corporation (TIFPC) manages 2.2 million acres of forestland located in Texas, Louisiana, Georgia, and Alabama. Pine plantations ranging in age from 0-20 years comprise 67% of the land base, 23 % is mixed pine-hardwood designated as mixed forest, and 10% is considered hardwood forest *(Figure1)*.

This document will address acres designated as hardwood forest. Presently, there are approximately 150,000 acres of fee land in this timber cover-type. Of these acres approximately 120,000 have been determined suitable for management.

Regeneration/harvesting in the hardwood forest began in 1990 and is ongoing today. To date nearly 9,000 acres have been naturally regenerated utilizing complete clearcuts or cleancuts (averaging 23 acres in size), about 24,400 acres have been entered using partial cutting methods, while roughly 86,600 acres remain untreated *(Figure2)*.

New objectives associated with Temple-Inland Forest's hardwood resources have necessitated the need to revise the current hardwood management plan. Initially, the objective of the hardwood management program was to provide a sustainable domestic short fiber source to the bleached liner board plant in Evadale, Texas. At that time, projections indicated a potential future shortage of hardwood fiber. The initial plan called for the establishment of even-aged patches to be managed on a 40-year pulp rotation. Since 1990, however, substantial improvements in grade log merchantability and associated price increases have allowed TIFPC to realize higher returns from natural

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hardwood resources. In addition, the recent sale of the Evadale Mill to Westvaco provides an opportunity to further improve revenues through the production of extended-rotation hardwood sawtimber and to expand markets associated with these products. In conjunction with this opportunity, however, is an increased responsibility to improve forest health, productivity, and value through the implementation of sound, innovative, and environmentally sensitive silvicultural systems on a site-specific basis. In order to effectively accomplish these goals a new management strategy will be required. Silvicultural restrictions implemented to ameliorate the effects of intensive, short rotation pulpwood production are less applicable to extended-rotation sawtimber production systems. Without increased silvicultural flexibility, long-term production costs will rise as a direct response to fragmentation of even-aged management units. However, proper development and execution of a scientifically based, dynamic, and silviculturally innovative management plan will ensure the maintenance of a healthy, productive, value-diverse hardwood forest.

Continued management of Temple-Inland's hardwood resource under current silvicultural restrictions will result in the systematic fragmentation of management units significantly reducing the future efficiency of management and extraction operations. For example, under the current plan, it is possible that a 100-acre tract of timber could be dissected into three or four discrete even-aged patches which all require unique silvilcultural treatments in subsequent rotations. Current revenue levels from our forest result from our ability to remove volume across large contiguous even-aged tracts by thinning outside clearcut boundaries. Once these large even-aged tracts are dissected into several small even-aged parcels, the volume we are now generating through thinning

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adjacent to clearcuts will not exist. Frequent and inefficient deployment of equipment and personnel will be required to manage these small even-aged patches and result in a substantial increase in operating costs. To further complicate the process, access for extraction operations may only exists for 6-8 months of the year. Increased logistic complexity will result in more time moving contractors and less time generating volume during an abbreviated logging season. For these reasons, the planning and implementation of even-aged management units should be carefully considered to optimize logistic considerations vital to maintaining sustainable value within Temple-Inland's operational hardwood forest.

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Management Vision/Goals/Objectives

VISION…

- The vision guiding the Hardwood Team will be to ensure environmental sustainability and ecological integrity of the hardwood forest, while achieving sustainable social and economical benefits.

THE GOALS ARE…

- To produce high-quality forest products
- To naturally regenerate the hardwood forest in a timely manner to sustain a desirable species composition
- To monitor and ensure forest health
- To ensure environmental sustainability and ecological integrity
- To derive sustainable social and economic benefits from the hardwood forest
- To develop and share knowledge gained from management of the hardwood forest ecosystem

THE OBJECTIVE IS…

- To optimize long-term forest Productivity, Health, and Value through research-based site-specific management, prescribed at the stand level, while adhering to Temple-Inland's Forestry Principles, SFI and following all relevant EMS Operational Control Procedures.

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Forest Resources

The existing forest cover to be managed is described as southern hardwood forest. It is composed of approximately 141,676 acres of bottomland hardwoods, 1,861 acres upland hardwoods, and 6,463 acres of coastal flatwood hardwoods *(Figure 3)*. Most of the forest occurs in the floodplains along the Neches River while the remainder is found in the Angelina and Sabine Rivers, and in creek bottoms. The majority of these stands were established over a relatively short period subsequent to heavy cutting during the early 1900's. Due to a self-proclaimed moratorium on this resource, by the company, during the 1940's, this forest was managed on a limited basis until 1990. Therefore, most existing stands are even-aged and somewhere in the range of 65-80 years of age.

Three major cover types are recognized within the TIFPC hardwood forest: 1) Sweetgum-red oak, 2) Red oak-white oak, and 3) Cypress-tupelo. Major hardwood species found growing in these associations are white oak (*Quercus. alba*), water oak (*Q. nigra*), willow oak (*Q. phellos*), cherrybark oak (*Q. falcata* var. *pagodifolia*), swamp chestnut oak (*Q. michauxii*), overcup oak (*Q. lyrata*), sweetgum (*Liquidambar styraciflua*) , hickorys (*Carya* spp.), black tupelo (*Nyssa sylvatica* var. *sylvatica*), red maple (*Acer rubrum*), sweetbay (*Magnolia virginiana*), American beech (*Fagus grandifolia*), elms (*Ulmus* spp.), green ash (*Fraxinus pennsylvanica*), sugarberry (*Celtis laevigata*), and water tupelo (*nyssa aquatica*) among others. Baldcypress (*Taxodium distichum* var. *distichum*), considered a deciduous conifer, is commonly found growing in association with some of the hardwoods before mentioned. Additionally, a small percentage of pines does exist scattered throughout the first two cover types mentioned.

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Environmental Limitations

The most prevalent environmental limitation faced by management in these riverine and creek bottom systems is periodic flooding. Due to excessive moisture from rain events and the inherent nature of the soil types found there, harvesting access is typically limited to 6-8 months during the year. Harvesting activities normally begin in summer and end in the fall. Additionally, ponded water from beaver dams can impede access to bottomland timber stands throughout the harvest season. Harvest scheduling is therefore controlled by these confines.

Land Use

Approximately 194,000 tons of hardwood and 46,000 tons of pine roundwood products are removed from the hardwood forest annually. Grade logs currently account for approximately 13% of the total volume, 18% tie logs, and 48% is hardwood pulpwood. These products are sold and delivered on the open market to local, in state, and out of state manufacturing facilities. Pine sawlogs make up about 16% of the total volume removed, while the remaining 5% is pine pulpwood *(Figure 4)*. Internal facilities utilize the majority of the pine products generated.

Consumptive and non-consumptive recreational activities take place on the forest by company employee, lessees, and others. White-tailed deer hunting is the most popular recreational pursuit. This is mainly due to the abundance of rich habitat that bottomland hardwood ecosystems offer in conjunction with adjacent upland pine forests. Species diversity of flora and fauna encompassed by the forest is some of the richest in the continental United States. These forests serve as corridors for non-game wildlife species

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as well. Additionally, hikers, bird watchers and others enjoy the sanctuary of Temple-Inland's hardwood forests.

Socioeconomic Conditions

Past and present management practices administered by the Hardwood Group have carefully taken into consideration social, as well as, economic conditions of the hardwood resources. Persons responsible for harvesting/regeneration will be ever mindful of potential environmental impacts and aesthetic quality when planning. Temple-Inland's Forestry Principles will continue to provide as a guide for responsible stewardship of the hardwood resource, as well as, other lands and forests owned and managed by the company. These Forestry Principles will help insure the renewability and perpetuation of the hardwood forest resources for future generations, as well as protection of human health and the environment. The Hardwood Group will conduct its silvicultural practices in a manner consistent with this statement, while continuing to provide quality wood products.

Adjacent Land Profile

As is typical of the Western Gulf Region, upland pine plantations lie immediately adjacent to bottomland hardwoods. These stands are intensively managed for sawtimber production. Target rotation age is approximately 25-33 years. The majority of these pine stands are owned and managed by TIFPC. Most products generated from these forests are utilized internally. These forests are managed in accordance with Temple-Inland's

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Forestry Principles and the EMS Control Procedures for all aspects of pine plantation operations.

Silvicultural Systems

Sound silvicultural practices shall be implemented to meet resource needs. They shall be the driving force, the means used to achieve the desired end. The silvicultural system will be the process by which we grow the hardwood forest stand to meet our objectives. This process shall include all practices over a rotation—harvest or regeneration cuttings, intermediate cuttings, and other cultural treatments—necessary for replacement and development of the hardwood forest stand. A site-specific prescriptive approach will be utilized to develop forest management plans.

Maintenance of sustainable value within Temple-Inland's operational hardwood forest on a site-specific basis will require the integration of several accommodating silvicultural systems. The following is a brief discussion of various silvicultural systems, their typical application, and a scientific evaluation of each method with regard to its utility within forested wetland ecosystems.

Hardwood forests are extremely complex from a management perspective. Over 40 commercial species occur in association with 250 non-commercial species within hardwood forests of the southeastern U.S. (Hopper and Nichols, 1994). These species associations are stratified vertically with regard to shade tolerance and horizontally as a function of physiographic position (Zobel and Davey, 1978). Species ecophysiological characteristics and natural stand developmental processes influence the compositional and structural aspects of the stand. In addition, dynamic hydrologic regimes, challenging

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soil structural characteristics, and limited operational accessibility further complicate stand manipulation efforts. An understanding of species-site interactions and the interdependence of dynamic environmental conditions is critical to the effective management of mixed bottomland hardwood forests. In addition, the silvicultural techniques employed must be adaptable to a wide range of site and stand conditions in order to optimize stand improvement or extraction operations. For these reasons, numerous silvicultural techniques for the management of hardwood forests have been, and continue to be developed.

Historically, hardwood silviculture has been classified into the broad categories of even-aged or uneven-aged silvicultural systems. The systems are differentiated based on the age-class distribution and the methods utilized to naturally regenerate the stand. A stand is considered even-aged if the difference between the oldest and the youngest trees is less than 20% of the length of the *rotation* (Smith, 1986). Even-aged systems favor shade-intolerant hardwood species such as oak, ash, and sweetgum (Hopper and Nichols, 1994). The available acreage and the desired rotation typically determine removals from even-aged forests. This is termed *area-based regulation*. Conversely, an uneven-aged stand is a stand with at least three distinct age classes with all age classes existing concurrently on the site. For this reason, uneven-aged stands are sometimes referred to as *all-aged stands*. Rather than a rotation of given length as in even-aged management, uneven-aged forests are managed through *volume regulation* and a *cutting cycle* is used to regulate removals and regeneration. Uneven-aged systems tend to favor regeneration that is more shade-tolerant such as ironwood and maple and lead to eventual shifts in species composition (Hopper and Nichols, 1994). As a result, uneven-aged silvicultural

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systems are not preferred for maintaining desirable and sustainable species composition. With the current age, condition, and composition of Temple-Inland's even-aged domestic hardwood resource, even-aged silvicultural systems provide the most appropriate methods for ensuring the continuation of current species composition through subsequent rotations and will be utilized on the majority of hardwood stands. Uneven-aged systems will be utilized in areas such as SMZ's and AMZ's where compositional shifts are desirable or in special-use areas where even-aged systems are not appropriate.

In the majority of naturally regenerated hardwood forests, the occurrence of desirable regeneration prior to harvest is essential to ensuring the continuation of the forest (Sander, 1972). A primary objective in harvesting hardwood forests is to provide the environmental conditions necessary for the establishment and development of adequate regeneration (Hodges, 1987; Belli et. al, 1999). Even-aged and uneven-aged *regeneration methods* have been developed to provide a range of stand treatments that will establish natural regeneration while accomplishing a variety of landowner objectives. Each regeneration method is distinct and specific to a desired outcome (Hopper and Nichols, 1994). Selection of a method is largely dependent on composition, condition, and overall management objectives with particular emphasis placed on regeneration considerations.

Even-aged Regeneration Methods

1. Clearcutting

Clearcutting is an even-aged regeneration method in which all stems down to a diameter of 1.0 inches in diameter at breast height (DBH) are removed or deadened. It is

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typically performed during or immediately following harvesting operations to optimize solar radiation availability critical to natural regeneration (Hopper and Nichols, 1994). The effectiveness of clearcutting as an even-aged regeneration method for bottomland hardwood forests is well documented (Kellison et al., 1981, Hodges, 1987). In an investigation of five regeneration methods, Toliver and Jackson (1988) reported clearcutting to be the most effective method within each of eight forested wetland site types ranging from alluvial river bottom to peat swamp. For these reasons, clearcutting provides an effective and flexible silvicultural tool for naturally regenerating even-aged systems. Little information regarding maximum clearcut size with respect to silvicultural efficiency or regeneration potential exists. Limited scientific investigation and subsequent literature regarding maximum opening size suggest that non-silvicultural considerations, such as public perception, play key roles in determining the acceptable size of even-aged management units. In addition, TIFPC Forestry Principles limit clearcut size within hardwood bottoms to a maximum of 30 acres. These constraints often prevent the implementation of silvicultural treatments designed to increase the health, productivity, and future value of Temple-Inland's hardwood forest.

2. Shelterwood Method

Shelterwood is also an even-aged regeneration method that refers to the gradual removal of the overstory through a series or *steps* of partial harvests. In contrast to thinning, which is primarily concerned with improving stand growth, it is designed to facilitate the establishment of natural regeneration (Hopper and Nichols, 1994). The number of steps indicates the number of subsequent stand entries prior to final overstory

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removal and release of the established regeneration. Existing stand condition often dictates the volume to be removed and the number of steps that can be made prior to overstory removal. Subsequently, a wide variety of residual stocking levels and volume retention may exist under shelterwood systems. Shelterwood systems are typically implemented in areas where advance regeneration quantity and/or quality are lacking. By removing a portion of the overstory, radiation becomes available to the regeneration strata stimulating establishment and development (Toliver and Jackson, 1988). Once established, the regeneration is released to grow with a final overstory removal. The ensuing stand then develops as an even-aged forest.

3. Shelterwood with Reserves Method

Shelterwood with reserves, (sometimes referred to as deferment cutting) is an even-aged regeneration method in which a portion of the original stems are retained until sexual maturity of the regenerated stand or through the entire rotation of the regenerated stand (Messina and Jenkins, 2000). Smith et al. (1989) recommends this technique as an aesthetic alternative to clearcutting in eastern hardwood stands. This method provides a potential balance of the ameliorative benefits of the shelterwood method and the regeneration advantages of clearcutting.

Uneven-aged Systems (Selections)

1. Single-tree Selection

This method involves the removal of single trees from each diameter class creating small openings within the canopy. The primary objective with single tree

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selection is to create a multi-structural, all-aged stand. However, single-tree selection is not recommended in forested wetlands because of the unpredictability of adequate regeneration establishment and growth within small gaps created by the removal of scattered single trees (Toliver and Jackson, 1988). Their results suggest that size of gap or opening greatly effects the quantity and quality of regeneration within forested wetland systems. In addition, single-tree selection may result in more frequent equipment traffic on wetland soils, which could lead to a decrease in long-term site productivity.

2. Group Selection Method

This method is also considered a complete silvicultural system. It is administered by removing groups of trees rather than single trees as in single tree selection, in order to better establish desirable natural regeneration. Because of concerns regarding the effects of small gap openings, guidelines for minimum opening size were developed and suggest that desirable regeneration increases with opening size (Smith, 1981; Golden, 1994). Dale et al., (1995) indicated that smaller openings not only had less regeneration density than larger openings but a higher percentage of undesirable species. In addition, their results indicated that basal area and total volume also increased with opening size. It is recommended that groups be no larger than two mature tree heights in width (Smith, 1986) and typically range from 0.1 to 1.5 acres creating small even-aged patches within the stand (Hopper and Nichols, 1994). In practice, group selection is very similar to patch clearcutting. The difference lies primarily in the choice of area or volume regulation (Golden, 1994).

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Intermediate Cuttings (Thinnings)

Unlike regeneration methods in which establishment of regeneration is the primary objective, intermediate cuttings are designed to enhance the growth, composition, and structure of the forest through density and competition management as well as the removal of undesirable compositional components. These objectives may be accomplished both pre-commercially or commercially and include a wide range of potential activities. Intermediate cuttings designed to enhance growth through density regulation are called thinnings while those designed to improve species composition are called release operations in young stands and improvement cutting in older stands (Smith, 1986).

1. Improvement Cutting

Improvement cutting in older stands is performed to increase productivity and improve stand composition without consideration of regenerating the site (Smith, 1986). It typically requires the removal of individual trees of undesirable species, diminished health, or poor condition. This method is widely utilized within Temple-Inland's hardwood forest to improve the health and condition of an aging resource until regeneration may be accomplished. In many cases, this method closely resembles shelterwood and may also vary widely with pre-treatment stand condition. Although not specifically designed to produce natural regeneration, improvement cutting in hardwoods frequently results in the establishment of regeneration. Improvement cutting typically leads to shelterwood and subsequent regeneration as an even-aged stand although it provides options for uneven-aged management as well.

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2. Timber Stand Improvement

Timber stand improvement (TSI) operations include treatments requiring investment without an immediate return from timber extraction (Smith, 1986). Such activities may include herbicide application, pre-commercial thinning, or pest management operations. Although not currently utilized within Temple-Inland's hardwood forest, current TIFPC research efforts are in place to develop TSI techniques for young naturally regenerated hardwood stands.

3. Crop-Tree Method

Crop tree management is a relatively new approach to hardwood silviculture developed in eastern hardwood systems for small landowners who wish to manage their timber for a variety of objectives. In this system, only trees in direct competition with selected crop trees are removed. The crop trees in turn respond to release with accelerated growth. Increasing intensity is accomplished by selecting and releasing additional crop trees rather than increasing opening size between crop trees. The system is designed to identify the trees with the greatest growth potential (or other potential such as mast production) and concentrate silvicultural efforts to enhance those trees (Perkey, et. al, 1993). Once the crop trees have reached economic maturity, the stand may be regenerated or regulated with uneven-aged management systems. This system provides an effective technique for a wide range of objectives. In addition to high value timber production, crop tree management may have great potential for the management of

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streamside management zones (SMZ's) and/or for wildlife habitat enhancement (Perkey, et. al, 1993).

Quality hardwood management requires site-specific silvicultural application. As silvicultural systems are designed to facilitate specific objectives, it is logical to consider a combination of techniques to meet management objectives. Although not necessarily mutually exclusive, on the ground application and the information required to make management decisions varies widely among systems. System integration is not unquestionable but poses substantial logistic, economic, and administrative challenges. However, with the range of demands placed upon Temple-Inland's aging hardwood resource, proper silviculture is critical to the maintenance of health and productivity and to ensure continued sustainability. A single strategy, although much easier to implement, may not provide sufficient silvicultural breadth to effectively accommodate a wide range of commercial and non-commercial objectives.

Over 8,000 acres of fee hardwoods have been regenerated since 1990 without a single documented regeneration failure. Messina, et. al. (1997), in a study conducted on Temple-Inland property, indicated no changes in species composition following various levels of even-aged harvest intensity. Based on the current desirability of species composition and the age class distribution within a large percentage of Temple-Inland's hardwood forest, even-aged silviculture would provide the best system for regenerating and establishing new forests. However, in many cases, past cutting practices (often occurring prior to acquisition by Temple-Inland) have resulted in stands that have developed under less than optimal circumstances. Optimizing the management of such stands may require a combination of methods to restore and maintain value.

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Species Selection

The criteria for species selection in the bottomland hardwood forest is based on a tree classification scheme developed by John Putnam (USDA Agriculture Handbook No. 181) more commonly referred to as the "Tree Class System" (Table 1 & 2).

SPECIES CLASSIFICATION			
CLASS A SPECIES	**CLASS B SPECIES**	**CLASS C SPECIES**	**CLASS D SPECIES**
COTTONWOOD	CYPRESS	BOXELDER	BLACK LOCUST
SWEETGUM	SWAMP BLACK GUM	WATER HICKORY	CATALPA (var. sp.)
GREEN ASH	BLACK GUM	BIRCH (var. sp.)	OSAGE-ORANGE
SYCAMORE	SUGARBERRY	HICKORY (var. sp.)	CHINABERRY
WHITE ASH	AMERICAN ELM	SASSAFRAS	BLACKJACK OAK
CHERRYBARK OAK	RED MAPLE	WINGED ELM	AMERICAN HORNBEAM
SHUMARD OAK	OVERCUP OAK	CEDAR ELM	EASTERN HOPHORNBEAM
NUTTALL OAK	AMERICAN BEECH	BLACK OAK	HONEY LOCUST
WILLOW OAK	SOUTHERM MAGNOLIA	HOLLY (var. sp.)	POST OAK
WATEROAK	COMMON PERSIMMON	FLOWING DOGWOOD	LIVE OAK
SWAMP CHESTNUT OAK	WILLOW		
WHITE OAK	SOUTHERN RED OAK		
BLACK WALNUT			
BASSWOOD			
PINE (var. sp.)			
BLACK CHERRY			
YELLOW-POPLAR			

Table 1. *Putnum classified each tree species typically found in mixed bottomland hardwood forests into Classes.*

TREE CLASSIFICATION SYSTEM
PREFERRED GROWING STOCK
• Trees in good growing condition
• Class A species
• Dominant or co-dominant crown class
• Good form and quality
• Can be left in stand without loss from degrade or mortality
RESERVE GROWING STOCK
• Trees in good condition that do not qualify as PREFERRED GROWING STOCK
• Class A, B, or C species
• Can be left for one or more cutting cycles with little risk
CUTTING STOCK
• Trees that must be cut during the first cutting cycle
• Poor condition or high risk
• Class D species

Table 2. *In mixed hardwood stands where species relationships are quite complex, we use the tree classification system to aid in forest management.*

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This system is one of the most valuable tools available for management of southern bottomland hardwood forests. Putnam created this classification system to aid as a basis for planning partial cuttings and for developing rules for marking hardwood timber. It has however, been modified and refined over the years to conform to specific management objectives, but the basic concepts advocated by Putnum are still being prescribed. These classes help the timber marker to identify the types of trees that should be left in the residual stand and the types of trees that should be removed in some type of partial cutting (Table 2). Utilized in this manner, the tree class system provides as a form of cutting priority for the Hardwood Department Foresters.

Additionally, cavity trees and mast producing species are favored for wildlife, especially in SMZ's and AMZ's. Furthermore, species diversity throughout the bottomland forest is a desired state. This will be achieved through the proper implementation of the tree class system.

Monitoring Forest Health and Dynamics

Currently, there is no formal monitoring system in place to evaluate forest health and dynamics of the hardwood forest. The high cost of conventional Continuous Forest Inventory (CFI) systems, along with the time and manpower necessary to conduct data collection on an ongoing basis, has led current management to explore new technologies that may compliment or perhaps replace traditional CFI methods. It is anticipated that this alternative state-of-the-art technology could provide more cost-effective means of gathering information relating to forest health and dynamics.

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The technology referred to above is the use of remotely sensed data to identify stand composition and condition with spatial references. This will be accomplished using acquired digital infrared imagery to distinguish species and health characteristics. Additionally, this effort is believed to improve the accuracy associated with the hardwood resource information. More specific benefits expected are:

- the elimination of reconnaissance cruises
- increase mapping consistency
- increased accuracy while stratifying acreage for site types
- time reduction associated with updating Geographical Information System
- more accurate stratified map information of hardwood timber stands would aid management planning of harvest operations

Temple-Inland has recognized the potential benefits of this cutting-edge technology and has made a significant financial commitment to further explore and develop this method for monitoring stand health, as well as, other changes that may occur over time in the bottomland hardwood forest. As this technology is developed and becomes available, the Hardwood Department envisions utilizing it to monitor and identify forest health and dynamics.

Environmental Management

Temple-Inland's Forestry Principles and the EMS Harvesting Procedures will be the guidelines for ensuring environmental safeguards. Associated with hardwood silviculture and extraction operations a performance monitoring system (Harvest Inspection Report) will be used to evaluate and correct deficiencies that may occur while

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harvesting. Additionally, an internal audit system that employs teams from separate management units will perform audits on an annual basis. The Company's Environmental Affairs Department directs the audit program and primary audit team leaders. The audit results are reported to management, with corrective action progress reported to the Board of Directors by the Group Vice President of Environmental Affairs. The audits follow a corporate audit protocol and verify compliance with each Forestry Principle's Objective and Performance Measure.

Protection of Rare, Threatened and Endangered Species

Currently, there are no known rare, threatened and endangered species in the hardwood forest owned by TIFPC. However, it is acknowledged that this forest type, as a whole, in itself, is considered unique. This is mainly due to dwindling acres caused by the conversion of hardwood stands to pine plantations throughout the region. Therefore, we remain mindful of this fact and will diligently strive to maintain the functions and values that this forest inherently possesses.

The Company does not presently have a program in place for the identification of rare, threatened and endangered species in hardwood forests. The Company does however, make provisions for endangered species protection under Objective 3 of Forestry Principles.

Annual Harvest

Harvest scheduling each year will be determined using area-based regulation. The principle of area control is very straightforward: harvest and regenerate the same number

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of acres each year that would be harvested in a fully regulated forest. The area-based regulation method of silviculture will produce an even-aged forest structure. The timber on compartments/stands scheduled for cutting each year defines the resultant volume harvested. Therefore, volumes and product mixes removed may tend to fluctuate until the forest becomes fully regulated. The planned rotation age for the hardwood forest is 60 years. In order to achieve a fully regulated forest by the year 2050, successful regeneration harvests must average approximately 2,000 acres annually. Additionally, roughly 4,000-5,000 acres will be scheduled for partial cuttings. A 5-year harvest schedule is in place and will be updated once a year.

Harvesting Operations

Timber harvesting in the hardwood forest is performed by experienced contract logging professionals. These professionals are handpicked based on their knowledge and expertise of site conditions and product types that are removed from the hardwood forest. Harvesting Staff within the Hardwood Group have worked diligently to locate and develop a reliable logging force that understands the challenges prevalent in this forest. Continued success of the Hardwood Department centers on retaining a viable hardwood logging force.

Timber harvesting of bottomland timber necessitates the need for adaptability due to inherently unique site conditions. The process begins with identifying and establishing access to the harvest area. Woods roads and company roads, are constructed and maintained, as needed, to accommodate heavy machinery. These roads are located to

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minimize stream crossings and allow for efficient access to timber. Once access is established, the harvesting operation begins.

The primary harvesting technique deployed is a two-pass undercut. In this process, there are typically two passes made through the stand area. The initial pass or "undercutting" consists of removing pulpwood and small diameter sawtimber. This insures that smaller trees are removed, intact, without breakage. When thinning, undercutting also reduces potential damage to residual timber. Finally, in the second pass, the emphasis shifts to removing the remaining specified larger diameter sawtimber trees.

The two felling techniques used in bottomland harvesting are manual and mechanical. In mechanized felling, a rubber-tired feller-buncher is used to cut trees designated for harvest. This machine primarily cuts pulpwood and small sawtimber. The stems are carefully laid in bunches, creating a convenient load for transporting to a central location (set). In situations were the butt diameter is a limiting factor for the throat of the shear-head on the feller-buncher, sawhands are used to manually fell. The majority of the bottomland stands require manual fellers. Sawhand felling reduces the amount of splinter pulls and split butts that may often occur on larger diameter stems. This tends to reduce loss in merchantable volume generally associated with mechanical felling of larger stems. De-limbing is the next step following felling. After de-limbing, the stem is both measured and cut into desirable lengths (bucking) or skidded tree length to the set for further merchandising. De-limbing and bucking are done manually using chainsaws. The process of harvesting is the conversion of trees into various products by means of felling, de-limbing, and bucking.

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Skidding is the next step in the harvesting process. It should be noted that skidding techniques in thinning and cleancut harvests differ. Skidding in partial cut stands requires that skidding traffic is concentrated to primary routes. This minimizes skinning (bark removal) that often occurs to the residual stand. Stems damaged along the main trail are usually removed to insure that the remaining stand is healthy and productive. All timber in cleancut stands is to be removed; therefore there is no concern with skinning trees.

Logs that have been skidded to the set are loaded or further merchandised to the specific product to be delivered. The loader takes the merchandized material from the set that has been through the merchandising process and places it onto a pole or frame trailer. These trailers are used in combination with truck-tractors in order to make the final transport to the manufacturing facility.

Stems harvested will be merchandised into the most valuable product according to our current markets and respective log specifications. This optimizes financial return to the Company. The Hardwood Department will continue to monitor forest fiber-utilization practices to ensure efficient use of forest resources while continuing to observe current markets, as well as locating new markets for hardwood products.

In order to protect and maintain water quality during harvesting operations, the Hardwood Department will continue to meet and/or exceed Best Management Practices (BMP's). Harvesting contractors are expected to follow BMP; water quality; and wetland regulations, in the performance of their responsibilities. In order to meet or exceed this standard, loggers are required to undergo BMP logger training to gain state SFI/BMP certification. Logger Certifications will be monitored, verified, and retained on file.

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Justification of Harvesting Activities

Temple-Inland's harvesting of the bottomland resource is conducted for several reasons: to maintain forest health and productivity, to meet silvicultural objectives, to generate revenue, and to develop wildlife and social benefits. Forest health and productivity are maintained by implementing the forest management plan. Harvesting according to this plan insures the removal of suppressed, dying, or infested stems to create an overall more productive and healthy forest. The harvesting team will work to ensure the full utilization of company controlled fiber while meeting silvicultural objectives set forth by management. These silvicultural objectives are necessary to maintain a long-term productive bottomland forest. Revenue is another aspect that is generated through harvesting in the bottomlands. A return on our investment is met allowing for the ownership of the bottomland forest and the establishment and development of the Hardwood Department. There are also many wildlife and social benefits that are developed during and after harvesting in bottomlands. Wildlife habitat is improved across the forest landscape by producing a mosaic of stand structure and tree species. The creation of various habitat conditions will benefit a variety of wildlife species. Additionally, establishing access in bottomland stands develops recreational opportunity in various forms.

Hardwood Research

Temple-Inland has periodically conducted research on its hardwood forests since 1982. However, in 1997 a hardwood research department was established to develop knowledge associated with Temple-Inland's hardwood resource. Initially, the program

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was geared toward development of cost-effective domestic short fiber through fertigation and intensive hardwood plantation systems. However, with the sale of Temple-Inland's linerboard mill in 1999, the focus of hardwood research has shifted toward long-term management with an emphasis on grade log production within the company's domestic hardwood landholdings.

The primary objectives of the hardwood research program center around increasing productivity, improving log quality, and enhancing stand composition while maintaining a value-diverse, naturally regenerated hardwood forest. These objectives are being met through a variety of past, current, and planned in-house and cooperative monitoring and research activities.

To evaluate the effects of current management practices on various environmental factors, a harvest impact study was initiated in 1992 by Texas A&M University and Mississippi State University. The effects of clearcutting and partial cutting on water quality, herpetofauna, carbon efflux, soil physical characteristics, small mammal populations, and species diversity were assessed to evaluate the potential environmental effects of hardwood silvicultural activities within Temple-Inland's hardwood forest. The general conclusion of the study indicated that Temple-Inland's bottomland hardwood harvest operations had minimal to no adverse impacts on water quality, woody vegetation, soil properties, nutrient cycling, herpetofauna, or small animals (Messina, et. al., 1997; Irwin, 1997).

Historically, hardwood research has focused on regeneration of desirable species and the environmental impacts of harvesting systems with little attention given to density management and stand improvement operations following successful regeneration and

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prior to initial commercial thinning. Although some work has been accomplished, damage to the residual stand has been a deterrent for intermediate stand operations in young naturally regenerated hardwood forests. However, this stage of stand development represents a period of great opportunity for increasing stand productivity and improving composition through stocking and density management. In addition, operations during the early developmental stages will create ephemeral within-stand wildlife habitat that does not currently exist.

Management of the large acreage of Temple-Inland's aging even-aged hardwood forest also presents a substantial silvicultural challenge. In order to capture naturally occurring mortality, removal of poor quality and at-risk stems is required. This often results in residual stem degradation of log quality from epicormic branching or damage sustained during harvest operations. The very operations that increase health and productivity within over-mature hardwood forests also increase the risk of economic degradation to the quality stems released during thinning. For these reasons, opportunities to increase productivity and the challenge of maintaining log quality of aging even-aged stands are fundamental to current and planned hardwood research activities.

Temple-Inland has established a series of studies within stands of differing ages to evaluate the cost, operational effectiveness and biological return of density management in young densely-stocked, naturally regenerated hardwood stands. Current projects include pre-commercial thinning at ages 4yrs. and 8yrs. (N.C. State Hardwood Research Coop.), 16yrs., (Temple-Inland) and 25yrs. (Louisiana State University). These projects are designed to evaluate the effects of various treatments at differing stages of stand

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development to develop an understanding of how and when to best facilitate composition, health, and productivity. Information from this research will be utilized to develop silvicultural systems that optimize stand development of Temple-Inland's naturally regenerated hardwood forests.

The effects of partial cutting on residual stem quality and the rate of mortality in unmanaged forests are currently being investigated. A research project was initiated in 2000 to evaluate the effects of thinning on stem mortality and log quality seven years after harvesting. In addition, a cooperative study was initiated in 2000 with the USFS-Center for Bottomland Hardwood Research to examine the effects of various residual-stocking levels on growth, damage, log quality, and natural regeneration. Information from these projects will be utilized to improve existing thinning practices and develop protocols best suited for over-mature, overstocked hardwood stands.

With a large acreage of even-aged hardwood forest, it is desirable to identify those stands in which management is most critically required. Age, disease, and pests may place certain stands at a higher risk of mortality or degradation. In an effort to rapidly identify such stands, Temple-Inland funded and is currently participating in a project utilizing multi-spectral satellite imagery to classify hardwood stands based on spectral characteristics. Through this process, a prioritization schedule can be developed for more effective planning and more timely implementation of silvicultural activities. The art and science of silviculture dates back several centuries and has resulted in the vast accumulation of knowledge associated with the biology, physiology, and ecology of growing and harvesting trees. The compilation of this knowledge provides a sound basis for current silvicultural practices and a platform for future innovation. As society's

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demands increase, assurance of ecologically sensitive and sustainable industrial forest practices, scientific substantiation and synthesis of new technology is critical to ensuring the validity of prescribed silvicultural applications. This research-based approach provides the knowledge and measurement criteria necessary for continuously improving silvicultural and extraction operations critical to the maintenance of Temple-Inland's value-diverse domestic hardwood resource.

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Literature Cited

Belli, K.L., Hart, C.P, Hodges, J.D., and Stanturf, J.A., 1999. Assessment of the regeneration potential of red oaks and ash on minor bottoms of Mississippi. S. Jor. Applied For., 23(3):133-138.

Dale, M.E., Smith, H.C., and Pearcy, J.N., 1995. Size of clearcut opening affects species composition, growth rate, and stand characteristics. USDA For. Serv. NE For. Exp. Stn. Res. Pap. NE-698. 21 pp.

Golden, M.S. 1994. Establishment of oak regeneration in group selection openings in a river floodplain forest. Proc. 8th Bienn. S. Silv. Conf. Auburn, AL. 1994. 413-418.

Hodges, J.D., 1987. Cutting mixed bottomland hardwoods for growth and regeneration. Proc. 15th An. Hrdwd. Symp. of the Hrdwd. Res. Council, Memphis, TN, 1987. 53-60.

Hopper, G.M., and Nichols, T., 1994. Hardwood silviculture: even-aged and uneven-aged systems. In: D.J. Moorhead and K.D. Coder (Editors), Southern Hardwood Management. USDA For. Serv. Mgmt. Bull. R8-MB 67, 1994. 51-58.

Irwin, K.J., 1997. Herpetofaunal community response to timber harvest practices in an east Texas bottomland hardwood forest. M.S. Thesis, Texas A&M University. 108 pp.

Kellison, R.C., Fredrich, D.J. and Gardner, W.E., 1981. A guide for regenerating and managing natural stands of southern bottomland hardwoods. North Carolina Ag. Res. Ser. Bull. 463. 24 pp.

Messina, M.G., Schoenholz, S.H., Lowe, M.W., Wang, Z., Gunter, D.K., and Londo, A.J. 1997. Initial responses of vegetation, water quality, and soils to harvesting intensity in a Texas bottomland hardwood ecosystem. For. Ecol. Manage. 90:201-215.

Messina, M.G., and Jenkins, J., 2000. Loblolly pine stand early development under reserve-tree silvicultural systems in East Texas. S. Jor. Applied For., 24(1):11-16.

Putnam, J. A., Furnival, G. M., and McKnight, J. S., 1960. Management and Inventory of Southern Hardwoods. USDA For. Serv. Agriculture Handbook No. 181.

Copied from an original at The History Center Diboll, TX www.TheHistoryCenterOnline.com 2002:100

Perkey, A.W., Wilkens, B.L., and Smith, H.C., 1993. Crop tree management in eastern hardwoods. USDA For. Serv. For. Resources Mgmt. NA-TP-19-93. Morgantown, WV. 39 pp.

Sander, I.L., 1972. Size of advance reproduction: key to growth following harvest cutting. USDA Forest Serv. Res. Pap. NC-79. 16 pp.

Smith, D.M., 1986. The practice of silviculture. Jonh Wiley and Sons, Inc., New York, NY, p. 16-19.

Smith, H.C., 1981. Diameters of clearcut openings influence central Appalachian hardwood stem development-a ten-year study. USDA For. Serv. Res. Pap. NE-476. 1981. 8 pp.

Smith, H.C., Lamson, I.L., and Miller, G.W. 1989. An esthetic alternative clearcutting? Deferment cutting in eastern hardwoods. J. For. 87:14-18.

Toliver, J.R. and Jackson, B.D., 1988. Recommended silvicultural practices in southern forested wetlands. Proceedings of the Symposium The Forested Wetlands in the United States. USDA Forest Serv. Gen. Tech. Rep. S.E. For. Exp. Stn. 72-77.

Zobel, B.J. and Davey, C.B., 1978. A simplified guild to hardwood management in the southeast. School of Forest Resources, N. C. State University, Raleigh NC.