VEGETATIVE COMPOSITION IN FORESTED AREAS FOLLOWING APPLICATION OF DESIRED FOREST CONDITION TREATMENTS

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Abstract--Desired forest conditions, or DFCs, are recently created parameters which strive to create diverse stands of hardwoods of various species and age classes, along with varying densities and canopy gaps, through the use of uneven-aged silvicultural methods and repeated stand entries. Little research has been conducted to examine residual stand composition and hardwood regeneration after DFC installment. The objectives of this study were to characterize forest overstory and midstory conditions after DFC treatments and to assess natural regeneration. Residual stand conditions after application of DFC harvest guidelines indicate that shade-tolerant species will be future site occupants, and oaks will diminish or disappear over time. This documented initial forest response to DFC treatments can be used by forest and wildlife habitat managers when assessing the potential outcomes of DFC management.

INTRODUCTION

Managers of southern bottomland hardwood forests have recently been introduced to a new forest management approach. Desired forest conditions, or DFCs, are parameters which strive to create diverse stands of hardwoods of various species and age classes, along with varying densities and canopy gaps, through the use of uneven-aged silvicultural methods and repeated stand entries. DFCs are frequently promoted as enhancing habitat conditions for many threatened neotropical migratory bird populations and other wildlife species (LMVJV 2011). However, little research has been conducted to examine residual stand composition and hardwood regeneration after DFC application. From a silvicultural standpoint, it is very important to characterize regeneration to determine what long term effects DFCs could have on hardwood forest composition.

Proponents of DFCs claim that this management practice will not shift forest composition toward shade-tolerant species (LMVJV 2011). Although oak or other commercially desirable trees are significant timber species on many southern bottomland hardwood sites and simultaneously provide valuable food and cover resources to many wildlife species, regeneration of these species is not a top priority of DFC management. Regardless of the objectives given by the creators of DFCs, it is responsible stewardship to consider the outcome of any land management practice prior to application. Since DFC parameters have been created in the last decade, it is imperative to begin to characterize and document early forest response in order to understand long-term forest impacts. These DFCs have recently been heavily promoted for use on nonindustrial private bottomland hardwood forest land (LMVJV 2011). It is the purpose of this study to provide critical information to land managers and other decision makers regarding the application of these practices.

The first objective of this study was to characterize residual forest conditions after DFC application, including species composition and basal area within the overstory and midstory. The second objective was to evaluate natural regeneration by species composition and density.

MATERIALS AND METHODS

Site Description

The study site was comprised of two adjacent tracts within a private landholding owned by Catfish Point Land and Timber Company LLC. It is located in Bolivar County, MS, (latitude 33.68° N, longitude 91.16° W), adjacent to the Mississippi River. Catfish Point is approximately 15 miles northwest of Greenville, MS. The Catfish Point Air Strip stand was approximately 84 acres in size, and the Catfish Point Main Road stand was 52 acres. DFC treatments were applied to the Air Strip stand in February 2010 and to the Main Road stand in February 2011. These soils were of alluvial origin and included very fine sandy loams, silt loams, and silty clay loams. These stands were behind the Mississippi River levee, and occasionally flood in late spring. The overstory was comprised of sugarberry (*Celtis laevigata* Willd.), boxelder

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(*Acer negundo* L.), pecan [*Carya illinoinensis* (Wangenh.) K. Koch], and sycamore (*Platanus occidentalis* L.). The midstory is dominated by sugarberry, boxelder, and American elm (*Ulmus americana* L.), and the understory is also primarily shade-tolerant regeneration.

Sampling Design

A nested-plot sampling method was used; therefore three concentric plots at a sample point shared a common plot center. The total number of plots sampled was based on the acreage of each tract with a sampling intensity of one set of plots per 2 acres, resulting in 68 plots to sample 136 acres. Plots were spaced on a systematic 4- by 5-chain line-plot grid. This inventory was conducted from June 25 to July 5, 2012 and represented a 10 percent overstory cruise.

According to DFC specifications, the intended goals for basal area and stand density were to be attained through the use of uneven-aged silviculture. Therefore, site treatments were applied with alternation of two variable retention cutting regimes, light-cut and heavy-cut, along with untreated control areas throughout the tract. Areas harvested using single-tree selection were classified as light-cut treatment areas, and areas harvested using group selection were called heavy-cut treatment areas. Attempts were made to equally distribute nested plots throughout all three treatment types. This was performed by offsetting plots perpendicular to the direction of travel, if necessary, to ensure that each entire set of plots was centered within the opening of either a light-cut or heavy-cut treatment. Plot centers were recorded by GPS and physically demarcated using a 36-inch pin flag.

The overstory was defined as stems within a dominant, co-dominant, or intermediate crown class and assessed using 0.2-acre (52.7-foot radius) plots. Species and diameter at breast height (d.b.h.) in 0.1-inch classes were recorded for each overstory tree in the plot. Midstory trees were defined as stems between 10-feet tall and the base of the general canopy and measured in 0.025-acre (18.6-foot radius) plots. Midstory information included species and d.b.h. in 0.1-inch classes for each tree in the plot. Understory species were defined as woody regeneration < 10-feet tall and sampled within 0.01-acre (11.7-foot radius) plots (Stanturf and Meadows 1994). Within the understory plots, all species were identified and assigned into height classes. The height classes were <1 foot, 1 to 2 feet, 2 to 3 feet, 3 to 6 feet, and 6 to 10 feet.

RESULTS AND DISCUSSION

Catfish Point - Air Strip Stand

Overstory--Average overstory basal area in 17 heavy-treatment plots within the Catfish Point Air Strip stand was 65.92 square feet per acre, with 25.59 trees per acre (table 1). Residual species composition (table 2) following the heavy treatment was comprised of sugarberry, sycamore, American elm, boxelder, hickory, pecan, and sweetgum (*Liquidambar styraciflua* L.) with sugarberry being the predominant species. Average overstory basal area among 12 light-treatment plots was 105.04 square feet per acre, with an average of 44.17 trees per acre. This treatment area had a residual overstory made up of 57.5 percent sugarberry. There were also American elm, boxelder, green ash (*Fraxinus pennsylvanica* Marsh.), hickory (*Carya* spp.), pecan, sweetgum, and sycamore throughout the stand. Based on 13 control plots, mean basal area was 93.85 square feet per acre with 48.46 trees per acre. Overstory of the control area was 67.5 percent sugarberry. Miscellaneous other species comprising minor portions of the stand were American elm, boxelder, cedar elm (*U. crassifolia* Nutt.), hickory, pecan, sweetgum, and sycamore.

Though this stand is now privately owned by Catfish Point Land and Timber Company, LLC, it was formerly owned and managed by Chicago Mill and Lumber Company. This particular stand was previously “high graded” by selection cutting for decades. This method of harvesting repeatedly removed the most commercially desirable species from the stand and failed to create conditions favorable for the regeneration of oaks. Thus, some portions of the stand naturally became devoid of desirable species.

According to Walker and Watterson (1972), less desirable species such as sugarberry and boxelder retained during high-grading timber harvests will continue to grow and regenerate to the detriment of other more desirable species.

Table 1--Average basal area and trees per acre in treatment areas at Catfish Point

	Basal area (*feet²/acre*)				Trees per acre			
	Air Strip		Main Road		Air Strip		Main Road	
Treatment	Overstory	Midstory	Overstory	Midstory	Overstory	Midstory	Overstory	Midstory
Control	93.85	21.19	75.46	20.52	48.46	129.23	46.25	215.00
Heavy	65.92	10.94	44.41	3.96	25.59	32.94	21.36	50.91
Light	105.04	13.86	58.67	11.15	44.17	103.33	29.29	108.57

Table 2--Average overstory species percent composition in treatment areas at Catfish Point

	Air Strip			Main Road		
Species	Control	Heavy	Light	Control	Heavy	Light
	percent					
American elm	11.1	11.5	8.5	2.7	8.2	4.9
Boxelder	4.8	2.3	3.8	4.1	--	--
Cedar elm	0.8	--	--	--	--	--
Green ash	--	--	1.9	1.4	--	--
Hickory	0.8	1.1	0.9	--	4.1	--
Pecan	3.2	8.0	5.7	8.1	18.1	24.4
Persimmon	--	--	--	5.4	--	--
Sugarberry	67.5	52.9	57.7	67.6	67.3	61.0
Sweetgum	4.8	9.2	15.1	2.6	--	--
Sycamore	7.1	14.9	6.6	8.1	--	9.7
Water oak	--	--	--	--	2.0	--

Based on the species composition in table 2, sugarberry was the primary component of both treatment areas and the control. Control areas had the highest level of sugarberry, which indicates that sugarberry was selected against when the stand was marked for DFC installment. In this case, the removal of sugarberry would also be helpful to promote the growth and regeneration of other more desirable trees both for wildlife and commercial timber interests. In fact, there were higher percentages of pecan, sweetgum, and sycamore in the heavy- and light-treatment areas compared to the control. Though these species are not the most beneficial trees to wildlife or the most valuable commercial species for timber production, they are an improvement over American elm, boxelder, and sugarberry.

Midstory--Average midstory basal area in 17 heavy-treatment plots was 10.94 square feet per acre with a mean of 32.94 trees per acre (table 1). Flowering dogwood was the largest component of the midstory in heavy-treatment areas and comprised 41.7 percent of this layer. Boxelder comprised 29.2 percent of the layer, and sweetgum made up 12.5 percent. Other less-abundant heavy-treatment area midstory species included American elm, pecan, and sugarberry (table 3). Average midstory basal area in 12 light-treatment plots was 13.86 square feet per acre with 103.33 trees per acre. Species composition of the light-treatment midstory plots varied from the heavy treatment. In these areas, sugarberry made up exactly 50 percent of the midstory species. Flowering dogwood (*Cornus florida* L.) was the second most common species with 20.6 percent. Other species present in these treatment areas were American elm, boxelder, and sycamore. Based on the 13 midstory plots in control areas, mean basal area was 21.19 square feet per acre with 129.23 trees per acre. The most common midstory species was sugarberry, which made up 70.5 percent of the layer. American elm, boxelder, flowering dogwood, and pecan were

Table 3--Average midstory species percent composition in treatment areas at Catfish Point

Species	Air Strip			Main Road		
	Control	Heavy	Light	Control	Heavy	Light
	percent					
American elm	9.1	4.2	5.9	6.8	4.8	4.8
Boxelder	13.6	29.2	17.6	45.5	--	47.6
Deciduous holly	--	--	--	--	4.8	--
Flowering dogwood	4.5	41.7	20.6	2.3	71.4	23.8
Pecan	2.3	4.2	--	--	--	--
Persimmon	--	--	--	2.3	--	--
Sugarberry	70.5	8.3	50.0	43.2	14.3	23.8
Swamp chestnut oak	--	--	--	--	4.8	--
Sweetgum	--	12.5	--	--	--	--
Sycamore	--	--	5.9	--	--	--

other species that comprised the remainder of the control area midstory. The midstory of the control and light-treatment areas was composed heavily of sugarberry. This is logical since the overstory in these areas is primarily sugarberry, and it is a shade-tolerant species (Putnam 1951). Based on the midstory species composition presented in table 3, the future overstory stand will likely be heavily comprised of sugarberry as well, followed by boxelder, American elm, and pecan.

Regeneration--Abundance of regeneration in the heavy-treatment areas is presented in table 4. Sugarberry had the highest abundance with 3.06 stems per plot in the smallest height class. In comparison, green ash had the greatest abundance in the 1- to 2- and 2- to 3-foot class with 3.94 and 4.35 stems per plot, respectively. However, green ash was among the least frequently occurring species across all plots (table 7). This indicates that green ash regeneration was likely very abundant in the few plots where it was observed. Sugarberry was by far the most prevalent species in approximately 82 percent of the plots, followed by boxelder (76.47 percent) and American elm (64.71 percent). Other species in low abundance and comprising < 12 percent each of the regeneration strata were deciduous holly (*Ilex decidua* Walt.), flowering dogwood, hickory, honeylocust (*Gleditsia triacanthos* L.) , sycamore, sweetgum, and water oak (*Quercus nigra* L.). Although 0.06 stems per plot of water oak were presented in table 4, the raw data indicates that this number is representative of one water oak seedling in one height class found on one plot out of 17 sample plots in heavy-treatment areas.

The most abundant regeneration species in the light-treatment areas was sugarberry (table 4). There was an average of more than six stems of sugarberry per plot in the smallest height class, with 0.92 stems in the 1- to 2-foot category and even fewer stems in the three remaining categories. Sugarberry regeneration was present on all light-treatment plots. Boxelder was also present on 58 percent of plots at an average rate of 2.00 stems per plot under 1 foot and fewer stems in all other height classes. American elm grew on exactly 50 percent of the plots, and its greatest abundance was 1.42 stems per plot in the smallest height class. There were minor amounts of cedar elm, flowering dogwood, hickory, and sycamore present in the regeneration strata as well.

Boxelder was the most abundant species in the control areas (table 4). It occurred on 53.85 percent of the plots at a rate of 2.46 stems per plot in the smallest height class. American elm and sugarberry were found in 30.77 percent of sample plots. American elm was more abundant

Table 4--Average regeneration species abundance by treatment and by height class at the Catfish Point Air Strip stand

	Heavy					Light					Control				
	Height class in feet														
Species	<1	1-2	2-3	3-6	6-10	<1	1-2	2-3	3-6	6-10	<1	1-2	2-3	3-6	6-10
	stems per plot														
American elm	1.76	2.94	2.65	0.65	--	1.42	0.5	0.25	--	--	0.08	0.15	0.23	--	--
Boxelder	0.71	1.41	1.47	0.94	0.24	2	0.5	0.83	0.25	0.08	2.46	0.62	0.23	--	0.08
Cedar elm	--	--	--	--	--	--	0.08	--	--	--	--	--	--	0.08	--
Deciduous holly	--	--	0.06	--	--	--	--	--	--	--	--	--	--	--	--
Flowering dogwood	0.12	--	--	--	0.06	0.67	0.17	0.08	--	--	--	--	--	--	--
Green ash	0.53	3.94	4.35	0.06	--	--	--	--	--	--	--	0.08	--	--	--
Hickory	--	0.06	--	0.06	--	0.08	--	--	--	--	--	--	--	--	--
Honeylocust	0.06	--	0.06	--	0.12	--	--	--	--	--	--	--	--	--	--
Pecan	--	--	--	--	--	--	--	--	--	--	--	--	0.08	--	--
Sugarberry	3.06	3.12	1.06	0.94	0.06	6.42	0.92	0.17	0.42	0.17	0.31	0.15	--	--	--
Sweetgum	--	--	0.06	0.35	0.18	--	--	--	--	--	--	--	--	--	--
Sycamore	--	--	0.06	0.88	--	--	--	--	0.08	--	--	--	--	--	--
Water Oak	--	0.06	--	--	--	--	--	--	--	--	--	--	--	--	--
Willow oak	--	--	--	--	--	--	--	--	--	--	0.31	--	--	--	--

in the 2- to 3- and 1- to 2-foot categories, yet sugarberry was most abundant in the smallest height class. There were also minor amounts of cedar elm, green ash, pecan, and willow oak (*Q. phellos* L.) regeneration scattered throughout the site. Willow oak was present on 15.38 percent of control plots in the < 1 foot height class but in comparatively low abundance (0.31 stems per plot). Raw data show that two willow oak seedlings were found on 2 plots out of 13 sample plots. These seedlings likely germinated from the previous year's acorn crop but will have little chance for survival in the low light conditions found in control areas of this stand.

Species composition of the regeneration strata at the Catfish Point Air Strip Stand is presented in table 6. Heavy-treatment areas were composed of 27.71 percent green ash, 25.69 percent sugarberry, and 24.95 percent American elm. Other less-common species were boxelder, deciduous holly, flowering dogwood, hickory, honeylocust, sweetgum, sycamore, and water oak. Light-treatment areas contained 53.59 percent sugarberry, 24.31 percent boxelder, and 14.36 percent American elm. Remaining species of minor occurrence were cedar elm, flowering dogwood, hickory, and sycamore. In contrast to the previous treatment areas, the control was dominated by 69.84 percent boxelder in the regeneration strata, followed by only 9.52 percent of both American elm and sugarberry. Cedar elm, green ash, pecan, and willow oak were the remaining species of regeneration found throughout the control. As previously mentioned, this relatively minor abundance of water oak and willow oak will not likely mature into advanced regeneration due a lack of available light resulting from future canopy closure and midstory development.

Catfish Point - Main Road Stand

Overstory--Average overstory basal area in 11 heavy-treatment plots was 44.41 square feet per acre with 21.36 trees per acre (table 1). Sugarberry was the dominant species which comprised 67.3 percent of the overstory (table 2). Pecan (18.4 percent) and American elm (8.2 percent) were also present throughout the stand. The two remaining species which comprised the overstory in heavy-treatment areas were hickory and water oak. Average overstory basal area in seven light-treatment plots was 58.67 square feet per acre with 29.29 trees per acre (table 1). Similar to the heavy-treatment areas, sugarberry comprised the vast majority (61.0 percent) of the light-treatment area overstory. Pecan was the second most common species in the stand but only made up 24.4 percent of the overstory species. American elm (4.9 percent) and sycamore (9.7 percent) were the other components of these areas (table 2). Average overstory among eight control plots was characterized by a basal area of 75.46 square feet per acre and a mean of 46.25 trees per acre. Sugarberry comprised 67.6 percent of the overstory species. All other species comprised < 10 percent each of the stand. These species included American elm, boxelder, green ash,

pecan, persimmon (*Diospyros virginiana* L.), sweetgum, and sycamore.

Basal area and number of overstory trees per acre were slightly lower in the Main Road stand. Upon visual examination of the Main Road stand, the overstory was obviously much less dense than the overstory of the Air Strip stand. Overstory species composition in the Catfish Point Main Road stand was very similar to the species composition of the Catfish Point Air Strip stand. Although these were separate stands, they were close in proximity and were subjected to the same harvesting practices of the past.

Sugarberry comprised over 60 percent of the stand across all treatment and control areas. As shown in table 2, heavy-treatment areas contained almost the exact same percentage of sugarberry as the control. Even though heavy-treatment areas were subjected to more harvesting, they contained slightly more sugarberry than light-treatment areas. In this stand, pecan appears to have been the preferred species for retention. All other species were relatively low in abundance across all treatment and control areas. Sycamore comprised 8 percent of the control overstory and 9 percent of the light-treatment areas, but was not found in heavy-treatment areas.

Midstory--Average midstory basal area in 11 heavy-treatment plots was 3.96 square feet per acre with a mean of 50.91 trees per acre (table 1). Flowering dogwood was the predominant species in these areas, comprising 71.4 percent of the midstory (table 3). Other minor species included sugarberry (14.3 percent), American elm (4.8 percent), deciduous holly (4.8 percent), and swamp chestnut oak (*Q. michauxii* Nutt.; 4.8 percent). Average basal area in seven light-treatment midstory plots was 11.15 square feet per acre with 108.57 trees per acre. In contrast with the midstory in heavy-treatment areas, midstory of the light-treatment areas was dominated by 47.6 percent boxelder. Flowering dogwood and sugarberry each composed 23.8 percent of the midstory, and the remaining midstory stems were American elm (4.8 percent). Average midstory basal area in eight control plots was 20.52 square feet per acre with 215 trees per acre. Boxelder made up 45.5 percent of this stand, and sugarberry comprised 43.2 percent. Remaining species were American elm (6.8 percent), flowering dogwood (2.3 percent), and persimmon (2.3 percent) (table 3).

Sugarberry and boxelder were the most prevalent midstory species in the Main Road stand. Heavy-treatment areas had the lowest proportion of sugarberry, and light-treatment and control areas had successively more stems. Control and light-treatment areas had high levels of boxelder, yet the heavy-treatment areas had no boxelder within the sample plots. In contrast, the heavy-treatment areas had a high level (71.4 percent) of flowering dogwood, whereas the light-treatment areas had 23 percent and the control areas had < 3 percent. The relatively low basal area (3.96 square feet per acre) and number of trees per acre (50.91) support the fact that flowering dogwood and the minor abundance of other species in this midstory were of small diameter and sporadic occurrence.

It is interesting to note that there was a small (4.8 percent) component of swamp chestnut oak in the midstory which equated to one stem sampled in one plot. Oaks typically do not grow well with the competition and low light levels found in the shaded midstory typical of bottomland hardwood forests. With this fact in mind, the importance of midstory control must not be underestimated prior to harvest activities to stimulate the germination and growth of oak seedlings into advanced regeneration before complete overstory removal. Lowery and others (1998) observed an increase in the growth and survival of oak seedlings in midstory control plots in a minor Mississippi bottomland. Their study determined that midstory injection during the early dormant season had the best control and ultimately promoted the greatest level of available light for oak seedlings.

Regeneration--Sugarberry was very common in approximately 90 percent of sample plots in heavy-treatment areas. Stems < 1-foot tall occurred at an average rate of 3.73 stems per plot, whereas stems between 1- and 2-feet and 2- and 3-feet tall were found at 1.91 and 1.27 stems per plot, respectively (table 5). There

Table 5--Average regeneration species abundance by treatment and by height class areas at the Catfish Point Main Road stand

	Heavy					Light					Control				
	Height classes in feet														
Species	<1	1-2	2-3	3-6	6-10	<1	1-2	2-3	3-6	6-10	<1	1-2	2-3	3-6	6-10
	stems per plot														
American elm	--	0.09	0.18	0.36	--	0.29	0.14	1.14	0.29	0.14	--	0.25	0.13	0.13	--
Boxelder	--	0.18	--	--	--	0.29	--	0.14	0.43	--	2.25	0.38	--	--	--
Cedar elm	--	--	--	--	--	0.14	--	--	--	--	--	--	--	--	--
Chinese privet	--	--	--	--	--	--	--	--	--	--	0.13	--	--	--	--
Eastern cottonwood	--	--	--	--	--	--	--	--	0.29	--	--	--	--	--	--
Flowering dogwood	0.90	--	--	0.36	0.18	--	--	--	0.14	--	--	--	--	--	--
Green ash	--	--	--	--	--	--	--	0.14	--	--	0.13	--	--	--	--
Hickory	--	0.18	--	--	--	0.14	--	--	--	--	--	0.13	--	--	--
Sugarberry	3.73	1.91	1.27	0.55	0.09	1.29	1.71	0.71	0.14	0.14	4.25	0.75	0.25	0.25	--
Swamp chestnut oak	--	--	--	--	--	--	--	-	--	--	--	--	0.25	--	--
Sweetgum	--	--	--	--	--	--	--	--	--	--	--	0.13	--	0.13	--
Sycamore	--	--	--	0.27	--	--	0.29	--	--	--	--	--	--	--	--
Water Oak	0.18	0.09	--	0.09	--	0.14	--	--	0.14	--	0.13	0.25	--	--	--
Willow oak	0.09	--	--	--	--	--	0.14	--	--	--	--	--	--	--	--

were also 0.55 sugarberry stems present per plot in the 3- to 6-foot height class. This heavy abundance of sugarberry regeneration across all height classes clearly expressed the ability of this species to flourish under low light conditions that prohibit the establishment of all but the most shade-tolerant species. This means a very low composition (2.0 percent) of water oak seed sources in the overstory of heavy-treatment areas (table 2), coupled with factors such as cyclical acorn crops and low levels of available light, have inhibited the establishment and growth of advanced oak regeneration in this stand. The combined total of five stems of oak regeneration in 9 percent of sample plots (table 5) confirms this hypothesis. When the height of these five stems is considered, only two stems were tall enough to be considered advanced regeneration. Unfortunately, survival of this advanced regeneration will be impeded by low light conditions.

Flowering dogwood was present on 27 percent of plots, and boxelder was found on 18 percent of plots. Flowering dogwood stems were present in the height class of < 1 foot, and in the 3- to 6- and 6- to 10-foot classes. Boxelder was only present in the 1- to 2-foot height class in 18.18 percent of sample plots. Other miscellaneous species including American elm, hickory, and sycamore between 1- and 6-feet tall were found on 9 percent of the plots. Though American elm and hickory regeneration are shade tolerant and likely developed under closed canopy conditions, the presence of sycamore indicates an area where substantial light is reaching the forest floor. It is unclear whether the sycamore originated from advanced regeneration or germinated following harvest, but it will likely suffer from the same decrease in light availability as the oak regeneration.

Sugarberry was the most common species in the regeneration strata across all treatment areas. It comprised 76.1 percent of the regeneration in heavy-treatment areas, 47.5 percent in light-treatment areas, and 55.7 percent in control areas (table 6). Other miscellaneous regeneration species in heavy-treatment areas included American elm, boxelder, flowering dogwood, hickory, sycamore, water oak, and willow oak. These species each comprised < 10 percent of the overall regeneration. Sugarberry was the primary species in light-treatment plots and comprised 47.5 percent of the regeneration. American elm made up 23.7 percent of regeneration and boxelder was 10.2 percent. Remaining species were cedar elm, eastern cottonwood, flowering dogwood, green ash, hickory, sycamore, water oak, and willow oak, and each comprised < 4 percent of the regeneration present. Approximately 55 percent of regeneration in the control areas was

Table 6--Species percent composition in the regeneration layer by treatment at Catfish Point

Species	Air Strip			Main Road		
	Heavy	Light	Control	Heavy	Light	Control
	percent					
American elm	24.95	14.36	9.52	6.4	23.7	5.1
Boxelder	14.86	24.31	69.84	1.8	10.2	26.6
Cedar elm	--	0.55	1.59	--	1.7	--
Chinese privet	--	--	--	--	--	1.3
Deciduous holly	0.18	--	--	--	--	--
Eastern cottonwood	--	--	--	--	3.4	--
Flowering dogwood	0.55	6.08	--	6.4	1.7	--
Green ash	27.71	--	1.59	--	1.7	1.3
Hickory	0.37	0.55	--	1.8	1.7	1.3
Honeylocust	0.73	--	--	--	--	--
Pecan	--	--	1.59	--	--	--
Sugarberry	25.69	53.59	9.52	76.1	47.5	55.7
Swamp chestnut oak	--	--	--	--	--	2.5
Sweetgum	1.83	--	--	--	--	2.5
Sycamore	2.94	0.55	--	2.8	3.4	--
Water Oak	0.18	--	--	3.7	3.4	3.8
Willow oak	--	--	6.35	0.9	1.7	--

sugarberry. Boxelder was the second most-common species and comprised 26.6 percent of the regeneration. Other species which occurred in control areas were American elm, green ash, hickory, Chinese privet (*Ligustrum sinense* Lour.), swamp chestnut oak, and sweetgum. Each of these species was < 6 percent of the overall composition.

Similar to the Catfish Point Air Strip stand, sugarberry was highly abundant across all treatment and control areas. American elm and boxelder also composed notable percentages of regeneration species across all areas. As previously stated, this regeneration is a strong indication of the primary overstory species of this stand prior to harvest. Though water oak, willow oak, and a few other somewhat desirable species were present, none of these species comprised over 4 percent of the total regeneration species in any treatment or control area.

In summary, regeneration across all treatment and control areas in this stand indicate that the future overstory will be comprised of sugarberry, American elm, boxelder, and other commercially undesirable species. The very low presence of oak regeneration and overall lack of environmental conditions conducive to the recruitment of future oak regeneration virtually ensure the perpetual loss of oaks and other commercially desirable shade-intolerant species in this stand.

CONCLUSION

This study was the first characterization of residual bottomland hardwood forest conditions of DFC applications in Mississippi. As such, all sampling methods were originally conceived and implemented to fully document the dynamic conditions across a forest following DFC application. It is important to note that this study simply provides an overview of conditions that were present in mid-summer of 2012. As of 2012, these findings are the sole documentation of early stages of DFC management in Mississippi.

Catfish Point DFC installation across 2 subsequent years was led and monitored by personnel experienced with marking bottomland hardwood timber to meet the forest parameters set forth by DFC objectives using uneven-aged management. Although the overstory of Catfish Point was heavily composed of less-desirable shade-tolerant species in all treatment areas, there was a notable decrease in sugarberry composition in the heavy treatment. This was

Table 7--Average percent occurrence of regeneration species by treatment at Catfish Point

	Air Strip			Main Road		
Species	Heavy	Light	Control	Heavy	Light	Control
	percent					
American elm	64.71	50	30.77	9.09	57.14	37.5
Boxelder	76.47	58.33	53.85	18.18	57.14	75
Cedar elm	--	8.33	7.69	--	14.29	--
Chinese privet	--	--	--	--	--	12.5
Deciduous holly	5.88	--	--	--	--	--
Eastern cottonwood	--	--	--	--	14.29	--
Flowering dogwood	11.76	16.67	--	27.27	14.29	--
Green ash	5.88	--	7.69	--	14.29	12.5
Hickory	11.76	8.33	--	9.09	14.29	12.5
Honeylocust	11.76	--	--	--	--	--
Pecan	--	--	7.69	--	--	--
Sugarberry	82.35	100	30.77	90.91	85.71	87.5
Swamp chestnut oak	--	--	--	--	--	12.5
Sweetgum	5.88	--	--	--	--	12.5
Sycamore	11.76	8.33	--	9.09	14.29	--
Water Oak	5.88	--	--	9.09	28.57	37.5
Willow oak	--	--	15.38	9.09	14.29	--

likely the intended result due to the high percent of sugarberry in the stand. A decrease in sugarberry could lead to an increase of other species, which could lead to greater species diversity.

Attaining species diversity is a goal of DFC management. Species diversity is undoubtedly beneficial to any naturally regenerated stand because it promotes stand development from interspecific competition, increased resilience to insects and disease, and many other ecological functions important to forest sustainability. However, the LMVJV (2007) currently suggests that species should not be a determining factor when marking timber prior to group and single tree selection harvests. Rather, the selection of harvest trees is based on the promotion of multi-strata canopy development, sustaining potentially low vigor trees for the recruitment of snags and coarse woody debris, and creating shrub-scrub habitat to support wildlife of special conservation concern.

These DFC objectives should be carefully weighed and considered against the goals of forest ownership by any manager considering DFC application. The initial forest response to DFC treatments is summarized below. It is also important to note that no observable differences in species composition were noted between the Catfish Point stands 1 and 2 years after harvest.

The Catfish Point Air Strip stand had a very high average basal area in light-treatment and control areas but a notably lower basal area in heavy-treatment areas. The Main Road stand at Catfish Point exhibited lower densities. Catfish Point had a high overall level of sugarberry, boxelder, American elm, and other species that are less desirable for commercial timber production and wildlife use. Both stands were characterized by a dense midstory of shade-tolerant species, primarily in control areas and light-treatment areas. Regeneration was variable in terms of abundance and species across both stands but was representative of the overstory on each site. The understory was primarily characterized by sugarberry and other shade-tolerant regeneration. Because DFC guidelines only allow for a maximum of 20 percent of the forest to be harvested using group selection, only a small area would be capable of developing advanced regeneration. It is therefore unlikely that shade-intolerant regeneration will develop into the overstory due to competition from other shade-tolerant species (Oliver and others 2005).

Future management activities at Catfish Point will depend on the goals of ownership. If

desired, the shift of species composition of these stands into more desirable species would require harvesting the vast majority of the current stands. The oak component of these stands is too low to ensure natural regeneration for stocking. Though costly, some form of artificial regeneration is the only way to increase the oak component of these stands in the foreseeable future.

In summary, forest managers should note the high tree densities of these post-treatment areas when considering uneven-aged forest management proposed through DFC implementation when managing commercially desirable shade-intolerant species. Data in this study indicate that DFC treatments will continue to promote recruitment and growth of shade-tolerant species into the future overstory at both Catfish Point stands. Future forest inventories of these and other DFC areas will be crucial to the understanding of the implications of DFC management. The review and consideration of these results should be evaluated alongside DFC goals just like any other management scheme in order to fully realize and promote the wise, ethical, and sustained use of the bottomland hardwood forest wildlife and resources in Mississippi.

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