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Effects of prescribed fire on the forest structure and composition at Land Between the Lakes National Recreation Area, KY

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HONORS THESIS

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Effects of prescribed fire on the forest structure and composition at Land Between the Lakes National Recreation Area, KY

Miranda R. Thompson
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Effects of prescribed fire on the forest structure and composition at Land Between the Lakes National Recreation Area, KY

Submitted in partial fulfillment
of the requirements
for the Murray State University Honors Focus

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ABSTRACT

With a regular fire regime present on the landscape, open canopies and herbaceous understories characterize oak forests in western Kentucky. However, a long period of fire suppression has changed the structure and composition of many forests in the Southeast. Forest managers at Land Between the Lakes have started using prescribed fire in an attempt to replicate aspects of a natural fire regime and increase the amount of open oak woodlands and savannas in the area. The prescribed fires in our study area were conducted during the dormant season and are very low intensity ground fires.

To understand how prescribed fire affects the forest structure and species composition of an oak-dominated landscape; we studied four different forest management types at Land Between the Lakes National Recreation Area (LBL), Kentucky, USA. The management types we studied included grasslands, areas burned within 6 months of data collection, areas left unburned for greater than 6 months, and areas with no active management. We used an analysis of variance to compare structural characteristics across the management types. We then compared the species composition across management types in the overstory, midstory, and understory using a permutational analysis of variance and non-metric multidimensional scaling.

We found no difference in stem density, amount of bunchgrass tussocks, forbs, or coarse woody material between the unburned and burned sites. This is consistent with several other studies conducted in this region that found it takes long-term and iterative prescribed fires to impact the midstory density. These studies, along with ours, also found that long-term management using fire is necessary to affect the species composition in the midstory. We did find that the species compositions were different across management types in the overstory and the understory. With the low intensity prescribed fires used at our study sites, it is more likely

that the species composition would be different in the understory than the overstory. Future research should be conducted to better understand the species composition at burn sites at Land Between the Lakes.

INTRODUCTION

Fire is a dynamic forest disturbance that has the ability to create and maintain unique ecosystems. In oak-dominated landscapes of North America, fire is a key disturbance. Historically, a fire return interval of 1-8 years across the Southeast maintained the oak-dominated savannas and woodlands that European settlers observed when they first arrived (Franklin 1994). With a frequent fire return interval, these landscapes had open canopies and midstories and an herbaceous understory. Oak savannas and oak woodlands were also historically maintained by grazing of large ungulates like bison and elk that are now functionally extirpated (Franklin 1994). However, according to Adams (1992), fire was the largest contributor to the development of oak forests. Our study area, Land Between the Lakes National Recreation Area (LBL) was historically dominated by oaks and hickories and was maintained by frequent fires. Using fire scar data, Gueyette et al. (2010) observed a mean fire return interval of 5.22 years from 1709-1944 in the area that is now LBL. Using historical data from LBL, Franklin (1994) observed that the lightning-caused fire regime in the area was complemented by Native Americans groups who used periodic burning to provide space for wildlife grazing and movement (USFS 2004). However, an era of fire suppression that began in the early 1900s changed the historic landscape of LBL and much of the Southeast.

In a process called "mesophication" (sensu Nowacki and Abrams 2008), in the absence of fire canopies and midstories will begin to close and shade tolerant trees will become dominant. Shade intolerant species such as post oak (*Quercus stellata* Wangenh) will decrease, while shade tolerant species such as sugar maple (*Acer saccharum* Marshall) and American beech (*Fagus grandifolia* Ehrh.) will increase (Nowacki and Abrams 2008; Knapp 2009; Ryan et al. 2015). According to Nowacki and Abrams (2008), mesophication occurs when increasingly cool, damp, and shaded conditions create a less flammable fuel bed and improve conditions for mesophytic species while conditions deteriorate for shade-intolerant, fire-adapted species. Mesophication has occurred over large areas of oak-dominated forests, especially on mesic sites. Mesophication is projected to expand from mesic sites into xeric uplands that oaks now dominate (USFS 2004; Van Lear 2004; Iverson 2007). These changes impact the abundance of native plants and the insects and wildlife that rely on them for food and shelter (Abrams 1992; Peterson and Reich 2001; May 2002; Hutchinson et al. 2005).

Management practices will influence forest structure and consequently determine which plants and animals will occur in a given forest. A growing base of knowledge and technology now supports prescribed burning as a method for increasing the ecological and economic value of forests (Ryan et al. 2015, Franklin 1994). The Southeast was one of the first regions to begin using controlled burning as a method to increase ecological value of forests and encourage habitats beneficial to upland game species (Johnson and Hale 2000). Because of the benefits of prescribed fire, many forests in the Southeast are now being managed with prescribed fire (Peterson and Reich 2001).

Reducing dangerous fuel loads and increasing regeneration of hard-mast species such as oaks and hickories are two of the main reasons that land managers utilize controlled burning as a management tool (Harper et al. 2016; Ryan et al. 2013; Peterson and Reich 2001). In 2004, the US Forest Service at LBL wrote a land and resource management plan that included objectives for increasing oak savannas and open oak woodlands (USFS 2004). These objectives addressed the Continuous Forest Inventory (CFI) conducted in 1996, which indicated a decrease in oaks in uplands with an encroachment of mesic species in these areas. CFIs are a method for tracking changes in forest structure and composition using plots that are measured periodically. The decrease in oaks is due in part to impaired oak regeneration on dry uplands, where mesic species are no longer excluded by fire (Franklin et al. 1993; USFS 2004). The age and condition of the current oak population raises concern over the sustainability of oak dominated forests in the area. LBL intends to increase the use of varying levels of prescribed fire and mechanical thinning to create a heterogeneous landscape with stands of varying ages and canopy openness (USFS 2004). Prescribed fire will open the canopy and stimulate herbaceous understory growth. Tree thinning in dense forests will stimulate the growth of young trees to increase the diversity in age structures (USFS 2004). Increasing the amount of sunlight that reaches the forest floor in stands subject to thinning and burning will promote an herbaceous understory, which is important for maintaining healthy populations of native species of plants and wildlife (May 2002, USFS 2004).

Currently there are some areas of LBL that are subject to prescribed burning while others are unmanaged. In order to better understand the forest structures that these contrasting management strategies create, we studied 20 sites throughout LBL that have been subject to 4 different management regimes. These include (1) areas that were burned within 6 months of data collection ("new burns"), (2) areas burned more than 6 months before data were collected ("old burns"), (3) unmanaged forested areas, and (4) grasslands. Within each of these management regimes, we studied the differences in forest structure by looking at structural characteristics of the overstory, midstory and understory. We also studied species composition in the overstory, midstory, and understory across the four management types. By quantifying the vegetation in these areas, we determined whether there were differences in forest structure and species composition between areas that had been burned versus areas that were not burned, and if the vegetation structure was different between areas that were recently burned and areas left unburned since USFS management began.

STUDY AREA

Land Between the Lakes National Recreation Area has been under the jurisdiction of the U.S. Forest Service (USFS) since 1998. Throughout the 18th and 19th centuries our study area was known as Between the Rivers and was dominated by agriculture, iron sme,lting, and logging industries that all led to a substantial extraction of the natural resources (Franklin 1994, USFS 2004). In 1938 and 1959, the Tennessee Valley Authority (TVA) began construction of dams that created Kentucky Lake and Lake Barkley, respectively (Franklin et al. 1993). During the 20th century several different government agencies managed LBL but the land has been under the jurisdiction of the USFS since 1998.

LBL is a 69,000 ha peninsular land mass surrounded on three sides, originally by the Tennessee and Cumberland Rivers and now by their reservoirs. LBL is located between 36°36’45” and 37°02’45” N latitude, and 87°52’25” and 88°13’35” W longitude, all within Lyon County, KY, Trigg County, KY, and Stewart County, TN. The area ranges from 6-13 km wide and is 64 km long, with Lake Barkley on the east and Kentucky Lake on the west (Franklin et al. 1993). LBL receives a mean precipitation of 1,210 mm annually, and the average temperatures are 3° C in the winter and 28° C in the summer (Franklin et al. 1993), with approximately 195 growing days. The area lies within the Mississippi Loess Valley ecoregion of Kentucky and the Western Highland Rim subsection of the Interior Low Plateau Province physiographic region. According to Franklin (1993), most of the area consists of highly dissected uplands, with parent material of limestone and loess.

According to the most recent USFS management plan, LBL is 92% forested, predominantly by mature oaks (USFS 2004). Küchler (1964) maps the potential vegetation for the area as oak-hickory. About 8% of the land cover is open, consisting of cropland, wildlife plantings, hayfields, maintenance openings, ecological restoration openings, old fields, and roads. Few recent data are available detailing current species composition, but Chester (1993) summarized that ridges and upper slopes are dominated by *Quercus* spp. such as scarlet (*Q. coccinea* Muenchh), blackjack (*Q. marylandica* Muenchh), and black oaks (*Q. velutina* Lam.). The *Carya* spp. on these slopes includes pignut (*Carya glabra* Mill.), sand (*Carya* pallida Ashe.) and mockernut (*Carya tomentosa* Lam.) hickories. Highly mesic slopes contain sugar maple, bitternut hickory (*Carya cordiformis* Wangenh), American beech, tulip tree (*Liriodendron tulipifera* L.), black gum (*Nyssa sylvatica* Marshall), and wild black cherry (*Prunus serotina* Ehrh.). To summarize, Chester (1993) found that the major woody genera in LBL are *Quercus* and *Carya,* with *Ulmus* and *Acer* "contributing significantly".

METHODS

Data collection

Initial data for the analysis were collected May-August 2014. We used remote sensing data and prescribed burning maps to select 20 sites representing 4 management types within LBL. We defined "unmanaged" as forest that had never received timber cutting or burning treatments under USFS. "Grasslands" were defined as areas that were dominated by native species of grasses and with few or no trees on the landscape. Finally, we separated the areas being managed with prescribed fire into two categories: "new burn" referred to areas that had been burned within 6 months of data collection, whereas "old burn" referred to areas burned longer than 6 months prior.

At each of the 20 locations, we collected data for the overstory, midstory, understory, and ground levels. At each location we had 5 subsites at each cardinal direction and a central point.

At the overstory level, we used a densiometer to measure canopy openness. At the midstory level, we measured the number of live stems < 10 cm diameter at breast height (DBH) in 16 m^2 plots. For the understory, we measured the number of bunchgrass tussocks/m^2 by counting the number of bunchgrass tussocks within m^2 quadrats. At ground level, we measured the percentage of ground covered by leaf litter, forbs, and coarse woody material using quadrats that were divided into 10cm x 10cm squares. Finally, woody and herbaceous species were identified by their relative abundance within each forest strata at each site.

Analysis

We tested for differences in forest structure among the management types using an analysis of variance (ANOVA). The response variables for the overstory and midstory were canopy openness and stem density, respectively. We analyzed four response variables for the understory: the number of bunchgrass tussocks and the coverage of leaf litter, forbs, and coarse woody material. All response variables were considered independently of each other. Before running tests, we applied logarithmic transformations to the number of living stems and number of bunchgrass tussocks. We applied logistic transformations to the canopy openness, percent forb coverage, and percent coarse woody coverage variables to adjust for skew.

We evaluated each response variable for normality using Shapiro-Wilk and for equal variances using Levene tests. We used ANOVA of each forest stratum to test for any significant differences between the means of the 4 management types. Then we used Tukey’s Honestly Significance Difference (HSD) tests to check for individual differences between each of the vegetation types within forest strata. For all statistical analysis we used R version 3.2.2.

We used constrained ordination to observe differences in species composition among the sites in the overstory, midstory, and understory. We used the non-metric multidimensional scaling (NMDS) method of ordination to create a dissimilarity matrix of our species abundances. This function defines the species by their dissimilarities in multidimensional space and then reduces these positions to 2 dimensions for visual representation. We used the Shepard plot to regress the reduced configuration against the original dissimilarities. After the stress was determined, we plotted the similarities on an ordination plot. We then created convex hull polygons for each management type and plotted them on the ordination plot. To see if there were differences in species composition among the sites, we used a permutational multivariate analysis of variance (PERMANOVA), which uses distance measurements. We used Bray-Curtis as our distance measurement.

RESULTS

Forest Structure

Although we found that the canopy was significantly more open in grasslands than it was in unmanaged forests, there was no difference in canopy openness between new burns and old burn sites, and both had significantly lower canopy openness than the unmanaged sites. These differences were significant ($F_{3/96}$= 23.91, $P < 0.001$). The mean canopy openness was greatest in grasslands (70.6 ± 3.82% SE; Figure 1A), least in unmanaged areas (17.3 ± 0.53%), and intermediate in new burns and old burns (30.55 ± 0.02% and 23.8 ± 0.83%, respectively).

Overall there was no difference in stem density among management types at the midstory ($F_{3/96}$= 4.35, $P = 0.163$). The management type with the lowest mean density of stems was grassland (3.2 ± 0.44 1 SE; Figure 1B). Stem density was intermediate in the unmanaged areas and new burns (4.8 ± 0.34 in unmanaged areas and 4.7 ± 0.35 in new burns) and highest in old burns (5.5 ± 0.34 in old burns).

There were significant differences among the group means for all of the understory structural components (number of bunchgrass tussocks; $F_{3/96} = 11.43$, $P < 0.001$, leaf litter coverage; $F_{3/96} = 20.79$, $P < 0.001$, forb coverage; $F_{3/96} = 3.06$, $P = 0.032$, and coarse woody coverage; $F_{3/96} = 11.58$, $P < 0.001$). The grassland management type had the most bunchgrass tussocks/m^2 (7.9 ± 0.23; Figure 2A), while the other three management types were similar (1.2 ± 0.6 in unmanaged areas, 2.5 ± 0.55 in new burns, and 1.9 ± 0.61 in old burns). In contrast, the grassland management type had the lowest coverage by coarse woody material (5.52 ± 10.03 %, Figure 2B) while the other management types were all similar (17.0 ± 19.99 % in unmanaged areas, 17.6 ± 15.04 % in new burns, and 22.5 ± 21.23 % in old burns). As expected, the recently burned areas had the least amount of leaf litter in the understory (21.4 ± 2.56 %, Figure 2C). Mean coverage by leaf litter was greatest in unmanaged areas and old burns (72 ± 2.68 % and 82.4 ± 1.27 %, respectively) and intermediate in grasslands (72 ± 2.68 %). Finally, the grasslands had the most coverage by forbs (12.07 ± 18.64; Figure 2D). Unmanaged areas and old burns had the least (3 ± 6.9 and 3.6 ± 7.4, respectively) and new burns had an intermediate amount of coverage by forbs (8.2 ± 12.94).

Species composition

We looked at a total of 84 species across 20 sites (see Table 1 for list of species and abbreviations). We found that the species composition was different among sites for the understory (Pseudo $F_{3/16} = 2.1$, $P = 0.005$) and the overstory (Pseudo $F_{2/11} = 1.95$, $P = 0.041$). There was no difference in species composition among the management types in the midstory (Pseudo $F_{2/11} = 0.69$, $P = 0.84$). The NMDS ordination plots for the overstory, midstory, and understory illustrated overlap in species composition for each of the management types (Figure 3). In the understory, grasslands and old burns almost completely overlapped with the new burn and unmanaged areas. For the overstory and the midstory species, the new burn sites are illustrated as an intermediate between the unmanaged and old burn sites.

DISCUSSION

We found differences in both structure and composition at all forest strata except for the midstory. This contrasts with a similar study by Blankenship and Arthur (2006), who examined effects of prescribed fire on forest structure on the Cumberland Plateau in Kentucky and found that repeated burning reduced midstory stem density by 91%. Our study showed no significant difference in the average stem density between unmanaged and burned areas. An important difference was that our study site has a shorter history of prescribed burning. This difference indicates that the patterns of burning may influence the effect on forest structure. Several other sources have documented field studies that resulted in changes in the forest structure and composition only when several years of repeated burning along with thinning methods were applied to an area (Waldrop et al. 1992; Van Lear 2004; Hutchinson et al. 2005; Iverson et al. 2007; Ryan et al. 2013; Harper et al. 2016). Along with increasing the frequency of fire, it may also be important to consider the intensity and seasonality of fires. LBL uses low intensity ground fires in the dormant season, which may have little impact on the midstory structure. Harper et al. (2016) found that a frequent fire return interval is needed to reduce stem density when the fires are implemented during the dormant season. A longer fire-return interval may produce similar results when fires are implemented during the late-growing season (Harper et al. 2016).

Grassland structure at LBL was as expected, with an open canopy and midstory and an understory dominated by bunchgrass tussocks. Unmanaged areas had the lowest canopy openness of all the management types and had dense leaf litter and coarse woody material coverage in the understory. This was to be expected since these areas have not been burned. Both management types that were burned had intermediate canopy openness. This could indicate that the prescribed fire methods at LBL are successfully influencing canopy openness, which helps with oak regeneration. However, it was unexpected that canopy openness would be greater in the burned areas than the unmanaged areas since LBL has only been using prescribed fire within the last decade (USFS 2013). Multiple studies state that few, low intensity fires will not impact canopy structure (Van Lear 2004; Iverson et al. 2007), and it is possible that this difference in canopy openness could be due to site bias.

Aside from canopy openness, the structure was not different between the unmanaged sites and the burned sites. The only exception was the amount of leaf litter. This similarity in structure between the burned sites and the unmanaged sites shows that USFS has not yet met their goal of a more open forest structure conducive to oak recruitment. It is possible that even with greater canopy openness, a dense midstory could prevent adequate light from reaching the forest floor and encouraging the growth of grasses, forbs, and shade-intolerant trees. Increasing the amount of grasses and forbs is beneficial to wildlife species and increases overall biodiversity (Hutchinson and Sutherland 2000; May 2002).

In the 2004 management plan LBL set a goal to increase oak and hickory recruitment on xeric sites (USFS 2004). These species of tree provide wildlife habitat and are often critical to the diets of many wildlife species (May 2002). Oaks and hickories require contact with mineral soil to germinate (Abrams 1992), which is very unlikely when there is a dense layer of leaf litter and woody material on the forest floor. The new burn sites had very little leaf litter so they would have been appropriate for oak and hickory recruitment in that sense. However, the old burn sites had nearly the same amount of leaf litter as the unmanaged sites. So one year after a fire, the conditions for oak and hickory recruitment would no longer be favorable. The unmanaged sites and the burned sites had similar amounts of coarse woody material. It takes several burns to reduce the fuel load in an area where fire has been suppressed (Ryan et al. 2013). It is important to note that woody material and dense leaf litter provides cover and food for insects, herpetofauna, birds, and small mammals. Studies have shown that fire has negligible direct impact on these groups of organisms (Harper et al. 2016). However, maintaining landscape heterogeneity by burning only certain areas within a landscape is important to ensure a variety of food and cover types.

The PERMANOVA analysis revealed differences in species composition in the overstory and the midstory. Since LBL has a short history of prescribed fire, the difference in species in the overstory may be a result of the sites rather than the treatments. Hutchinson et al. (2005) found that the composition of tree species in the midstory was not substantially altered by fire. Several studies have found that repeated burning in conjunction with methods such as mechanical thinning are necessary to maintain forests with open structures (Van Lear 2004; Hutchinson et al. 2005; Iverson et al. 2007; Ryan et al. 2013). Van Lear (2004) points out that with long-term fire exclusion, the fuel bed becomes increasingly wet; when wetter fuels are coupled with cooler temperatures caused by canopy closure, flammability is reduced to such a degree that beginning a new prescribed fire regime can be extremely difficult. Ryan et al. (2013) emphasized that continuous fine, dry fuels are required for natural fires to occur in an ecosystem; while closed-canopy forests may accumulate sufficient fuel bed continuity, these fuels are rarely dry enough to burn under prescription. This could be one of the reasons that the fires at LBL had little impact on the midstory.

In order to make more informed management decisions, there should be a few other considerations when studying fire at LBL in the future. Future studies should consider the effects of mechanical thinning along with prescribed fire. LBL has included mechanical thinning as a management tool in their management plan, so it would be beneficial to study how this aids in meeting their goals for forest structure and composition (USFS 2004). Future studies should also consider the timing, frequency, and intensity of burning at LBL. These characteristics are known to influence the overall structure and species composition following a prescribed fire (Abrams 2000; Iverson et al. 2007; Knapp et al. 2009).

MANAGEMENT IMPLICATIONS

Literature supports that low intensity prescribed burns will not reduce the midstory or overstory (Waldrop et al. 1992; Van Lear 2004; Hutchinson et al. 2005; Iverson et al. 2007; Ryan et al. 2013; Harper et al. 2016). With a dense midstory and overstory, sufficient light cannot reach the understory to initiate the growth of forbs and grasses in the understory. One solution to this problem is to increase the intensity of prescribed fires (Harper et al. 2016). However, this strategy poses a risk to the health and quality of overstory trees. LBL has established goals for removing overstory trees for timber sales, so damaging trees with fire would reduce the quality of trees that could otherwise produce revenue. Instead of increasing the intensity of fires, LBL could increase the frequency of fires. Frequent, low intensity prescribed fires coupled with mechanical thinning can produce the forest structure results that LBL has laid out in their plan (Peterson and Reich 2001; Hutchinson et al. 2005; Harper et al. 2016).

Deciding on a fire interval requires consideration of the wildlife goals of an area. Harper et al. (2016) suggest a 5-7 year interval for a woody understory that benefits songbirds. However, if LBL wants to create a woodland or savanna forest structure, a shorter fire return interval (3-5 years) is ideal (Peterson and Reich 2001; Harper et al. 2016). Multiple fire regimes could be used in an area to create a heterogeneous landscape that benefits a wide variety of types of wildlife. If a fire return-interval is too frequent it may inhibit the growth of soft mass and woody plant species that are important food and habitat for wildlife. Too long of a fire return interval and the effects of mesophication begin to occur.

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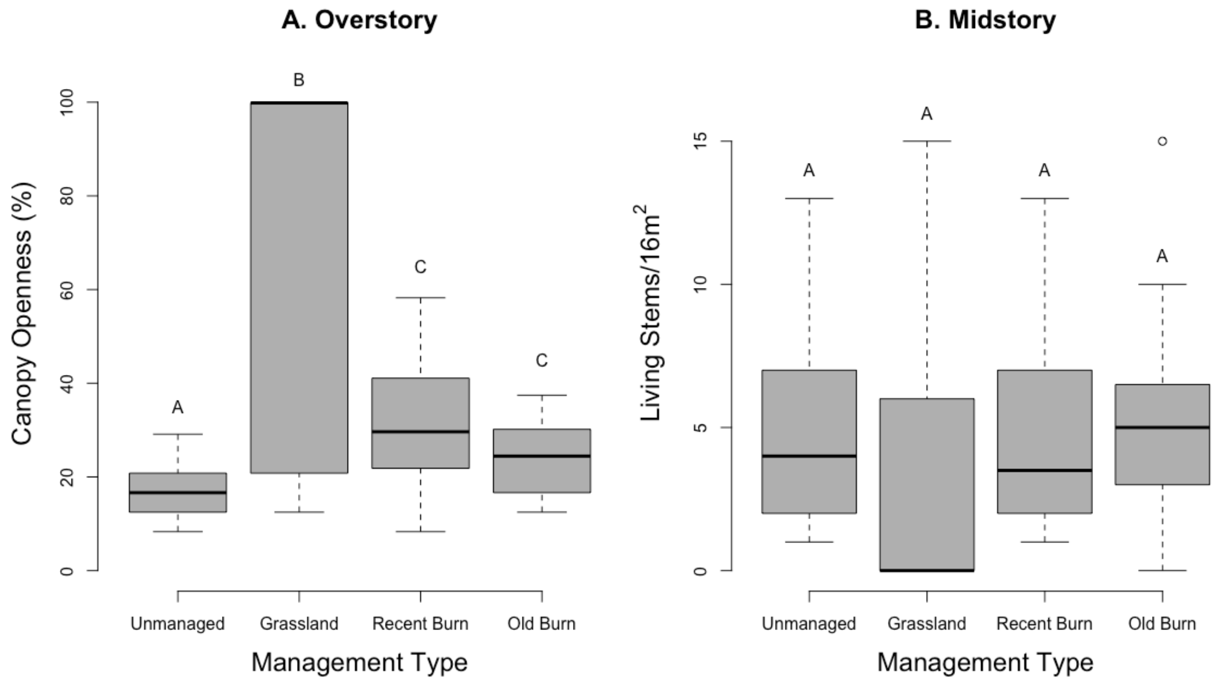

Figure 1. Mean canopy openness in the overstory (A) and mean density of living stems in the midstory (B) among the difference management types at Land Between the Lakes National Recreation Area. Letters above each box represent differences as per Tukey post-hoc tests. Error bars represent the minimum and maximum non-outlier data points.

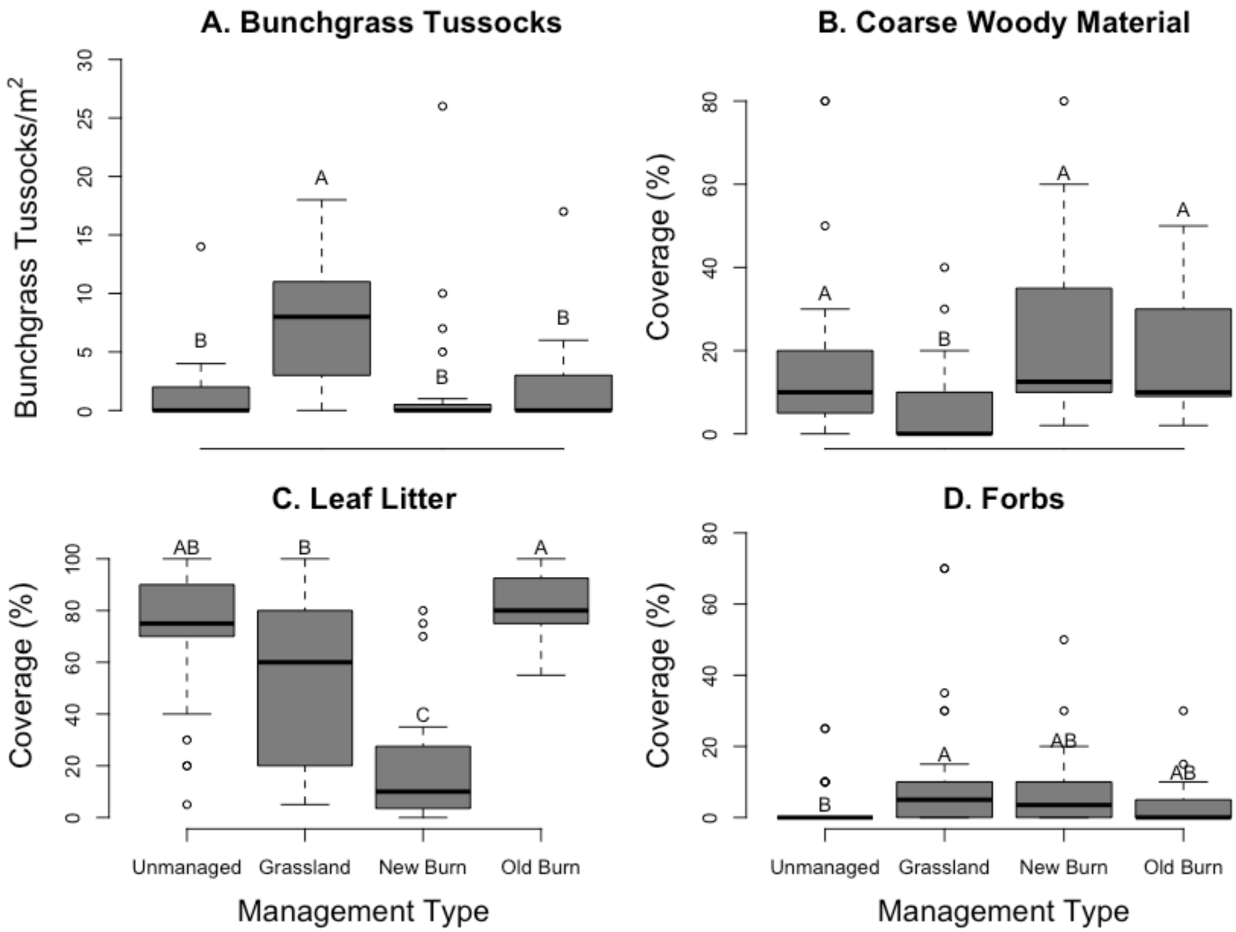

Figure 2. Characteristics related to understory vegetation at 4 management types at Land Between the Lakes National Recreation Area, including: (A) number of bunchgrass tussocks/m^2, (B) percent coverage of coarse woody material, (C) percent coverage of leaf litter, and (D) percent coverage by forbs. Letters above each box represent the results from Tukey's HSD post hoc tests. Error bars represent the minimum and maximum non-outlier data points.

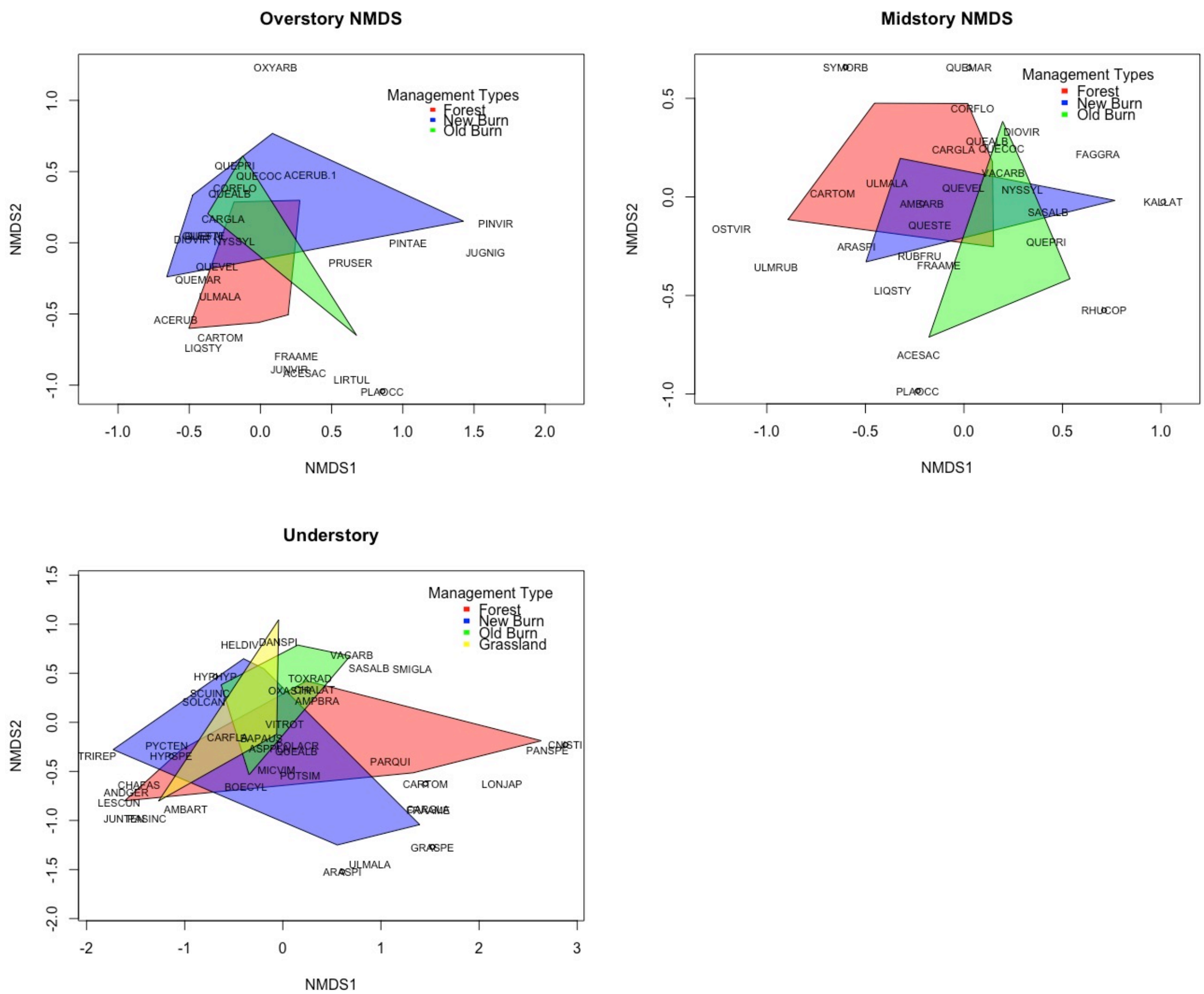

Figure 3. NMDS plots of the species of trees, shrubs, and herbaceous plants found in the overstory, midstory, and understory. Polygons represent the management types.

ACERUB	*Acer rubrum*	Red maple
ACESAC	*Acer saccharum*	Sugar maple
AGEALT	*Ageratina altissima*	Snake root
ALBJUL	*Albizia julibrissin*	Silk tree
AMBART	*Ambrosia artemisiifolia*	Common ragweed
AMEARB	*Amelanchier arborea*	Serviceberry
AMPBRA	*Amphicarpaea bracteata*	Hog peanut
ANDGER)	*Andropogen gerardii*	Big bluestem
ARASPI	*Aralia spinosa*	Devil's walking stick
ASITRI	*Asimina triloba*	Pawpaw
ASPPLA	*Asplenium platyneuron*	Ebony spleenwort
BAPAUS	*Baptisia australis*	Blue wild indigo
BOECYL	*Boehmeria cylindrica*	False nettle
CARFLA	*Carex flacca*	Blue sedge
CARGLA	*Carya glabra*	Pignut hickory
CAROVA	*Carya ovata*	Shagbark hickory
CARTOM	*Carya tomentosa*	White hickory
CELOCC	*Celtis occidentalis*	Common hackberry
CERCAN	*Cercis canadensis*	Eastern redbud
CHAFAS	*Chamaecrista fasciculata*	Patridge pea
CHALAT	*Chasmanthium latifolium*	Woodoats
CNISTI	*Cnidoscolus stimulosus*	Bull nettle
CORFLO	*Cornus florida*	Flowering dogwood
DANSPI	*Danthiona spicat*a	Poverty oat grass
DIOVIR	*Diospyros virginiana*	Common persimmon
ELAUMB	*Elaeagnus umbellata*	Japanese silverberry
FAGGRA	*Fagus grandifolia*	American beech
FRAAME	*Fraxinus americana*	White ash
GLETRI	*Gleditsia triancanthos*	Honey locust
HELDIV	*Helianthus divaricatus*	Woodland sunflower
HYPHYP	*Hypericum hypericoides*	St. Andrew's cross
JUGNIG	*Juglans nigra*	Eastern black walnut
JUNTEN	*Juncus tenuis*	Slender rush
JUNVIR	*Juniperus virginiana*	Red cedar
KALLAT	*Kalmia latifolia*	Mountain-laurel
LESCUN	*Lespedeza cuneata*	Chinese bushclover
LINBEN	*Lindera benzoin*	Spicebush
LIQSTY	*Liquidambar styraciflua*	Sweetgum
LIRTUL	*Liriodendron tulipifera*	Tuliptree
LONJAP	*Lonicera japonica*	Japanese honeysuckle

MICVIM	*Microstegium vimineum*	Japanese stillgrass
NYSSYL	*Nyssa sylvatica*	Blackgum
OSTVIR	*Ostrya virginiana*	American hophornbeam
OXASTR	*Oxalis stricta*	Yellow wood sorrel
OXYARB	*Oxydendrum arboreum*	Sourwood
PANSPE	*Panicum species*	Panic grass
PARQUI	*Parthenocissus quinquefolia*	Virginia creeper
PASINC	*Passiflora incarnata*	Maypop
PHYAME	*Phytolacca americana*	American pokeweed
PINTAE	*Pinus taeda*	Loblolly pine
PINVIR	*Pinus virginiana*	Virginia pine
PLAOCC	*Platanus americana*	American plane
POLACR	*Polystichum acrostichoides*	Christmas fern
POTSIM	*Potentilla simplex*	Common cinquefoil
PRUSER	*Prunus serontina*	Black cherry
PYCTEN	*Pycnanthemum tenuifolium*	Narrowleaf mountain mint
QUEALB	*Quercus albra*	White oak
QUECOC	*Quercus coccinea*	Scarlet oak
QUEFAL	*Quercus falcata*	Spanish oak
QUEMAR	*Quercus marilandica*	Blackjack oak
QUEPRI	*Quercus prinus*	Chestnut oak
QUESTE	*Quercus stellata*	Post oak
QUEVEL	*Quercus velutina*	Eastern black oak
RHUCOP	*Rhus copallinum*	Winged sumac
ROBPSE	*Robinia pseudoacacia*	Black locust
RUBFRU	*Rubus fruticosus*	Blackberry
SABANG	*Sabatia angularis*	Rosepink
SAMCAN	*Sambucus canadensis*	Elderberry
SASALB	*Sassafras albidum*	Sassafras
SCUINC	*Scutellaria incana*	Downy skullcap
SMIGLA	*Simlax glauca*	Glaucous-leaved greenbriar
SOLCAN	*Solidago canadensis*	Canada golden-rod
SORNUT	*Sorghastrum nutans*	Indian grass
SPIVIR	*Spiraea virginiana*	Virginia meadowsweet
SYMORB	*Symphoricarpos orbiculatus*	Coralberry
TOXRAD	*Toxicodendron radicans*	Poison ivy
TRAVIR	*Tradescantia virginiana*	Virginia spiderwort
TRIREP	*Trifolium repens*	White clover
ULMALA	*Ulmus alata*	Winged elm
ULMRUB	*Ulmus rubra*	Slippery elm

VACARB	*Vaccinium arboreum*	Sparkleberry
VIOSOR	*Viola sororia*	Common blue violet
VITAES	*Vitis aestivalis*	Summergrape
VITROT	*Vitis rotundifolia*	Muscodine