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Comparison of Stands Designated as Old Growth and Those in Managed Hardwood Areas at Tara Wildlife Properties

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By

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Comparison of stands designated as old growth and those in managed hardwood areas at

Tara Wildlife properties

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Forest community characteristics on six forest stands in northeastern Mississippi were investigated. Study sites included two cottonwood stands, two managed hardwood stands, and two unmanaged hardwood stands. Relationships between forest stand components and habitat characteristics were estimated. Measured forest stand characteristics included regeneration, midstory and overstory to estimate species composition and forest structure. Basal area, crown density, standing dead trees and fallen dead tree measurements were also taken in the fall of 2010. A higher amount of tree species in the cottonwood and managed hardwood stands with the unmanaged hardwood stands having the lowest number of tree species. It was also detected that the unmanaged hardwood stands contained a higher DBH of 29.0 cm than the remaining stands. Cottonwood stands had a higher tree per hectare than the other stands. The unmanaged hardwood stands also contained the largest amount of standing and fallen dead trees.

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CHAPTER I

INTRODUCTION

Old-growth forests are defined as ecosystems distinguished by old trees and related structural attributes. Old-growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics, which may include tree size, accumulations of large dead woody material, number of canopy layers, species composition, and ecosystem function (Spies, 2004). The concept of old-growth was originally created for the Pacific Northwest forests, based upon the concept that those forests undergo succession towards a climax community that is disrupted by natural disturbance (Batista and Platt , 1997; Frankin et al., 1981). However, the southern hardwood forests of North America (particularly in the Southeast) are often affected by natural disturbances and may not reach a climax or "steady state" of growth as per the original concept of an old-growth community (Batista and Platt, 1997). In this instance old-growth forests may be defined as one that has not been recently been cleared and whose dynamics are essentially the same as that of its historical structure and composition (Batista and Platt, 1997, Hunter 1989). For this reason, Davis (1996) developed classifications to describe various stages of old-growth forests. This categorization allowed for an increased amount of mature hardwood stands to be labeled as "old-growth", including as much forested land as possible to foster protection of remaining forests in this classification. Protection of these older age class forests is often viewed as important for conservation of many rare species that require features of mature forest types, such as closed canopy conditions, large cavity trees, multiple canopy layers, abundant standing and downed deadwood, and moist litter conditions (Hunter 1990). Prior to European settlement, old-growth bottomland hardwood forests dominated a large portion of the landscape of the Lower Mississippi Alluvial Valley (LMAV)(Putnam et al., 1960); however, by the 1940's less than 50% of landscape remained intact due to extensive clearing for agricultural practices throughout the LMAV (Twedt and Loesch 1999) thereby making these southeastern old-growth communities a rare and seldom researched ecological commodity. These old growth forests have numerous meanings and values both in social and ecological terms. To some, the thought of an old-growth forest's ecological importance is secondary to the notion that "they just don't want large old trees cut"(Spies, 2004). However, the ecological importance of these majestic forest stands cannot be overlooked. Old-growth diversity is variable in tree species composition, disturbance regime, presence or absence of human disturbance, and longevity or age (Spies and Frankin, 1996; Frelich 2002).

Old-growth forests typically possess numerous levels of vegetative strata, thereby supporting a greater abundance of bird species than forest that contain a simple vertical structure of vegetation (Dickson, 2001). These stands also possess characteristics such as large cavity trees and downed woody debris. Goodburn and Lorimer (1998) found in their study of 10 old-growth stands and 6 even aged secondary-growth stands that the greatest diversity of cavity nesting trees were in the old growth stands while the greatest biomass of downed wood debris was in the even aged secondary growth stands. Conservation of remaining mature or natural forests can be important for the recovery and protection of rare flora and fauna of riparian and bottomland hardwood forests (Walker, 2001). A number of rare and threatened or endangered species often inhabit mature hardwood forests. Some of these species may include : Louisiana black bear (*Ursus americanus luteolus*), Rafinesque big-eared bat (*Coryrhynchos rafinesquii*), and at least 10 species of plants such as pondberry (*Lindera melissifolia*) (Yarrow and Yarrow, 1999; Harvey and Saugey, 2001; Pelton, 2001).

Managers can influence forest habitat conditions silviculturally by thinning or harvesting trees to promote growth in residual vegetation and by retaining biological legacies (Coates and Button, 199; Shifley, 2004). Biological legacies can be defined as large diameter trees, standing snags, decadent trees, and other pre-harvest structures found throughout southern oak-hickory stand types (Thatcher et al., 2007). Thinning in relic stands that exhibit a large percentage of canopy closure can and does create openings that allow for decreased competition among vegetative resources used by a variety of wildlife (Canham 1988). Thinning has traditionally been implemented as an intermediate silvicultural treatment to maximize economic returns for fiber production (Smith et al. 1997). However, crown-release, gap-creation, and other ‘thinning with retention’ techniques have been proposed as methods for managing various aspects of biological diversity by promoting the development of structural stand complexity in second-growth forests (DeBell et al., 1997, Coates and Burton, 1997, Franklin et al., 1997, Carey, 2003, Keeton, 2006).

Managing and manipulating hardwood stands through silvicultural activities can be a catalyst for positive or negative effects on wildlife habitat. These changes can be large or small, and short-lived or long-term depending on the specific practice used, time of year applied, and how often activities are performed (Yarrow and Yarrow, 1999). Activities such as thinning are acceptable to benefit both wildlife and timber production by moving hardwood stands out of a closed canopy stage of succession and accelerating the development into later stage forest conditions (Hayes et al., 1997). Such silvicultural practices promote heterogeneous forest structure and mimic the natural disturbance, such as fire, wind, tornados or other natural disturbances, that advance hardwood stands and accelerate their development (Twedt and Somershoe, 2008). Because so many wildlife species benefit from practices that promote heterogeneous forest structure, many of these practices have been coined "Wildlife-Foresty" practices (Twedt and Somershoe, 2008). These "Wildlife-Forestry" practices, when applied to the bottomland hardwoods of the LMAV, are an economically acceptable way to support many species of songbirds as well as resident game species such as eastern wild turkey (*Meliagris galapalvo*) and white-tailed deer (*Odocolius viginianus*) (Wilson et al., 2007; Twedt and Somershoe, 2008). These species are benefited by increasing the amount of available biomass and browse that is available due to the decrease in canopy closure (Peltz et al., 1999). Vegetation such as greenbriar (*Smilax sp*.), southern dewberry (*Rubus trivialis*), muscadine grape (*Vitis rotundifolia*), and Japanese honeysuckle (*Lonicera japonica*), which are all preferred food source plants for many song birds and game species, are more abundant in areas that have been thinned as compared to areas that have a large percentage of canopy closure (Miller and Miller, 1999).

In addition to old growth and managed hardwood stands, cottonwood stands are another major LMAV habitat type. These stands thrive best on the well drained sandy and silty loam soils along the Mississippi River batture (McKnight, 1970) and encompass lands productive not only for timer production but for wildlife as well. These stands may provide habitat for some species of birds like worm-eating warblers (*Helmitheros vermivorum*) that may not otherwise be found.

The Purvis Grange Foundation property consists of set-aside stands which have been set aside to not manage silviculturally. The latter area will be hereafter known as unmanaged stands and will be allowed to follow a growth character consistent with natural forest succession. As, well, as Hardwood stands which have a history of harvesting which will hereafter be known as managed stands. And cottonwood stands that are approximately 37 years of age. Purvis Grange Foundation, Inc. property is located in northwestern Warren County, Mississippi, in partial Sections 1, 2, and 12, Township 17 North, Range 1 East; Section 7, Township 17 North, Range 2 East; and Section 35, Township 18 North, Range 1 East. This property has been owned by the same family (the Purvis Family) since October 7, 1861 when the property was deeded to William Reginal Purvis. After William's passing in 1906, the property was quick claimed to The Purvis Grange Plantation. The property was then inherited by Herbert Bryant. After his passing in 1983, Tara Wildlife was licensed 4 years after in 1987. On December 13, 2001 the Purvis Grange Foundation was founded as a 401 C 3 organization with the goal of conservation and continued education of the public.

Under the careful management and stewardship commitment of the Purvis Grange Foundation, Inc., the findings of this study will provide a natural resources management educational element to this already conservation minded corporation. This study will provide information and insight to private landowners to better manage their natural resources and efficiently reach the goals and expectations for their property. Importantly, this study will also add to the body of knowledge on 100 acres of southern bottomland hardwood habitat that will be set aside in perpetuity for study by current and future generations.

This study addresses the following objectives:

1. Assess and compare stocking density in 37 year old cottonwood plantations with hardwood inclusions, silviculturally managed bottomland hardwood stands, and unmanaged old-growth hardwoods that have been designated to never be silviculturally managed in perpetuity.

2. Measure, describe, and compare stand variables within the three stand types, important to accessing wildlife habitat.

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CHAPTER II

STUDY AREA AND FIELD METHODS

Study Area

The study area (Figure 2.1) is located on lands owned by Purvis Grange Foundation, Inc. in northwestern Warren County, Mississippi, in partial Sections 1, 2, and 12, Township 17 North, Range 1 East; Section 7, Township 17 North, Range 2 East; and Section 35, Township 18 North, Range 1 East. This property has been owned by the same family (the Purvis Family) since October 7, 1861, when the property was deeded to William Reginal Purvis. After William's passing in 1906, the property was quick claimed to The Purvis Grange Plantation. The property was then inherited by Herbert Bryant. After his passing in 1983, Tara Wildlife was licensed 4 years after in 1987. On December 13, 2001, the Purvis Grange Foundation was founded as a 501 (c) (3) non-profit organization with the goal of conservation and continued education of the public.

The property is comprised of approximately 2833 contiguous hectares (ha) and is composed of oxbow lakes, cottonwood plantations with natural hardwood inclusions, unmanaged bottomland hardwood forests, and managed hardwood forests (Figure 2.2) that have been subjected to thinning from below and some overstory removal. The Mississippi River serves as the western property boundary for the tract of land used in this study.

Three stand types were selected from the acreage owned by Purvis Grange Foundation, Inc. to test ecological similarities: 37-year old planted cottonwood plantations with natural hardwood inclusions, managed hardwood stands which have been subjected to planned silvicultural treatments, in approximately 2004, through thinning from below with some overstory removal (age class approximately 70 years)and unmanaged bottomland hardwoods ($\geq$ 100 years of age)which have not been silviculturally treated by Purvis Grange Foundation, Inc., to my or any member of the foundations knowledge, since the acquisition of the property in 1861. The latter area will be allowed to follow a growth character consistent with natural forest succession. In allowing these unmanaged bottomland hardwoods to undergo succession they may eventually exhibit characteristics which could represent pre-European settlement forest conditions (Batista and Platt, 1997). Criteria for stand selection consisted of location of the sites relative to edge and/or roads, geographical variance of the property to encompass topographical features (determined by use of USGS Topographic Maps) that are commonly found within the property, and the past/present silvicultural treatment which the managed stands have undergone (silvicultural thinning operations conducted circa 2004) . Based on these criteria two stands were selected from each of the three stand types to provide a comprehensive view of the stands located on Purvis Grange Foundation, Inc. owned properties.

Soils within the study area were identified as CrC- Commerce, Robinsonville, and Crevasse soils (United States Department of Agriculture Web Soil Survey). Because of the similarities among these soils, the mixed pattern of their occurrence and heavy forest cover conditions, it is not feasible to map these soils separately in some parts of the county (United States Department of Agriculture, 1964). Commerce soils (silty clay loam) make up approximately 60% of the study area, Robinsonville soils (fine sandy loam), approximately 25%, and the Crevasse soils (loamy fine sand) approximately 15% (United States Department of Agriculture, 1964).

Field Methods

Forest Inventory

Each of the three stand types includes two (2) non-adjacent sites of approximately 20.4 ha each, for a total of six individual study areas (122.9 total hectares). Plots were established within each of the six (6) experimental units using DeLorme XMap 5.2 Professional (DeLorme, 2007) on a 80.4m X 100.5m spacing using the line plot intercept method (Figure 2.3). Each line for the line plot intercept was configured to begin 50.25m from the northeastern corner and proceed south 40.2m to the first plot as to not bias the sample with edge effected growth as described in Parker et. al (2010) throughout each of the six experimental units. Plots were allocated throughout each of the six experimental units to achieve a ten percent (10%) sample of the area (Figure 2.3). The number of plots varied by stand as not all stands were the same acreage due to shape and geographic contours. Between 25 and 29 fixed 0.08 ha (25.23 meter radius) sampling plots were established throughout each stand (Figure 2.4). GPS (Garmin GPSmap 76CS x) was used to digitally record and archive data of plot locations (Huff et al., 2000). Each point was recorded and the location was verified with DeLorme XMap 5.2. Regeneration, any woody stem < 2.54 cm in diameter at the base, was evaluated using a 0.004 ha (5.64 m) radius plot with species and height recorded (Figure 2.4) (Avery and Burkhart, 2002). Pulpwood, any woody stem 15.24 cm to 30.226 cm DBH, was evaluated in 0.04ha (17.84

m) radius plots and recorded by species, height, and DBH (Figure 2.4) (Avery and Burkhart, 2002). Sawtimber, any woody stem ≥ 30.48cm DBH was evaluated in the entire 0.08 ha plot and was recorded by species, DBH, merchantable height, total height, and crown class (Figure 2.4) (Avery and Burkhart, 2002). Azimuths from plot center to each sawtimber tree recorded were taken as a reference to facilitate a comparison of growth in future studies.

Percentage of crown density was recorded within each of the 0.08- ha plots using a spherical densitometer. An initial measurement was taken at plot center, a second measurement was recorded north of plot center half the distance of the plot radius, 12.61 meters, a third measurement was recorded at the northern most edge of the plot. This process was repeated for the all directions (south, east, and west) which resulted in a total of nine locations in each plot. The average of all nine readings was recorded. Stand basal area was also estimated at each plot center using a 10 BAF (Basal Area Factor) prism.

Standing dead tree measurements were taken within each plot by classifying trees using species, if discernable, and portion of the tree remaining (twigs remaining, small and large branches remaining, large branches only, or no branches and only stem reaming). The density of the standing dead trees was also taken classifying them as either sound or intermediate. Total height was measured, as well as the diameter of the tree at DBH.

Fallen dead wood measurements were taken within each plot. Species and wood type (not hollow, hollow, colonizers (contains larva and other detritus organisms) were recorded along with diameter measurements at DBH and condition of the tree (sound, intermediate, or rotten).

Percentage of vine coverage by species on all sawtimber stems was taken by visually estimating the percentage of the first log (4.87 meters above DBH) that was covered by various vine species.

Evaluation of Plant Community Characteristics

Vegetative density data were recorded at twenty (20), randomly selected plots within each of the six (6) study areas for a total of one-hundred twenty (*n*=120) plots over the entire study area (Table 2.1). Within each plot, a 30.5 m (100') transect line was extended from east to west with the center of the transect line crossing plot center. Percent coverage along the transect line was recorded by species within both the understory layer (<1 meter) and midstory layer (1-3 meters) (Coles-Ritchie et al., 2004, Honnay et al., 2001). Vegetative components were recorded at intervals of 0.1524 meters (6 inches) by species, form, and percent coverage of the transect line. Bare ground, leaf litter, and woody debris were also recorded by percent occupancy along the transect line. Species were then grouped, as being shrubs, woody vines, midstory and ground cover trees, grasses and grasslike species, forbs, and legumes. All vegetation was identified using Radford et al. (1974) and Miller and Miller (1999).

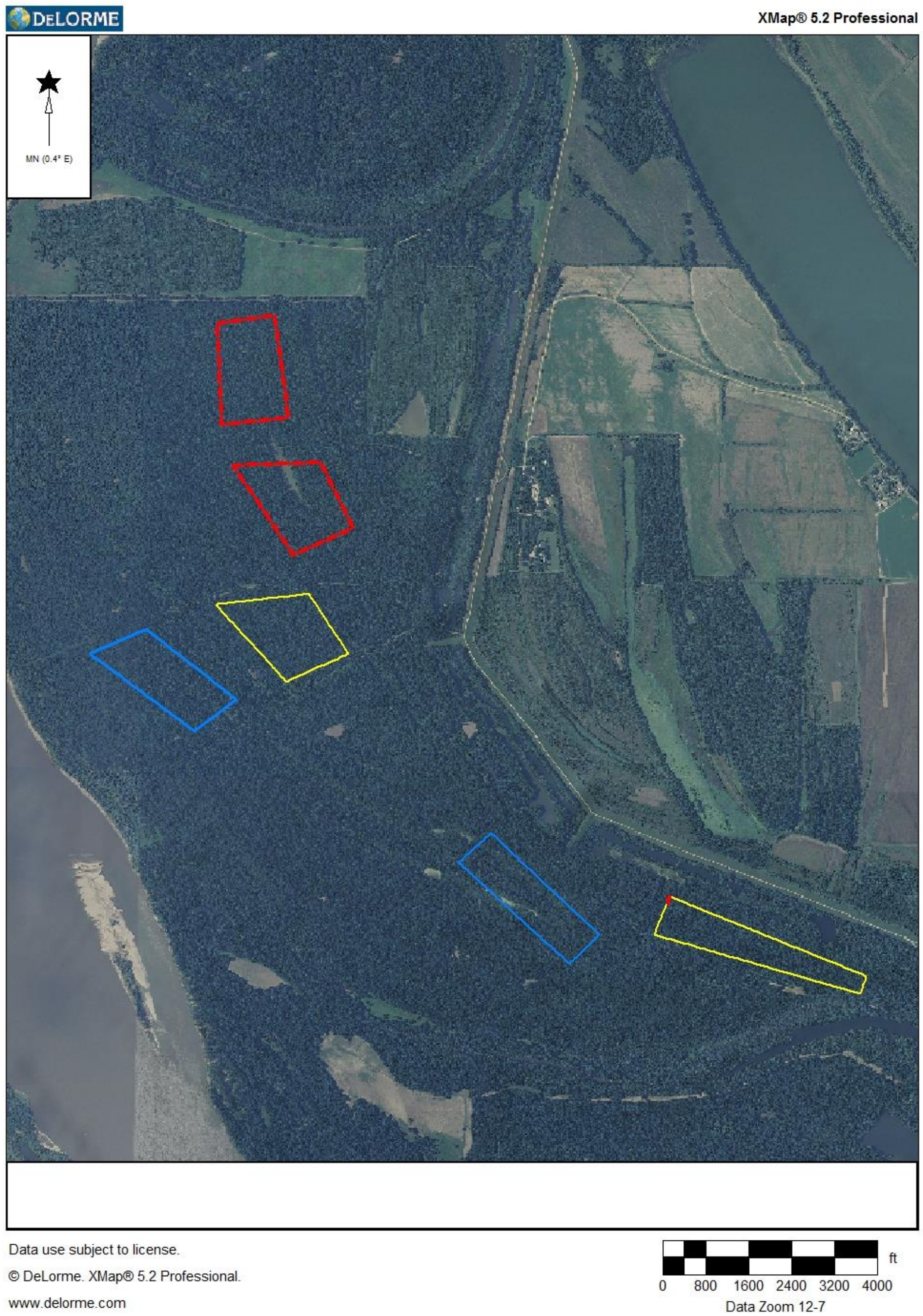

Figure 2.1 Study sites for Purvis Grange Foundation near Warren County, Mississippi, in 2010 – 2012.

Study area encompasses a total of 122.9 hectares broken up into approximately 50 acre blocks.

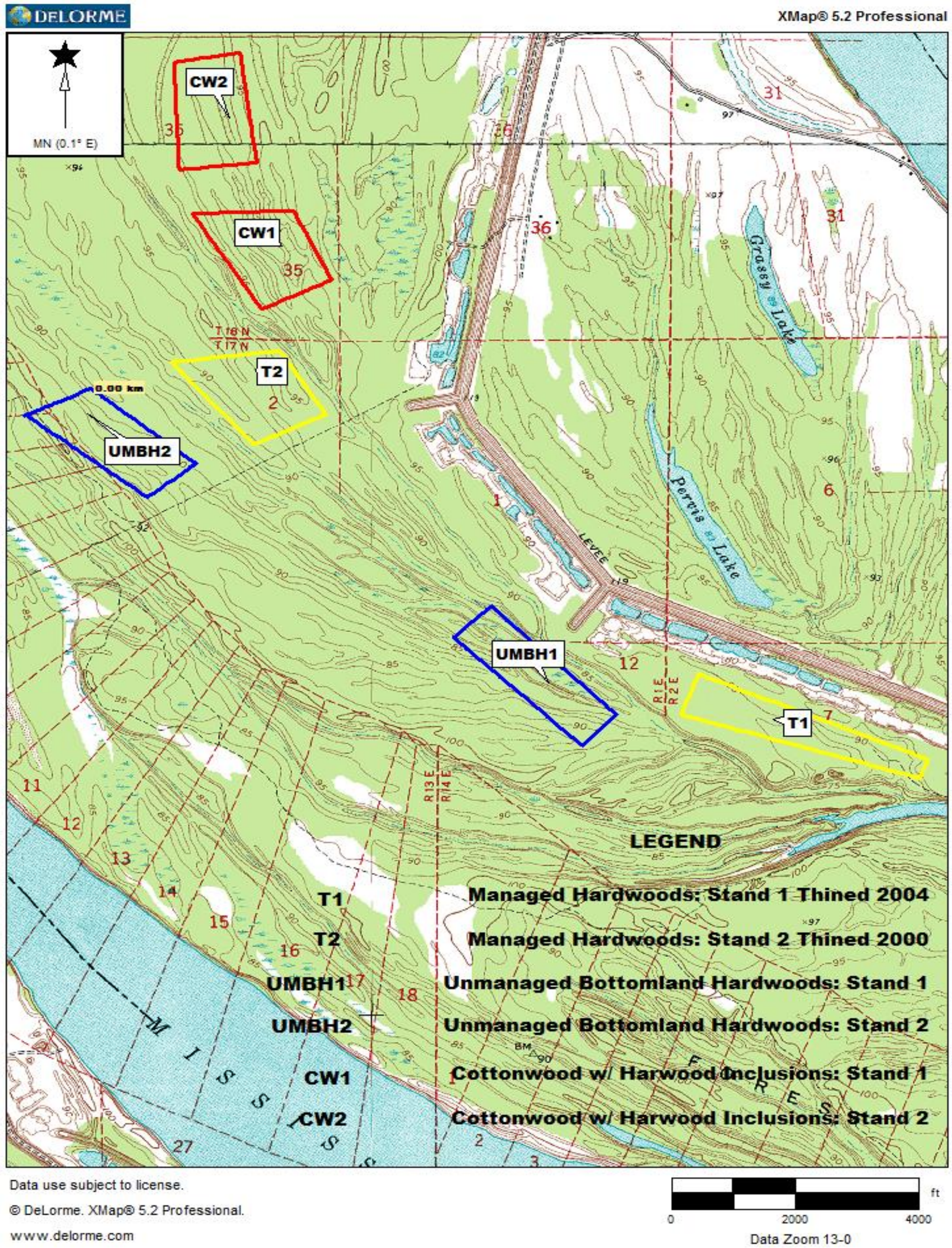

Figure 2.2 Study sites for Purvis Grange Foundation near Warren County, Mississippi, in 2010 – 2013.

Shown are cottonwood plantations with hardwood inclusions, managed hardwoods subjected to planned silvicultrual treatments, and unmanaged bottomland hardwoods with topographical characteristics of each stand.

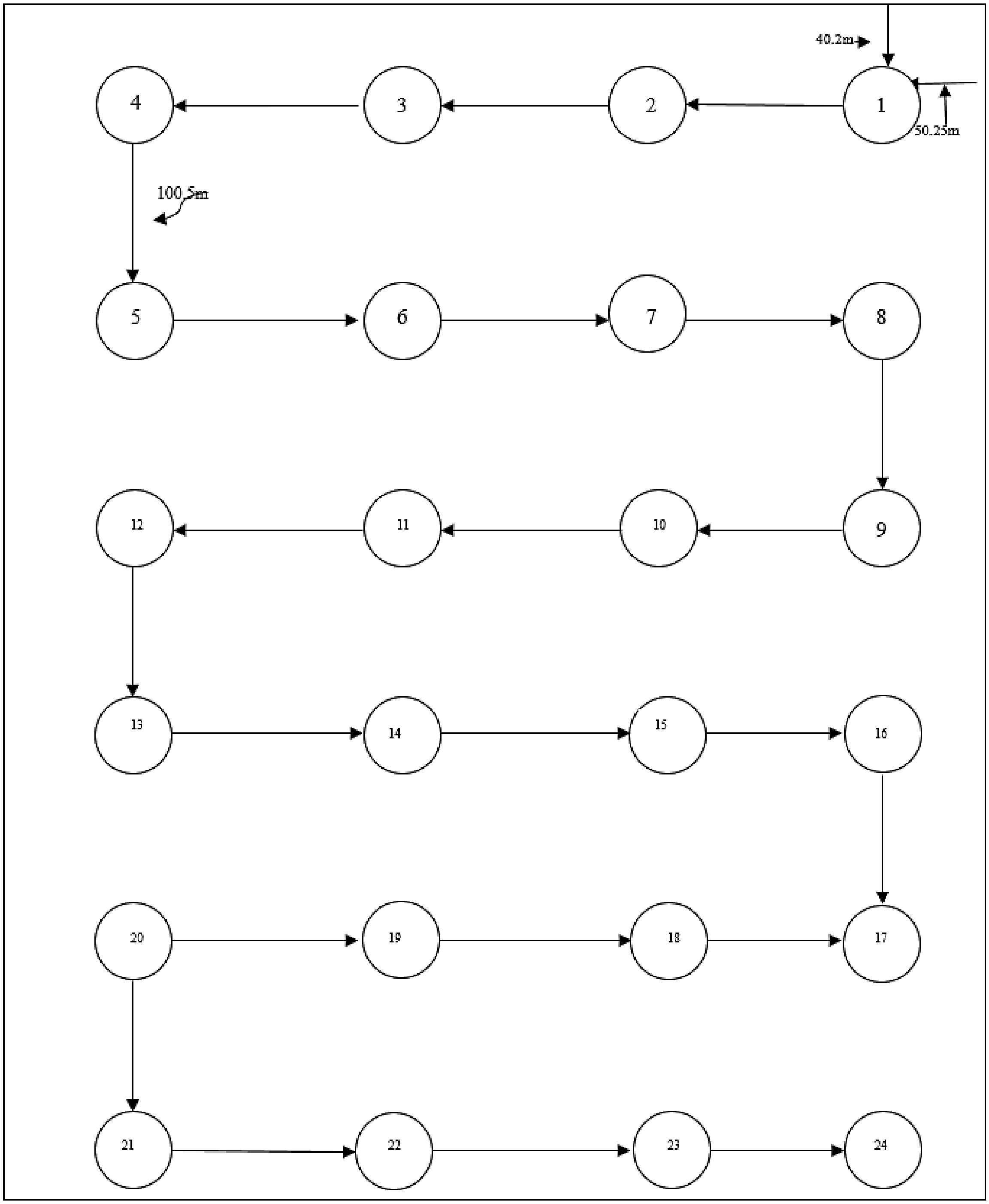

Figure 2.3 Experimental design for a timber inventory within the planted cottonwood plantations with natural hardwood inclusions, managed hardwoods which have been subjected to planned silvicultural treatments through thinning and unmanaged bottomland hardwoods which have never been silviculturally treated by Purvis Grange Foundation, Inc.

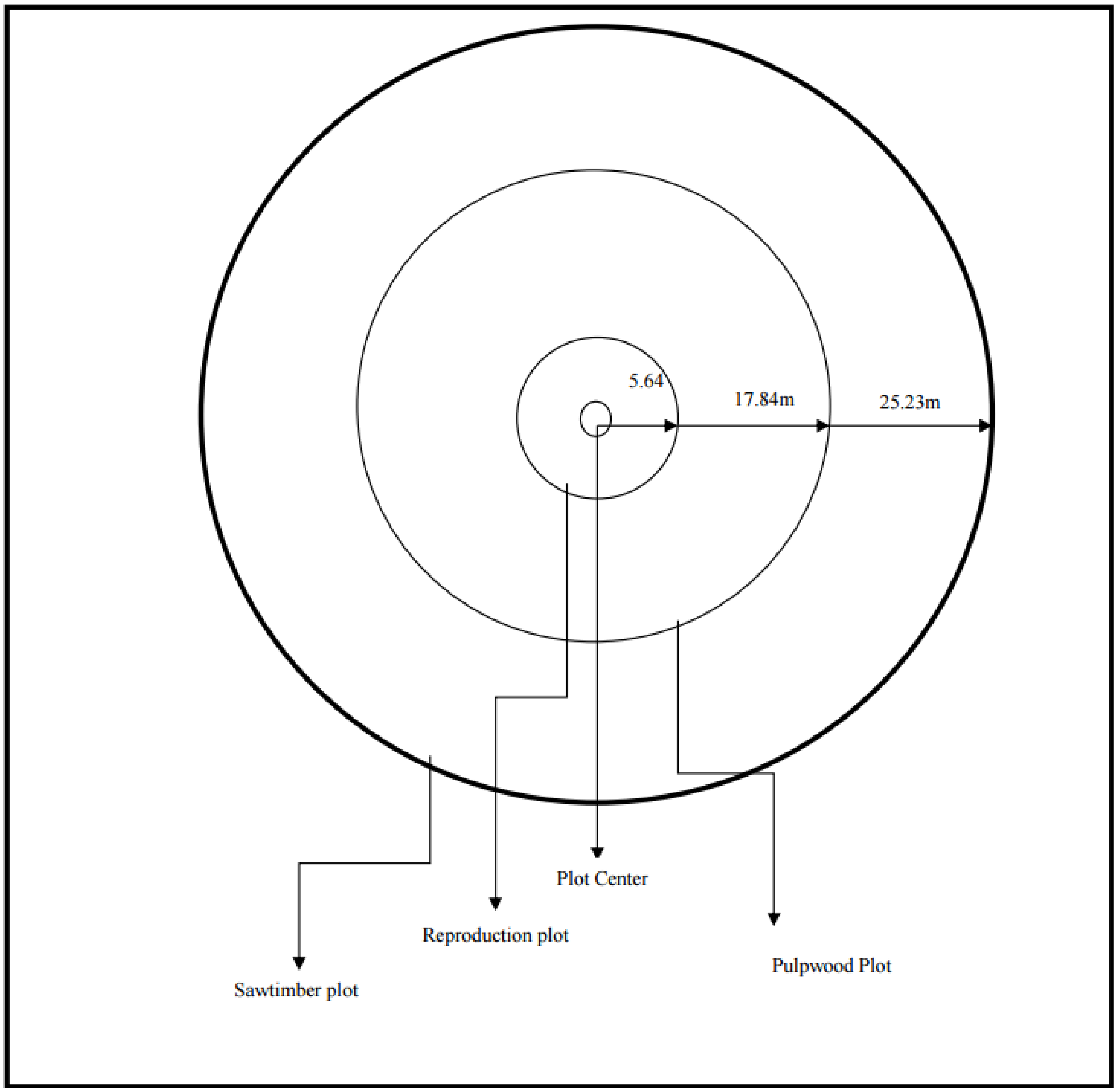

Figure 2.4 Experimental design for a timber inventory at the plot level within the planted cottonwood plantations with natural hardwood inclusions, managed hardwoods which have been subjected to planned silvicultural treatments through thinning and unmanaged bottomland hardwoods which have never been silviculturally treated by Purvis Grange Foundation, Inc.

Table 2.1 Number of sample points used in estimating timber volume and vegetation communities within different forest stand types of Purvis Grange Foundation, Inc.-Owned Lands, Warren County, MS.

			# Sample Points (Timber)		# Sample Points (Vegetation)		
Stand Type	# Sites	Stand Name	Per Stand	Per Type	Per Stand	Per Type	Total Plots Per Stand Type
Planted Cottonwoods W/ Hardwood Inclusions	2	CW 1, CW 2	25	50	20	40	90
Managed Hardwoods (Thined 2002 and 2004)	2	MH 1, MH 2	25	50	20	40	90
Unmanaged Bottomland Hardwoods	2	UBH 1, UBH 2	25	50	20	40	90

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CHAPTER III

RESULTS

A total of 1,577 individual tree observations were recorded within the three habitat types with 11 species, detected over all stratums, in cottonwood plantations, 14 species in managed hardwoods, and 14 species in unmanaged hardwoods. The most common species in the dominant crown class were *Ulmus americana, Celtis laevigata, Gleditsia triacanthos.* The most common species in the midstory and understory were *Asimina triloba, Ligustrum sinense, Forestiera acuminate*, and *Carya illinoinensis* (Table 3.1).

Cottonwood plantations were comprised of 44.2% cottonwood, (+ 0.2), 26.8% sugarberry (+ 0.4), 8.1% sweetgum (+ 0.3), 7.9% sycamore (+ 0.3), 5.7% boxelder (+0.2), 2.8% water oak (+0.3), 2.0% pecan (+0.3), 1.2% American elm (+0.3), 0.6% green ash (+0.3), 0.4% bitter pecan (+0.3), and 0.2% honeylocust (+0.3) (Table 3.1). Eleven tree species with a mean DBH of 39.0 cm (+ 0.1) and a mean height of 15.5 meters was located in cottonwood plantation stands. Of the total tree composition, oak species (*Quercus*) comprised 2.8 % of 493 trees detected (Table 3.3). Total volume per hectare within the cottonwood plantation stands was 22,893 board feet/hectare Doyle for a total across the treatment type of 942,470 board feet Doyle (Table 3.2). Mean basal area was 9 m^2/hectare and mean canopy closure were 76.3%. Mean reproduction was 1598.3 stems/ha and a mean of 4.81 standing dead snags/ha (+ 0.01) was detected in all cottonwood stands for 197.93 standing dead snags across the entire treatment type. A mean of 5.05 downed snags/ha (+ 0.01) was detected in all cottonwood stands for 207.82 downed snags across the entire treatment type. Total volume of the stand, volume per hectare, mean canopy closure, mean reproduction, mean standing dead, total standing dead, mean fallen dead, and total fallen dead were all obtained using Microsoft Excel®.

Managed hardwood stands were comprised of 53.9% sugarberry (+ 0.2), 13.2% bitter pecan (+ 0.4), 8.6% sweetgum (+ 0.3), 6.1% ash (+ 0.3), 5.4% water oak (+0.2), 3.8% boxelder (+0.3), 3.6% American elm (+0.3), 1.9% sweet pecan (+0.3), 1.0% honey locust (+0.3), 1.0% Nuttall oak (+0.3), and 0.8% sycamore (+0.3), 0.4% cherrybark oak (+0.1), 0.2% overcup oak (+0.3), and 0.2% persimmon (+0.2); (Table 3.1). Overstory and mid-story contained 14 species of trees with a mean DBH of 39.37cm (+ 0.2) and a mean height of 12.19 meters for all managed hardwood stands. Of the total tree composition, oak species (*Quercus*) comprised 6.8 % of 523 trees detected. The total volume per acre within the managed hardwood stands was 18,543 feet/hectare Doyle for a total volume across the treatment type of 761,731 board feet Doyle (Table 3.2). Mean basal area was 6.78 m^2/ha and mean canopy closure was 71.0% (Table 3.2). Mean reproduction was 4,240.3 stems/hectare (Table 3.2) and a mean of 6.5 standing dead snags/ha (+ 0.01) was detected in all cottonwood stands for 267.02 standing dead snags across the entire treatment type. A mean of 6.5 downed snags/ha (+ 0.01) was detected in all cottonwood stands for 267.02 downed snags across the entire treatment type (Table 3.3).

Unmanaged hardwood stands were comprised of 65.8% sugarberry (+ 0.2), 13.0% sweet pecan (+ 0.4), 6.4% American elm (+ 0.3), 3.9% boxelder (+ 0.3), 3.0% bitter pecan (+0.2), 2.0% sycamore (+0.3), 1.4% persimmon (+0.3), 1.2% swamp privet (+0.3), 1.2% honey locust (+0.3), 0.7% ash (+0.3), 0.4% water oak (+0.3), 0.4% Nuttall oak (+0.1), 0.4% sweetgum (+0.3), and 0.2% cottonwood (+0.2); (Table 3.1). Overstory and mid-story contained 14 species of trees with a mean DBH of 38.40cm (+ 0.2) and a mean height of

12.22 meters. Of the total tree composition, oak species (*Quercus*) comprised 0.7 % of 561 trees detected. The total volume per hectare within the unmanaged hardwood stands was 20,313 feet/hectare Doyle for a total across the treatment type of 824,514 board feet Doyle (Table 3.2). Mean basal area was 7.43 m^2/ha and mean canopy closure was 76.8% (Table 3.2). Mean reproduction per was 3,160.5 stems/hectare (Table 3.2). A mean of 7.96 standing dead snags/ha (+ 0.01) was detected in all unmanaged hardwood stands for 316.28 standing dead snags across the entire treatment type. A mean of 8.17 downed snags/ha (+ 0.01) was detected in all unmanaged hardwood stands for 336.04 downed snags across the entire treatment type (Table 3.3).

Statistical Analysis

Statistical analysis was performed using Analysis of Variance (ANOVA). ANOVA was performed on six measured variables (trees per acre (TPA), basal area per acre (BAPA), average DBH (AvgDBH), average height (AvgHT), percent crown density (% CrwnDensity), and number of species (NumSpec)). Upon completion of ANOVA it was found that three out of six measured variables were considered significantly different.

Cottonwood Plantation

Cottonwood plantations were found to be significantly different from both managed hardwood stands and unmanaged hardwood stands in regards to TPA at $P \leq 0.05$ (P=0.004, P=0.0000) (Table 3.4). Cottonwood plantations also differed significantly from unmanaged hardwoods in regards to AvgDBH at P≤ 0.05 (P=0.0049) (Table 3.4). Cottonwood Plantations also differed from unmanaged hardwoods with regard to NumSpec at P≤ 0.05 (P=0.0025) (Table 3.4).

Managed Hardwoods and Unmanaged Hardwoods

Managed hardwoods were found to be significantly different from unmanaged hardwoods with respect to the NumSpec in each plot at $P \leq 0.05$ (P=0.0017) (Table 3.4). This was the only measured parameter in which a significant difference was achieved between the managed and unmanaged hardwood stands.

Discussion and Conclusion

Not surprisingly, the cottonwood, managed and unmanaged hardwood stands on Purvis Grange Foundation, Inc. owned properties varied greatly from one another. This is particularly true of three specific measured variables: number of trees per acre, average DBH, and number of species.

The numbers of trees per acre in cottonwood plantations were found to be significantly higher (67.3) than in the managed (45.7) and unmanaged hardwood stands (39.4). This is due to both rapid growth rates of the cottonwood species which have been found to grow from 1.5m to 3m in the first year of growth and the influx of naturally occurring hardwood species, particularly *Carya illinoinensis, Celtis laevigata,and Liquidambar styraciflua*, over the years in both the midstory and overstory of the stand leading to an increased stand density (Twedt and Portwood, 1997, Twedt et al., 1999). These numbers on the other hand are lower in the managed hardwood stand due to past silvicultureal activities such as thinning. While thinning has a direct influence on habitat structure, browsing by deer may also influence the structure of forest stands by decreasing reproduction within the stand due to heavy browsing of seedlings (R.M. Degraaf et al., 1991). Cottonwood stands that have increased in density over time through ingrowth of midstory structure have been found to be more likely habitat for some species of breeding birds not normally associated with other stand types such as worm eating warblers (*Helmitheros vermivorum*) (Twedt and Portwood, 1997).

The average DBH of trees differed among stand types; however, it was greatest in the unmanaged hardwood stand (11.4 in.) and differed the most from the cottonwood plantations (8.8 in.). Several factors can influence the amount of DBH growth that a single tree can incur, such as, site quality and species associations, stand density and stocking, and management regime (Trimble, 1969). Being that the cottonwood plantations were an artificially stocked stand that has been allowed to grow with natural hardwood inclusions. It is natural that this stand has a higher TPA as shown in the above results. Thus, leading to a decreased amount of DBH growth when compared to a lesser stocked stand, the unmanaged hardwood stand with a TPA of 39.4, the lowest of all three measured stand types.

The number of species of trees differed among stand types; however, it was greatest in the cottonwood plantations (4.5) and managed hardwood stand (4.6) and differed the most from the unmanaged hardwood stand (3.5). In Runkle (1981) it was found that in some old growth forests the sapling species or regeneration that was to replace dead or dying canopy were often of the same origin leading to a decrease in diversity of the stand composition. Also in Yarrow and Yarrow (1999) they state that creating disturbance in a stand through mechanical thinning processes may cause an increase in species diversity due to increased amounts of sunlight and soil disturbance. This further supports that these findings are relevant.

Table 3.1 Number of trees and trees per hectare of regeneration, midstory and overstory within different forest stand types of Purvis Grange Foundation, Inc.-Owned Lands, Warren County, MS.

	Cottonwood Plantations		Managed Hardwoods		Unmanaged Hardwoods	
SPECIES	# of trees	trees/ha	# of trees	trees/ha	# of trees	trees/ha
Acer negundo	196	4.8	1015	24.7	586	14.2
Populus deltoidies	39	0.9				
Ulmus americana	978	23.8	45066	1094.7	35365	859.0
Celtis laevigata	37712	916.0	75719	1839.2	53340	1295.6
Gleditsia ticanthos	783	19.0	5075	123.3	1758	42.7
Asimina triloba	15064	365.9	13195	320.5		
Ligustrum sinense	3052	74.1	4263	103.5	3517	85.4
Forestiera acuminata	2739	66.5	2436	59.2	17389	422.4
Carya illinoinensis	391	9.5	2436	59.2	3126	75.9
Liquidambar styraciflua	3913	95.0	5075	123.3	391	9.5
Quercus nigra	783	19.0	16646	404.3	4103	99.7
Diospyros virginiana			203	4.9		
Carya aquatica			812	19.7	7620	
Quercus pagoda			1827	44.4		
Fraxinus pennsylvanica			406	9.9	2540	61.7
Platanus occidentalis					195	4.7
TOTAL	65650	1594.7	174174	4230.7	129930	2970.9

Table 3.2 Summary of stand metrics within different forest stand types of Purvis Grange Foundation, Inc.-Owned Lands, Warren County, MS

Treatment Type	Per Hectare Volume	Total Volume	Average Basal Area/Hectare	Average Canopy Closure	Reproduction/ha
Managed Hardwoods	18,543	761731	6.78m^2	71%	4,204.3
Cottonwood Plantations	22,893	942470	9.38m^2	76%	1,598.3
Unmanaged Hardwoods	20,313	824514	7.43m^2	76%	3,160.5

Table 3.3 Summary of standing dead and fallen dead tree counts within different forest stand types of Purvis Grange Foundation, Inc.-Owned Lands, Warren County, MS

	COTTONWOOD PLANTATION		MANAGED HARDWOODS		UNMANAGED HARDWOODS	
	NUMBER/ HA	TOTAL TRACT	NUMBER /HA	TOTAL TRACT	NUMBER/ HA	TOTAL TRACT
STANDING DEAD	4.81	197.93	6.50	267.02	7.69	316.28
FALLEN DEAD	5.05	207.82	6.50	267.02	8.17	336.04

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