Beyond the Timberline: Assessment of Supplemental Income Opportunities, Forest Management Practices, and Attributes of Southern Pine Straw Types

by

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Abstract

Of Alabama's 23 million acres of timberland, over 13 million acres of it is owned by family forest landowners. Therefore, they play a pivotal role in the future of Alabama's forest. Due to a combination of shift in ownership and land degradation, timberland is being separated into small tracts. Management is likely deficient, as smaller tracts are less likely to have a management plan or received forest management advice. By educating and improving alternative income opportunities, this enables landowners to manage their land to support healthy, sustainable forests. A common opportunity within the Southeast is pine straw. With correct management practices, landowners can take advantage of this enterprise and earn a reliable, annual income. For the proposed study, there are two objectives. First, it is imperative to get a better understanding of what motivates landowners regarding forest management, how supplemental income opportunities are managed, and what are their perspectives regarding markets for alternative income opportunities. Second, it is important to understand the differences among the three most used pine straw species, longleaf, slash, and loblolly, used for mulch in the Southeast.

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List of Abbreviations

AFC	Alabama Forestry Commission
CNH	Control with no herbicide
CWH	Control with herbicide
FFLs	Family forestland owners
LB	Loblolly pine
LL	Longleaf pine
NIPF	Nonindustrial private forest
NTFP	Non-timber forest product
SL	Slash pine

Chapter 1

Introduction

Within the United States, private forest owners hold approximately 56% (423 million acres) of the country's forestland (Butler 2008). In the southern United States, private landowners hold approximately 86% of the forestland (Wear and Greis 2013). Approximately 6.5% of Alabama's timberland is publicly owned and 94% of it is privately owned. Of the privately owned land, approximately 6% of it is owned by forest industries and 87% of it is owned by non-industrial private sector (AFC 2018).

Within Alabama, there are approximately 23 million acres of timberland, which ranks second among the 48 contiguous states in private timberland coverage. Approximately 94% of the timberland in Alabama is privately owned (AFC 2019). Much of Alabama's private timberland (88%) is owned by non-industrial private forest (NIPF) landowners (AFC 2018). Of the NIPF landowners in Alabama, approximately 70% are family forestland owners (FFLs) that make up 60% of the total timberland (Butler and Butler 2016). FFLs include individuals, families, trusts, and estates, and they are unique in that they have diverse backgrounds, experiences, a wide range of management objectives, and a variety of reasons for owning their land (Zhou 2010).

The Southeast is considered the wood basket of the United States (Schultz 1997) and Alabama is an important contributor. Alabama is third in overall timberland acreage (AFC 2018) and second in private timberland acreage in the United States (AFC 2019). Therefore, private forest landowners, specifically FFLs, have a significant role in determining the future of forests, wildlife, and the forest products industry within Alabama, the Southeast, and across the United States. Further, in addition to land degradation from population growth and a generation shift,

increased frequency and severity of drought, severe weather events, catastrophic wildfires, insects and diseases, and invasive species are expected to pose threats to southern forests in the coming years (Wear and Greis 2012). Managed forests in good health and vigor are better equipped to withstand such threats, but appropriate landowner education and involvement is needed (Megalos 2016). Due to timberland increasingly being separated into smaller tracts (Wear et al. 2007), it makes them more difficult to manage and can cause a lack of management altogether, which can lead to increased degradation and loss of opportunity. Educating, supporting, and improving the opportunities for FFLs to manage their forest land and generate supplemental income will increase their livelihoods and support the health and sustainability of forests and the demand for forest products in the years to come.

Though commercial forest management operations benefit forested communities in several ways, conversions from native forest to pine plantations, can be less favorable for producing non-timber forest products (NTFPs) and other additional income opportunities for FFLs (Joshi et al. 2000). Additionally, these types of transitions can contribute to forest health issues (Asaro et al. 2017). Though intensively managed forests have been linked to increased early successional habitat, which some wildlife species need (Jones et al. 2009), and reduced timber health hazards and pests (Asaro et al. 2017), FFLs that choose to establish plantations may not maintain the proper management practices due to lack of knowledge, lack of financial incentive from depressed timber markets, or costs associated with management practices. This lack of appropriate management practices can cause increased risks from disease, insect attacks, drought, and wildfire (Amacher et al. 2005) that negatively impact wildlife habitat (Owens et al. 2014) and tree growth (Moser et al. 2003).

There are many alternative income opportunities for FFLs, such as recreation activities, NTFPs, agritourism, and silvopasture. NTFPs are comprised of plants, fungi, and other flora materials, and these products do not include wildlife or other fauna (Chamberlain and Predny 2003). Many parts of plants and fungi, such as roots, tubers, branches, sap, and small diameter wood, are harvested for monetary gain or personal enjoyment (Chamberlain et al. 2018). NTFPs can be classified into the following five categories: culinary, decorative, medicinal, nursery stock and landscaping, and fine arts and crafts (Barlow et al 2015). From several market categories, the following are some notable species that are sold and marketed within the United States: beargrass (*Xerophyllum tenax*) (decorative), sugar maple (*Acer saccharum*) (culinary), saw palmetto (*Serenoa repens*) (medicinal/ dietary), American ginseng (*Panax quinquefolius*) (medicinal/ dietary), balsam fir (*Abies balsamea*) (decorative), Frasier fir (*Abies fraseri*) (nursery stock and landscaping), paper birch (*Betula papyrifera*) (fine arts and crafts) (Chamberlain et al. 2018).

Options for NTFP enterprises are dependent on the region where the NTFP and markets are present. In the Northeast and some parts of the Southeast and Midwest, a popular medicinal and dietary NTFP is American ginseng (Chamberlain et al. 2018). Knowledge of site conditions and native species and its requirements are essential for NTFP operations. Trendy NTFPs in the Southeast include the following: galax (*Galax urceolata*), pinecones (*Pinus spp.*), elderberry (*Sambucus nigra*), pine straw (*Pinus spp.*), and many others (Barlow et al. 2015). Though interest in managing forests for NTFPS has grown considerably, there is still very little known about the characteristics of raw materials, those who collect them, or the enterprises that market and produce them (Chamberlain and Predny 2003). An emerging NTFP category is nursery stock

and landscaping. In the Southeast, a common enterprise within in this NTFP category is pine straw.

Throughout much of the United States, organic mulches have been used for various landscaping and horticultural applications. One of the more common organic mulches used in the Southeast is pine straw, and it has gained a large popularity as an organic mulch. Pine straw helps insulate roots during extreme temperatures, reduces moisture loss, protects against soil compaction, and protects against wind and rain erosion (Taylor and Foster 2004a). It has also been found that pine needles can interlock, which helps the mulch remain in place during rain and wind events (Taylor and Foster 2004a).

There are three common pine species that are used for their pine straw, longleaf pine (*Pinus* palustris Mill.), slash pine (*Pinus elliottii* Engelm.), and loblolly pine (*Pinus taeda* L.). These three pine species are often grown by landowners in across the Southeast, which goes to explain why these three species are used for mulch purposes (Dyer 2012).

Loblolly pine is a medium to large sized evergreen conifer that is distributed throughout much of the southeastern United States (Carey 1992c). It is considered to be the most commercially important forest species in the South, and its native range stretches across 14 states, from Southern New Jersey to central Florida to eastern Texas (Langdon 1990). It can grow in a variety of soils, but it will grow best in soils that are moderately acidic and have poor drainage (Carey 1992c). In the southern United States, this pine species makes up more than one half of the standing pine volume and is dominant on an estimated 29 million acres (Langdon 1990). Loblolly pine trees are often used for wind barriers, soil stabilization, timber, and pine straw (Carey 1992c). Loblolly pine is characterized by 12.7 to 23.9 cm needles with usually three, occasionally four, needles per fascicle. Loblolly pine is commonly used for timber and

wildlife habitat species in a natural setting and shade trees and wind and noise barriers in an urban setting (Langdon 1990). Anecdotally, it seems to be the least desirable of the three species in terms of mulch.

Longleaf pine is a long-lived evergreen conifer found in the in Atlantic and Gulf coastal plains, Piedmont region of Georgia and Alabama, and the Valley and Ridge Province of Georgia and Alabama (Carey 1992b). Its native range extends from southeastern Virginia to eastern Texas to the central and upper portions of Florida (Boyer 1990). Longleaf pine commonly grows on sandy, well drained soils, and it is intolerant of both shade and competition (Carey 1992b). In the past, longleaf pine was estimated to occupy 60 million acres, but, in more recent times, it is only estimated to occupy 4 million acres (Boyer 1990). Fire is required for the longleaf pine establishment. Longleaf pine provides essential habitat for many wildlife species, can provide superior quality timber, and is popular in regard to pine straw. Longleaf pine is characterized by 20 to 46 cm needles, with usually three needles per fascicle. It is used for a broad range of forest products, including habitat for wildlife, cattle operations, and pine straw (Boyer 1990). It is a common organic mulch and seems to be favorite among pine straw producers. Largely anecdotal, reasons for this are said to be due to longer needle length, better color retention, and slower rate of decomposition (McConnell 2016).

The slash pine is an evergreen conifer found in the coastal plains of South Carolina to as south as Florida and as west as eastern Texas (Carey 1992a). Its native range, which is the smallest of the three pine species, extends from the southernmost counties of South Carolina south to central Florida, and west to Tangipoa Parrish Louisiana (Lohrey 1990). Slash pine grows in moist soils that have poor drainage, and it is used for soil stabilization, resin production, and timber production (Carey 1992a). It was one of most planted timber species in North

America in the past (Lohrey 1990). The slash pine is characterized by 15 to 30 cm needles with usually two, occasionally three, needles per fascicle. Slash pine is used for resin and turpentine, cattle grazing operations, protection for wildlife during inclement weather, and pine straw (Lohrey 1990). Anecdotally, it seems to be the in the middle of the three pine species in terms of desirable as a mulch.

Mulch, in general, is defined as the materials that are applied to, or grow upon, the soil surface (Chalker-Scott 2007). Mulch can be classified into organic and inorganic. Commonly used organic mulches are wood chips, shredded bark, pine straw, wheat straw, and compost. Organic mulches are commonly used in residential and commercial landscaping applications. Improved soil properties, weed suppression, plant growth and survival, and its ability to add aesthetic value are common objectives for applying mulch (Rose and Smith 2009). Numerous studies have been done concerning the effects of mulch on these objectives, as well as, studies concerning the effects of mulch on insect repellency, decomposition of mulch, and mulch resistance to offsite movement due to wind and water.

Mulch can provide several benefits, such as improved soil moisture and maintenance of soil temperatures. When exposed to the elements, bare soil loses water by evapotranspiration, but, when mulched, it has a higher soil moisture due to increased percolation and retention and decreased evapotranspiration (Chalker-Scott 2007). Soil temperature is also affected by mulch. The amount of heat that is exchanged between soil and its surface determines the soil temperature. Compared to a mulched soil, non-mulched soils have been reported as much as 10˚C warmer (Greenly and Rakow 1995). Mulches can also affect nutrient availability by way of decomposing or leaching. As pine straw decomposes, nutrients such as potassium (K), nitrogen (N), and phosphorus (P) are released into the soil (Blevins et al. 1996).

Mulch can have an impact on weed suppression, and the size of the mulch can play an important role in determining the effectiveness of weed suppression. In a study conducted by Maggard et al. (2012), all mulched treatments were able to reduce weed growth relative to non-mulched plots, but finer mulches were the least effective in the suppression of weeds. Similar results of coarser mulch being more effective in reducing weed population numbers than other mulches were supported by Billeaud and Zajicek (1989) and Greenly and Rakow (1995).

Mulch can influence tree growth. Typically, tree growth increases due to the benefits that mulching provide, such as reduced competition from weeds, increased water availability, and increased nutrient availability. Factors such as mulch depth and presence of mulch can play roles in tree growth. A study by Greenly and Rakow (1995) showed that the overall depth of mulch plays a pivotal role within shoot growth, where mulch placed at a depth of 7.5cm increased shoot growth than other depths. Green and Watson (1989) showed that mulched trees appeared to be larger, greener, and less stressed and had larger crowns than those that were not mulched. When mulched, trees can have an increase in overall tree growth in diameter and/or height, as a result from suppression of weed germination and establishment (Maggard et al. 2012).

Decomposition rates of organic mulches have impacts on aesthetic and economic values, as well as soil and plant benefits. Typically, as organic mulches decompose, nutrients are released into the soil, which can affect soil fertility. The rate at which an organic mulch decomposes affects the rate to which nutrients are released into the soil. There are few studies that have tested the decomposition rates of organic mulches. Duryea et al. (1995) tested six landscaping mulches, cypress, eucalyptus, melaleuca, pine bark, pine needle and utility trimming mulch (GRU), and found that eucalyptus and GRU mulches decomposed the most after one year,

21% and 32% respectively, and the other mulches decomposed between the rates of 3% and 7%.

Regarding pine straw, there is very little research that looks at the decomposition of pine needles in a landscape setting. However, there are a few studies that look at the decomposition rates of pine needles in a forest setting. In the southern United States, slash pine needle decomposition averaged a decay rate of 15% mass loss per year (Gholz et al. 1985). In a study by Sanchez (2001), mean decay rate for loblolly pine needles after three years was 33%. The rate and effect of mulch decomposition can affect its effectiveness in the environment and could potentially affect the price behind it.

The purpose of this thesis is to assess FFLs in Alabama to gain knowledge about alternative income generating opportunities on forest land, better understand forestland owners' motivation, or lack thereof, for managing forestland, provide information on and compare the attributes of pine straw mulch produced by longleaf, slash, and loblolly pines, and to educate landowners and consultants on the significant opportunities in Alabama to generate alternative income from their forestland and management practices associated with pine straw productions and markets. To achieve these research objectives, the thesis presents the results of two surveys and a study:

1. The first survey focused on gaining information about forest ownership, income practices, and management practices.
2. The second survey focused on gaining more detailed information about alternative income opportunities and other information that was not covered in the initial survey.
3. The field study that compared the attributes of pine straw in a landscape setting from three common southern pine species (longleaf, loblolly, slash) often used by the pine straw industry.

Chapter 2

Assessment of family forest owners, forest management practices, and alternative income opportunities in Alabama

2.1 Introduction

Alabama has a total land area of approximately 32 million acres, and of that total land area, timberland accounts for approximately 23 million acres (71%). Approximately 94% of the timberland in the state is privately owned. FFLs hold significant amounts of forestland within Alabama. Therefore, FFLs are vitally important to the future of natural resources within the state.

In general, it has been found that FFLs with fewer than 10 acres of land often use it for residential or developmental purposes, while FFLs with greater than 500 acres are more likely to have goals and objectives driven by timber production (Zhou 2010). In Alabama, FFLs who own between 10 and 500 acres make up 98% of the total family forest ownerships (Butler and Butler 2016). Zhou (2010) found that FFLs in Alabama that own between 10 and 500 acres own it for a variety of reasons and not for economic reasons alone. Specifically, the top three reasons statewide for owning their forest land were non-timber related and consisted of passing the land on to heirs (legacy), enjoying the beauty and scenery, and for hunting and fishing (including protecting and/or improving wildlife habitat) (Zhou 2010). Additionally, Zhou (2010) found that reasons for owning forestland were different among the regions of the state. Reasons for owning in the northern regions of the state were similar to the overall statewide reasons, with legacy and the aesthetic values of beauty and scenery as two of the top reasons for owning. Within the central region, legacy and hunting and fishing were the top two reasons for owning. However, timber production was viewed as a higher importance in the central region than the northern

region. In the southern region, legacy, timber production, and hunting and fishing were among the top reasons for owning. Timber production was the highest importance in the southern region relative to the central and northern regions, as it was the second most important reason. FFLs in the northern region were more likely to focus on non- timber-based reasons, and FFLs in the southern region were more likely to focus on timber-based reasons. This is likely due to historical land practices, location of timber markets, and site productivity. Historically, timber production has been predominant within the southern region of Alabama.

The National Woodland Owners Survey (NWOS) found similar results for FFLs in Alabama (Butler et al. 2016). It also reported similar results for the southeastern United States and for the entire country. FFLs make-up approximately 58% of all forest owners in the Southeast and 43% of all forest owners in the United States. The only main difference found between that of the Southeast and the United States was that legacy was of a higher importance to FFLs for owning their land in the Southeast and enjoying beauty and scenery was found to be the highest importance across the United States (Butler et al. 2016).

Due to a combination of land degradation and a generation shift, timberland is being separated into smaller tracts and management is likely deficient (Butler 2011). As of 2013, it was reported that 12%, 12%, and 13% of FFLs had a written management plan in Alabama, the Southeast, and the United States, respectively, and lack of knowledge, ability, and fear of wrongdoing (Butler 2011), costs, and weakness of timber markets are some of the reasons contributing to this result. Effective engagement in educating and motivating FFLs about the importance of managing their land and taking steps to implement and maintain it is important for improving the health and resiliency of forests, wildlife species and their habitat, and meeting the current and future demand for timber products. In turn, educating FFLs on business planning and

operating, alternative markets for forest owners, and improving income generating opportunities will not only contribute to their overall economic well-being, but also provide the opportunities needed to generate revenue that can support their overall goals and desires as FFLs, as well as improve the health and sustainability of their forest resource.

Non-timber forest products (NTFP) and recreation activities are two popular alternative income opportunities. Non-timber forest products (NTFP) offer a wide range of alternative income opportunities for FFLs. NTFP can be placed into the following five categories, edible and culinary, specialty wood, medicinal and dietary supplement, and landscaping (Barlow et al. 2015).

Recreation activities are a popular way to generate alternative income from forestland. One of the most common recreational enterprises in Alabama and across the Southeast is leasing land for hunting rights. Demand for quality hunting areas has created a vast market and an incentive for family forest owners to consider this alternative income enterprise (Harper et al. 1999). Hunting leases have several advantages for FFLs, such as reliable stream of income, reduction in trespass problems, and help in managing wildlife habitat, but they also have some disadvantages. These include increased liability and insurance, potential conflicts with other forest operations, and increased investment related to habitat management and accessibility (Miller 2016). With each alternative income opportunity, there is a need for proper forest management practices.

FFL decisions about their forests are influenced by economics, aesthetics, personal values, whether they live on property or not, recreation of various forms, and social factors. It is recognized that actions of landowners are important factors in determining outcomes of conservation goals (Bean and Wilcove 1997; James 2002). Some FFLs, fearing restrictions to

land use, may alter property management in an effort to eliminate species of concern (Wilcove et al. 1996). Economic theory suggests conservation is more likely to occur when there is the possibility of monetary benefits (Makowski et al. 1990; Benson 1991). If there is a monetary cost to conservation, activities to promote it are less likely to occur (Carr and Tait 1991; McCann et al. 1997).

This study seeks to better understand alternative income generating opportunities other than timber, forest management activity and philosophies of FFLs in Alabama. Information from this study will also increase our understanding on why forest management is deficient for this group of landowners. A better understanding of this information will allow natural resource professionals to better bridge the gap among sound forest management, healthy forests and producing revenue. Further, this study will focus on educating FFLs about the importance of healthy, more resilient forests, forest management processes, business management, and supplemental income opportunities that can increase their economic well-being and potentially support the costs associated with managing their forests. This may help motivate FFLs to implement forest management practices, which, in-turn, will lead to healthier forests and improve the livelihood of these citizens.

The overall objective of this project is to assess FFLs in Alabama to gain knowledge about alternative income generating opportunities on forest lands and to better understand their motivation, or lack thereof, for managing their forestland. Specific aims of the project are to better understand how revenue generating sources are managed, assess FFLs' views on the financial aspects and markets for such sources, recognize issues and concerns these FFLs have, and to better understand their forest management philosophy. To address these aims and the overall objective of this project, we developed a questionnaire to gain further information

regarding FFLs' characteristics, reasons for owning, income generation, forest management practices, and concerns with forestland. We developed a second questionnaire to hone in on some of the preliminary data from the first questionnaire and obtain more information on alternative income generation. This provides important information so natural resource professionals can successfully educate, address, and support the needs of these FFLs through research, outreach, and extension. Outcomes of these surveys will be directly translatable to FFLs and the enhancement of their livelihoods through the betterment of forest management, business practices, and increased opportunities for producing income.

2.2 Methods

The first questionnaire was developed to obtain more information regarding reasons for owning, income generation, as a whole, forest management actions, concerns, and philosophy, and descriptive information about family forest landowners. This survey's administration followed the Dillman's Tailored Design Method, which utilizes a pre-notice letter, first-round survey packet, reminder letter, and a second-round survey packet, to administer the surveys (Dillman 2000). All components from the survey, its documents, and its protocols were approved by the Auburn University's Institutional Review Board.

In fall 2018, the first survey process was initiated. A random sample of 1,000 FFLs in Alabama who own at least 10 acres of forestland was obtained from county tax roll records. FFLs selected for the sample were mailed a pre-notice letter in August of 2018. Within approximately 10 business days from mailing the pre-notice letter, a cover letter, the main questionnaire, and a prepaid return envelope was mailed to all addresses deemed valid. Within approximately 15 business days from mailing the cover letter and questionnaire, a reminder letter and another copy of the questionnaire was mailed. An on-line version of the questionnaire was

also available, and the link was included in the cover letter and reminder letter mailed to each FFL. The information letter provided further details about the study, the IRB protocol number and dates, and explanation that participation within this study was completely voluntary. Invalid addresses were accounted for, and incomplete surveys and surveys with missing data were excluded from analysis.

Using a 0.05 alpha level to test for statistical significance, several nonparametric statistical tests were used. Based on the data type (categorical, ordinal, continuous, etc.), the appropriate nonparametric statistical test was conducted using R Studio. For the nonparametric measures of correlation, Spearman Rho (ρ) was used. To determine if there were any statistically significant differences in ordinal responses among groups, the Mann- Whitney U Test was used.

This survey was expected to take approximately 15 minutes to complete. The survey questions consisted of multiple choice and fill in the blank. Questions in the survey were formed and guided by the need to better understand how many FFLs generate income from their forestland, how they manage such practices or businesses, the financial aspects involved in their decision making, experiences with past and present markets, the views on future markets, concerns and issues with operating a forest enterprise, and past, current, and future forest management philosophy and plans. The first survey is available in Appendix A. Its pre-notice letter is found in Appendix B, the cover letter is found in Appendix C, and the reminder letter is found in Appendix D.

2.3 Results

Assessment of FFLs and Income Generation

In total, there were 192 responses and 45 surveys that were returned due to invalid address. This yielded a response rate of 19.2%. 57 of the 192 responses were ones that stated that

they wished not to participate. Missing data from returned surveys were excluded from each analysis. Respondents were categorized based on forestland area owned. Forest ownerships ranged from a minimum of 10 acres to a maximum of 80,000 acres, with an overall median of 114.5 acres. When forest ownership was classified into categories, the largest category was 10 to 50 acres, which consisted of 27% of respondents (Fig. 1).

Respondents were asked to select their primary reason for owning forestland. A range of options were provided for respondents to choose from. The primary reason for owning forestland was variable, however, the top three reasons were timber production (43.0%), hunting and/or fishing (38.0%), and where you live (25.6%) (Fig 2). It should be noted that several of the respondents gave more than one reason as the primary reason for owning their forestland.

Respondents were then asked a series of questions regarding income generation from their forestland. Respondents were asked to rank their interests in generating income from their forestland on a 5-point Likert scale, with 1 = definitely not interested and 5 = definitely interested. The majority of respondents (85.1%) indicated that they were at least moderately interested in generating income from their forestland (Fig. 3). Respondents were then asked whether they generated any form of income from their forestland. 61.7% of respondents do not any generate income from their forestland. As number of acres owned increases, percent of respondents that generate income from their forestland increases and percent of respondents that do not, decreases (Fig. 4). Based from the responses to this question, FFLs were divided into two groups, those that generate income and those that do not.

For those that generated income from their forestland, another series of questions were asked regarding the income source from their forestland. Participants were asked to rank their interest in continuing to generate income from their forestland, with 1 = definitely not interested

and 5 = definitely interested. It was clear that those that generate income from their forestland want to continue to do so, as 97.8% of respondents selected “probably yes” or “definitely yes” (Fig. 5). Participants were asked how much income they generated annually from timber harvests, but there was not enough information to adequately answer this question. Most of these respondents that generated income (93.3%) have generated income from timber harvest on their forestland. Timber harvest made up the majority of income generated from forestland for most forestland owners (63.9%) (Fig. 6). Participants were asked how much income they generated annually from means other than timber harvests, but there was not enough information to adequately answer this question. Additionally, 60% of respondents who generated income from their forestland have done so by means other than timber harvest. Income generation from means other than timber harvest made up 20% or less of the total income generate for most forestland owners (71.4%) (Fig. 7). Among those respondents that generated income on their forestland from sources other than timber harvest, the top three sources selected based on percent response were hunting and fishing leases (75%), other (29%), and pine straw (17%) (Fig. 8). The “other” category consisted of a variety of responses including honey production, conservation reserve programs (CRP), cattle grazing, and entertainment such as for parties and weddings. Lastly, forestland owners that generated income from means other than timber harvests were asked to rank the market availability of products on a five point Likert scale (1 = very weak, 5 = very strong), how they sell their products, how much acreage they have to produce their products, and how much revenue they generated from the income activity. However, there was not enough

responses to these questions to include them in the assessment as each of these questions had fewer than 10 responses.

Assessment of Forest Management Practices and Forest Health Concerns

Participants were asked to rank the importance of forest management, with 1 = not at all important and 5 = extremely important. The majority of respondents (69.0%) view forest management as "extremely important" compared to 4.0% of respondents who view forest management as "not important at all" (Fig. 9). Similarly, the majority of respondents are concerned with the future of their forest and its condition as 89.3% selected they are at least "moderately concerned" about the health and resiliency of their forest (Fig. 10). Only 10.7% of respondents indicated little to no concern for the health and resiliency of their forest. For the FFLs that displayed at least a little concern regarding their forest's health and resiliency, a follow up question that addressed many different types of concerns was asked. The concern level was ranked on a five-point scale, with 1 = none at all and 5 = a great deal. The top three concerns based on percent respondents selecting a "great deal" were insects and disease (44.2%), invasive species (33.7%), and severe storm damage (27.4%) (Fig. 11).

Participants were then asked a series of questions about management activities of their forest. They were asked if they have ever received management advice, currently manage their forestland, and if they have a written management plan. Most respondents have received some sort of management advice (58.3%) about their forestland, and 69.8% of respondents currently

manage their forestland. However, 75.0% of respondents do not have a written management plan (Fig. 12).

For those that currently manage their forestland, the majority get assistance from a private consultant (47.3%), followed by state and local government (16.2%) (Fig. 13). However, the second greatest response was that they do not get assistance and manage their forestland and they do it on their own (29.7%) (Fig. 13). Further, when asked what they manage for, the top three based on percent responses were timber (83.8%), wildlife (75.7%), and recreation and fire protection, which both received 51.4 percent of responses (Fig. 14). For those that do not manage their forestland, the top reason, which received 52.0% of responses, was they did not know what to do or how to do it, followed by 20.0% that stated they were not interested (Fig. 15).

Relationships among Income Generation, Forest Management, and Forest Health and Resiliency

A series of statistical tests were conducted to analyze relationships among income generation, forest management, and forest health and resiliency. A series of Mann-Whitney U tests were used for dichotomous groups. When observing the mean ranks produced by the Mann-Whitney U tests, FFLs that generated income from their forestland owned significantly more forestland acres than their counterpart ($p < 0.001$) (Table 1). The results of the Mann-Whitney U tests for the ratings of importance of forest management between these two groups followed a similar trend. When observing the mean ranks produced, forestland owners that generated income viewed forest management as significantly more important than forestland owners that

did not generate income from their forestland ($p < 0.001$) (Table 2). The mean ranks produced for the rankings of concern between these groups showed no significant difference (Table 3).

Next, forest management was subject to a series of Mann-Whitney U tests. When observing the mean ranks produced by the Mann-Whitney U tests, FFLs that received forest management advice for their forestland owned significantly more forestland acres than their counterpart ($p < 0.001$) (Table 4). When observing the mean ranks produced by the Mann-Whitney U tests, FFLs that currently manage their forestland owned significantly more forestland acres than FFLs that do not ($p < 0.001$) (Table 5). Similarly, the mean ranks showed that forestland owners that had a written management plan owned significantly more forestland than forestland owners that did not have a written management plan ($p < 0.001$) (Table 6).

A number of correlations, specifically Spearman Rho, were tested among responses to questions regarding forest management, forest health and resiliency, and income generation. These correlations showed that there were significant, positive correlations between the rankings of interests in income generation and forest management importance ($p = 0.001$, $\rho = 0.478$), interest in income and concern for forest health and resiliency ($p = 0.03$, $\rho = 0.269$), and forest management importance and concern for forest health and resiliency ($p = 0.001$, $\rho = 0.601$) (Table 7).

Assessment of Carbon Sequestration and Incentive Programs

To further our assessment of alternative income opportunities and forest management, a series of questions were included to better understand FFLs perception of carbon sequestration and incentive programs in general. First, participants were asked how familiar they with carbon sequestration. The majority of FFLs (67.2%) were not familiar with carbon sequestration (Fig.

16). For those that were not familiar, a follow up question regarding the interest in learning about carbon sequestration was immediately asked after. Uncertainty was the most common selected response, as 32.5% of respondents chose that they "might or might not" be interested in learning about carbon sequestration. However, 40.0% of respondents chose either "probably yes" or "definitely yes" to learning about carbon sequestration (Fig. 17). For those that were familiar, a question regarding whether the landowner has managed for carbon was asked. The results showed the vast majority have not managed for carbon (95.0%). Uncertainty was the most common selected response, as 31.9% of respondents selected "might or might not" be interested in managing for carbon sequestration if there were incentives available (Fig. 18). However, 48.7% of respondents chose either "probably yes" or "definitely yes" in being interested in managing for carbon sequestration. Participants were then asked a couple of questions regarding incentive programs. First, they were asked if they have received incentives for their forestland. The majority of participants (86.0%) did not receive any incentives for their forestland. However, the larger ownerships, 1,000 plus acres, did have a large proportion of FFLs that received incentives (Fig. 19). FFLs were then asked about their interests in learning about incentive programs for their forestland. The majority of the respondents (68.6%) indicated that they were either "probably interested" or "definitely interested" (Fig. 20).

Figures and Tables

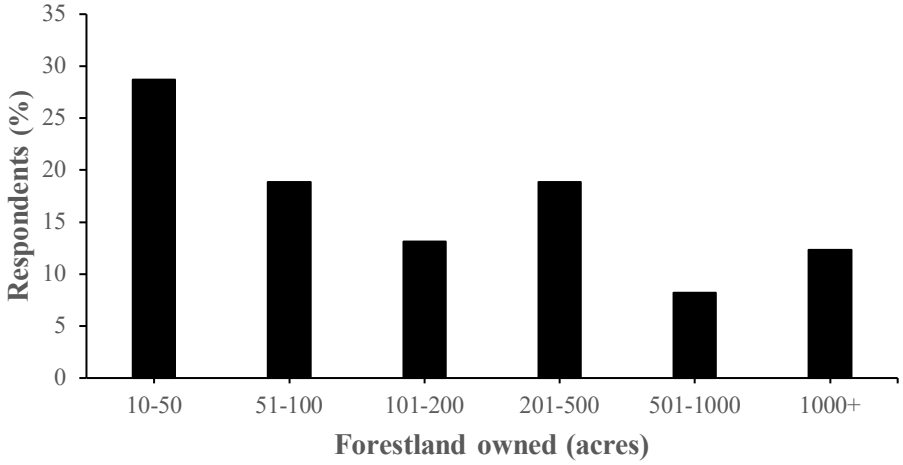

Figure 1: Classification of forestland acreage owned based on percent response from survey participants (n = 122).

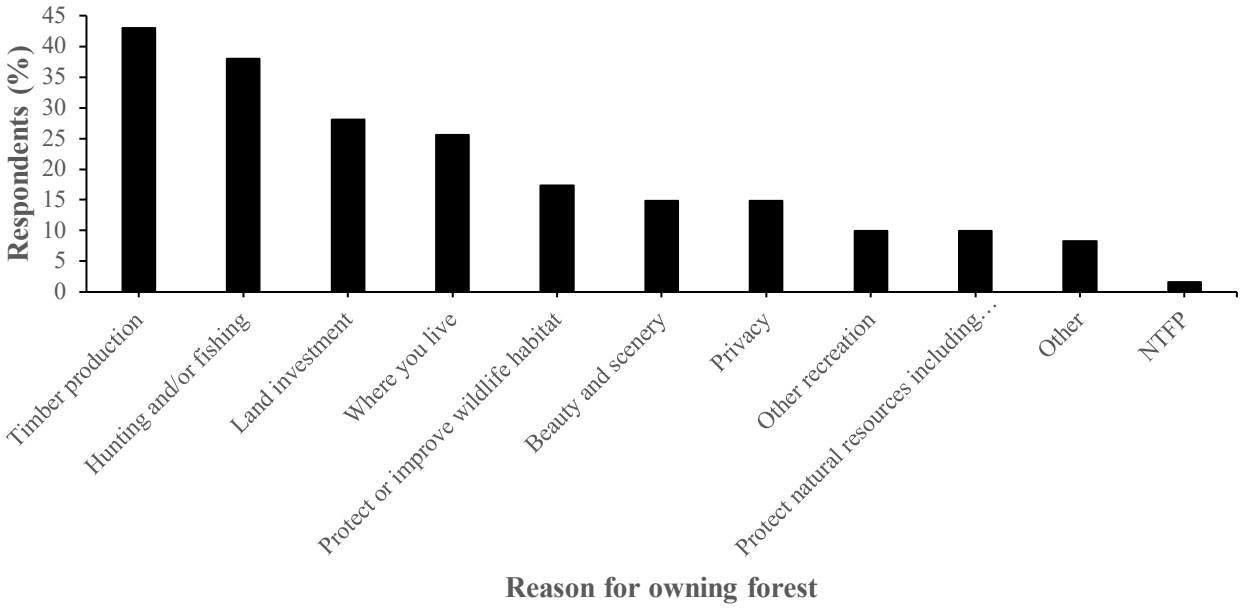

Figure 2: Primary reasons for owning forestland based on percent response from survey participants (n = 121).

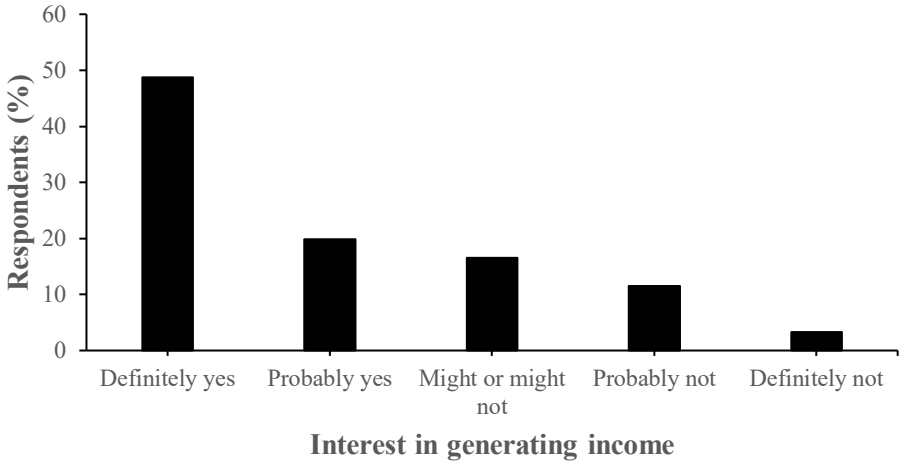

Figure 3: Interests in generating income from forestland based on percent response from survey participants (n = 121).

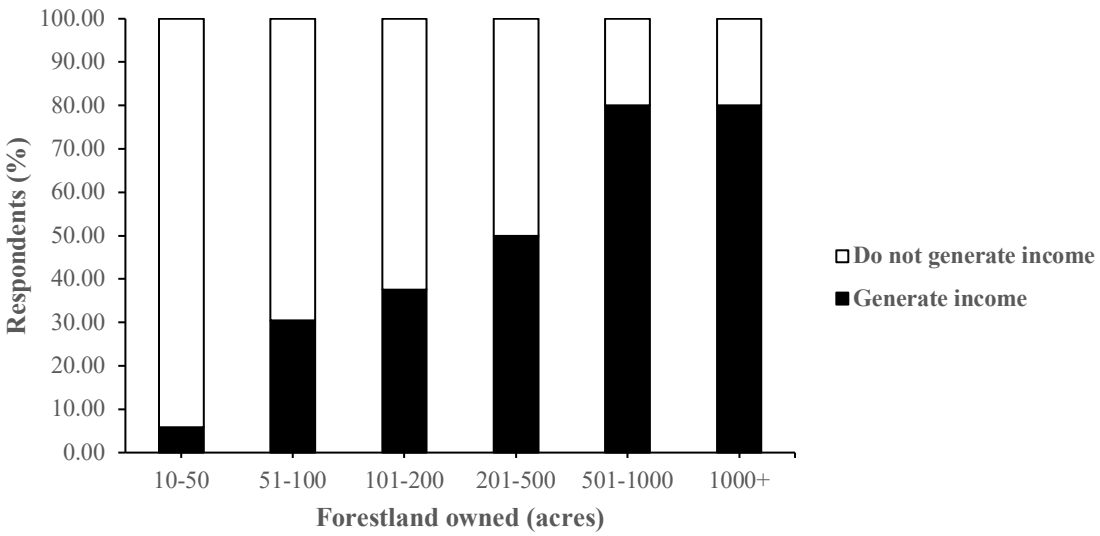

Figure 4: Proportion of FFLs from each class of forest ownership that generate income based on percent response from survey participants (n = 120).

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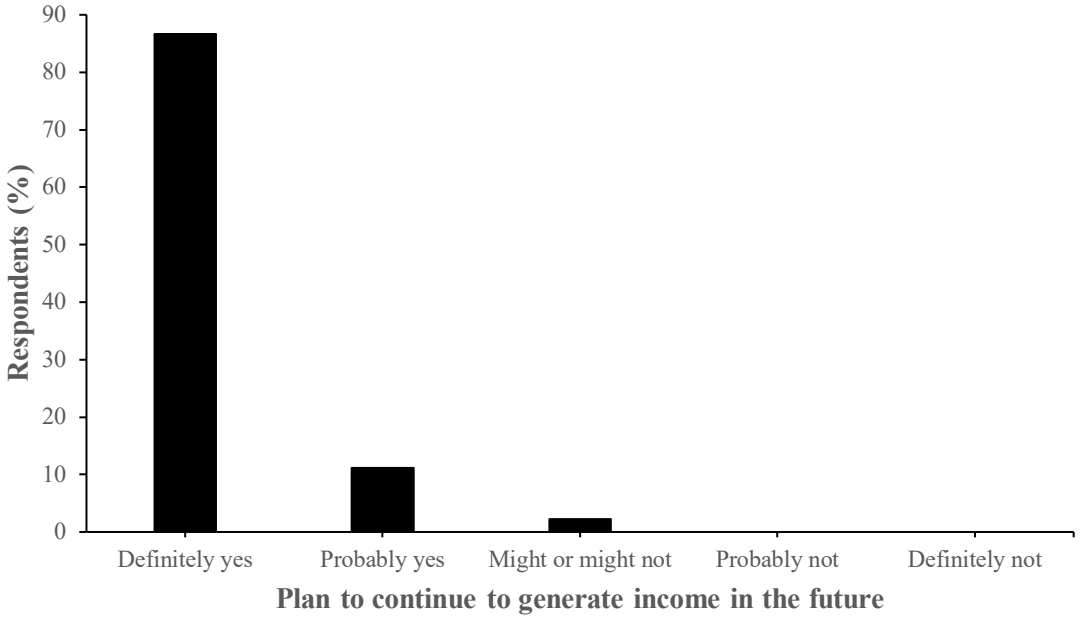

Figure 5: Interests in planning to continue to generate income from forestland based on percent response from survey participants (n = 45).

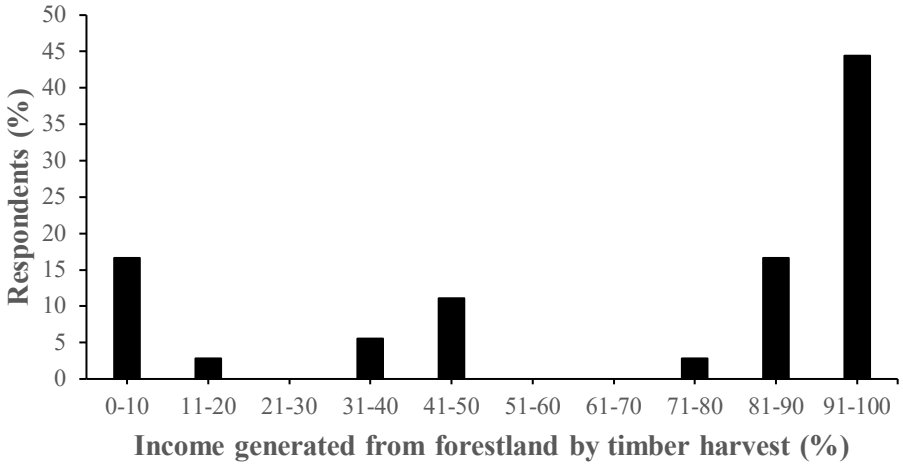

Figure 6: Percent of income FFLs generate from the forestland from timber harvest based on percent response from survey participants (n =36).

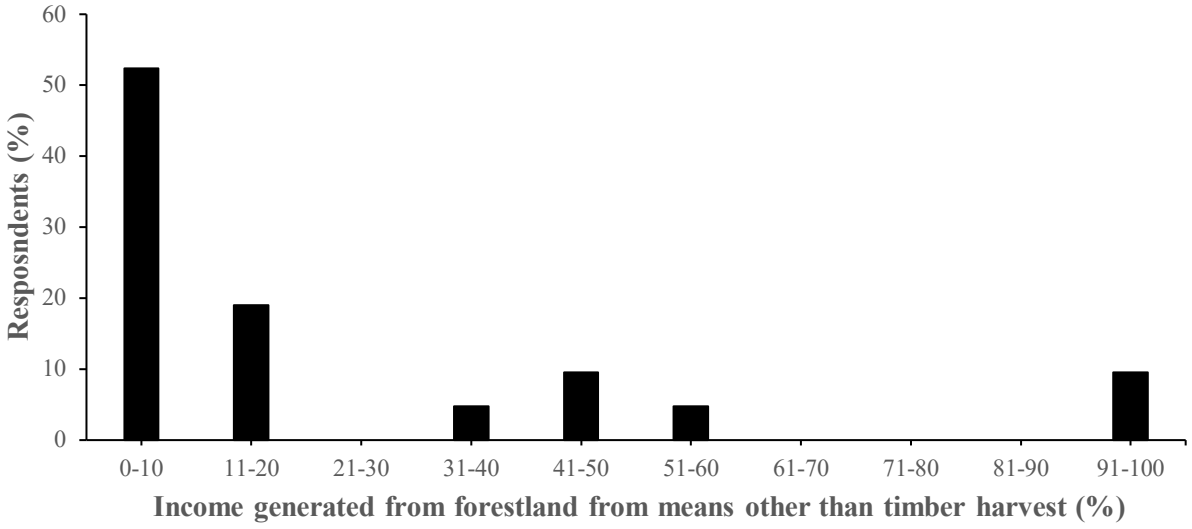

Figure 7: Income generation classes for FFLs that generate income from their forestland by means other than timber harvests based on percent response from survey participants (n = 21).

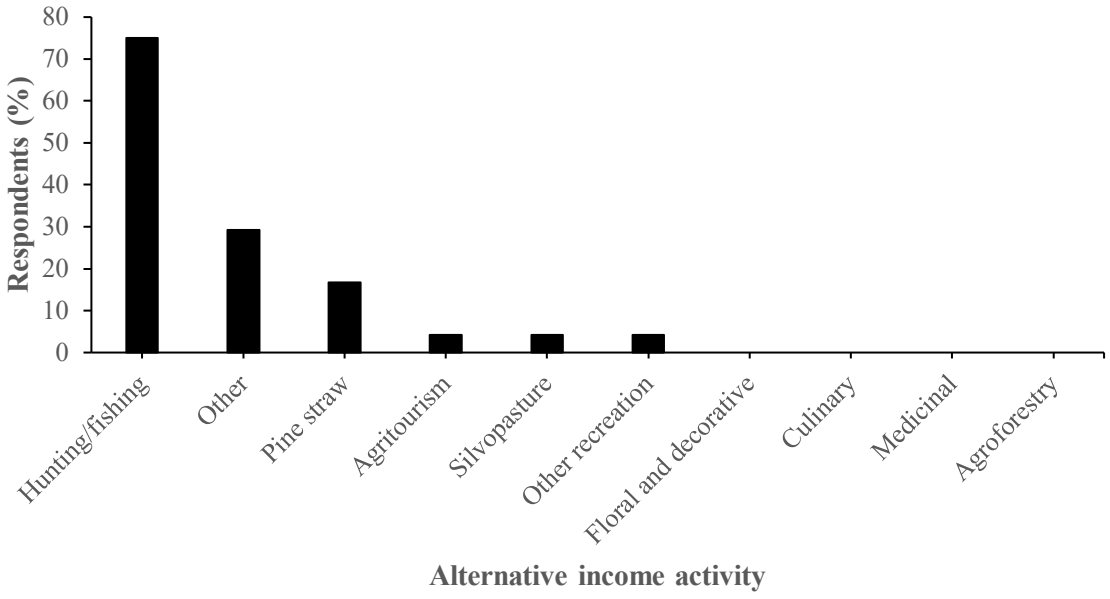

Figure 8: Alternative income activities that FFLs are participating in based on percent response from survey participants who generate income from sources other than timber (n = 24).

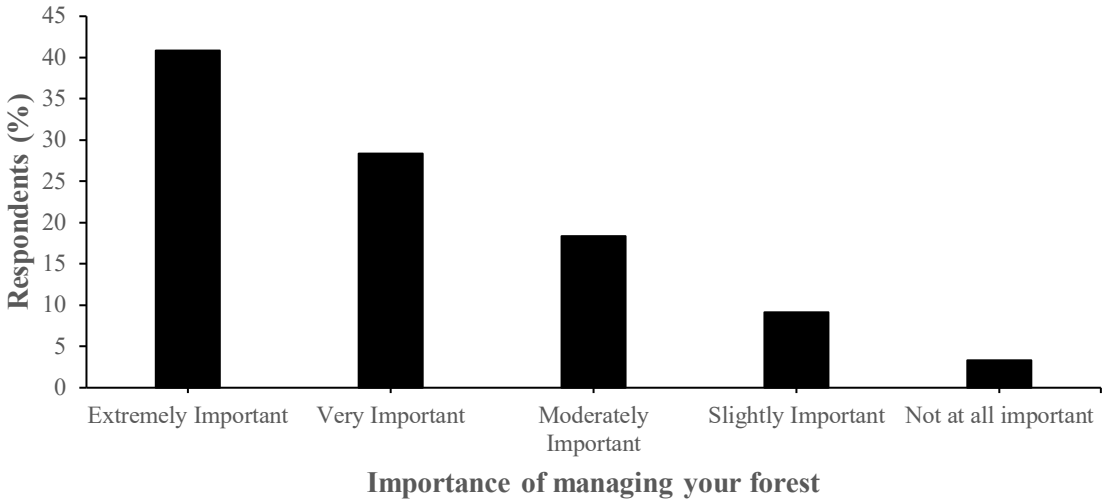

Figure 9: Importance of forest management among FFLs based on percent response from survey participants (n = 120).

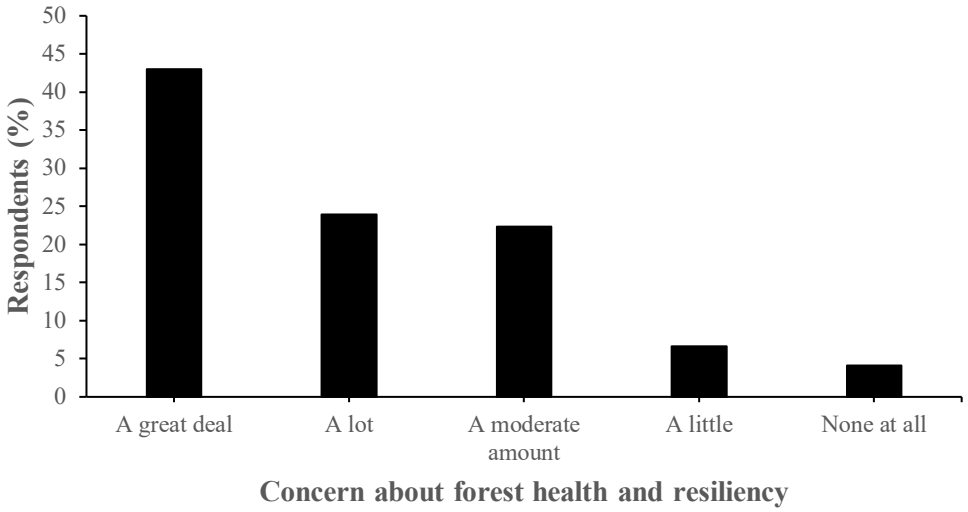

Figure 10: Concern about forest health and resiliency among FFLs based on percent response from survey participants (n =121).

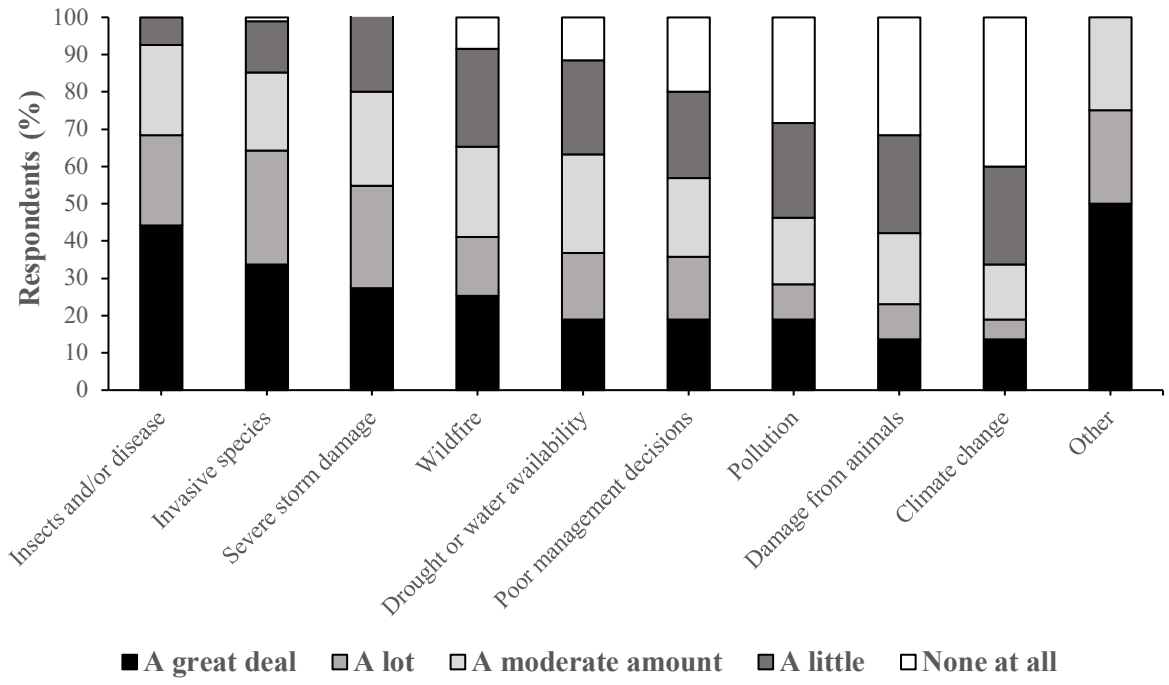

Figure 11: Concern level of various aspects of forest health and resiliency based on percent response from survey participants (n = 95).

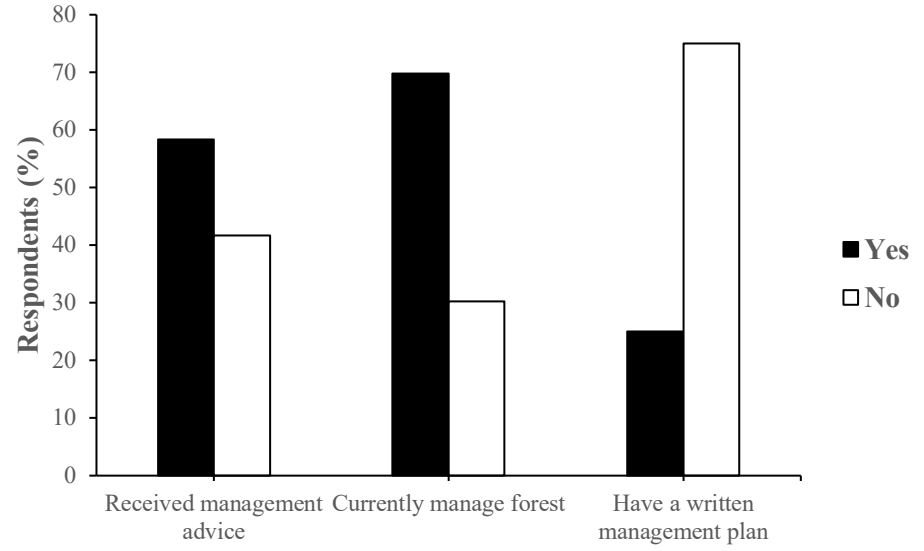

Figure 12: Proportion of FFLs that have received forest management advice, currently manage their forest, and a have a written management plan based on percent response from survey participants (n = 96).

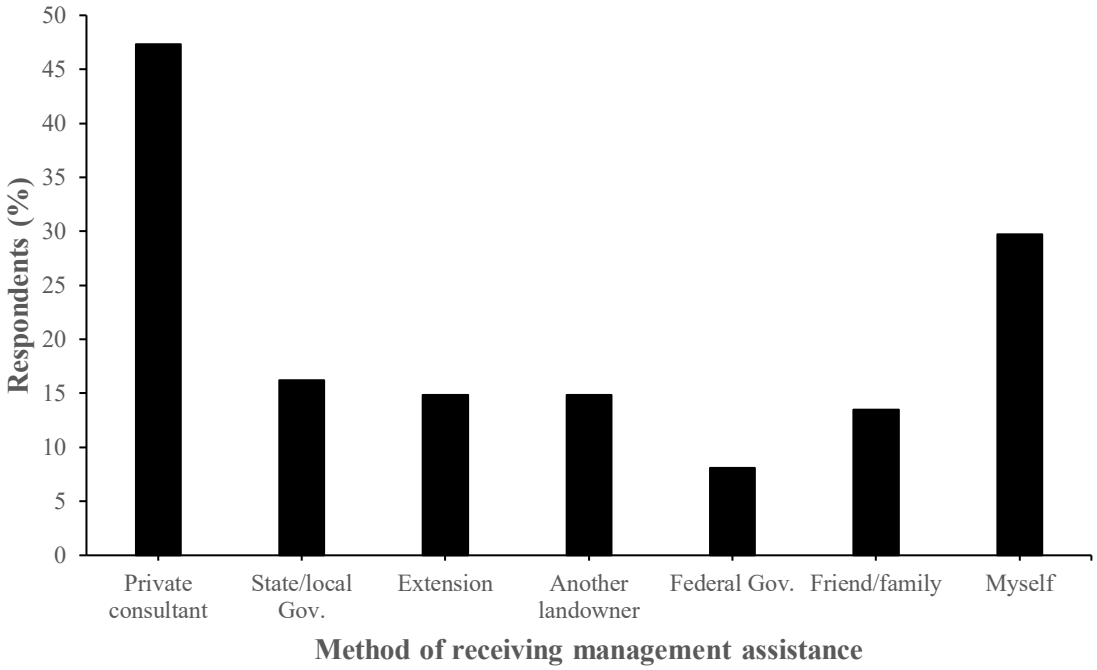

Figure 13: Method used by FFLs for receiving assistance in managing their forestland based on percent response from survey participants (n = 74).

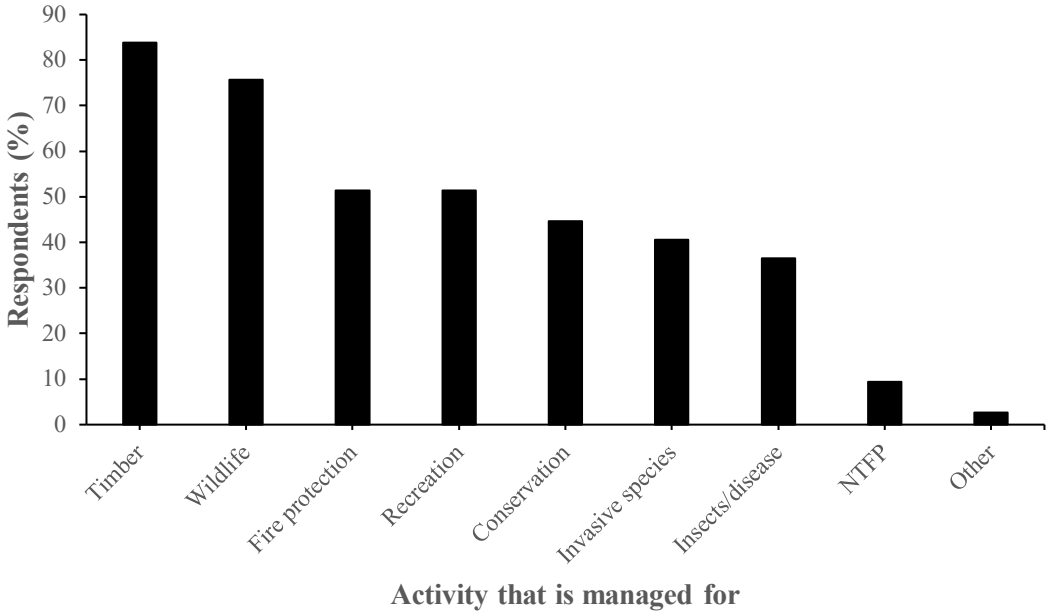

Figure 13: Activities that FFLs are managing their forestland for based on percent response from survey participants (n = 74).

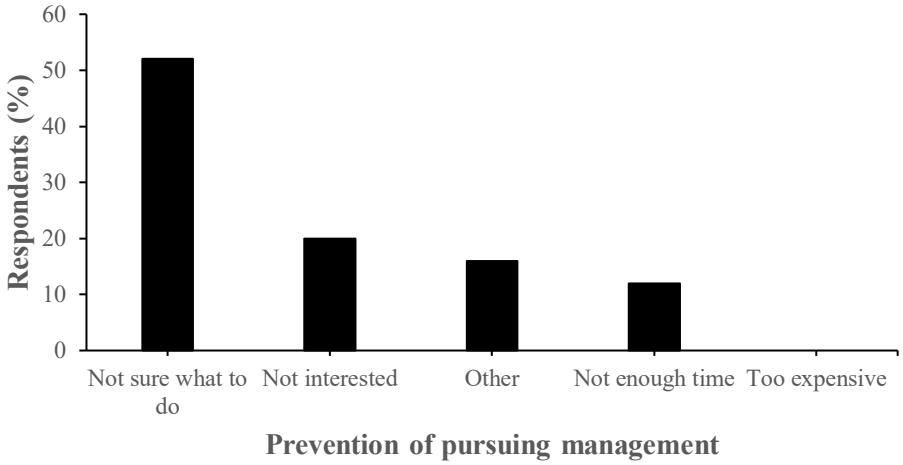

Figure 14: Factors that are preventing FFLs from pursuing forest management based on percent response from survey participants (n = 25).

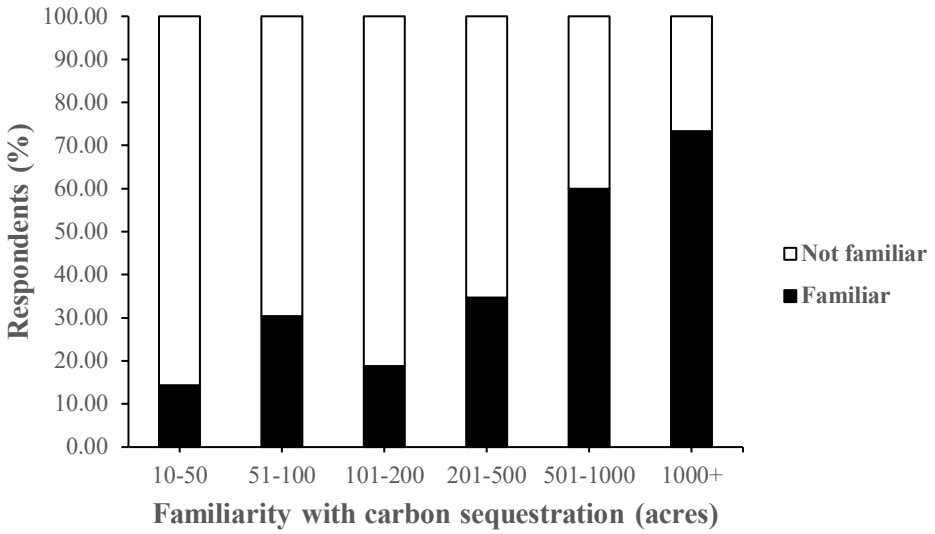

Figure 15: Proportion of FFLs from each forest acres ownership class that is and is not familiar with carbon sequestration based on percent response from survey participants (n =122).

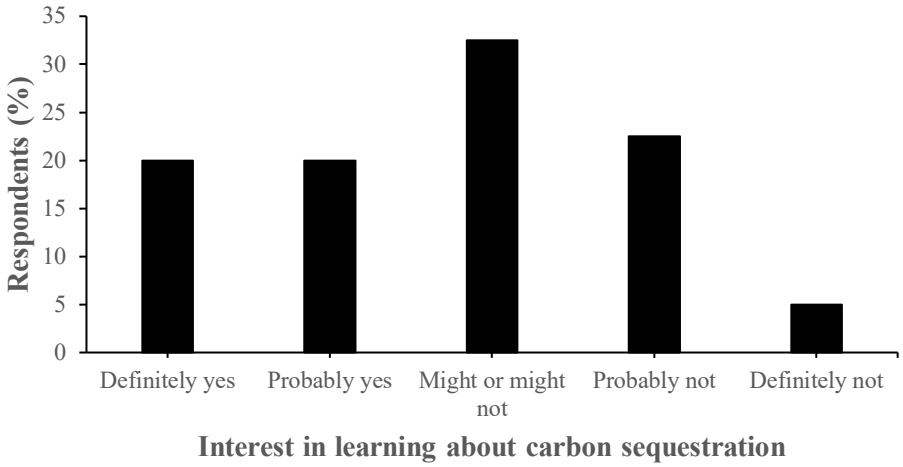

Figure 16: Interests in learning about carbon sequestration based on percent response from survey participants who selected they are not familiar with carbon sequestration (n = 80).

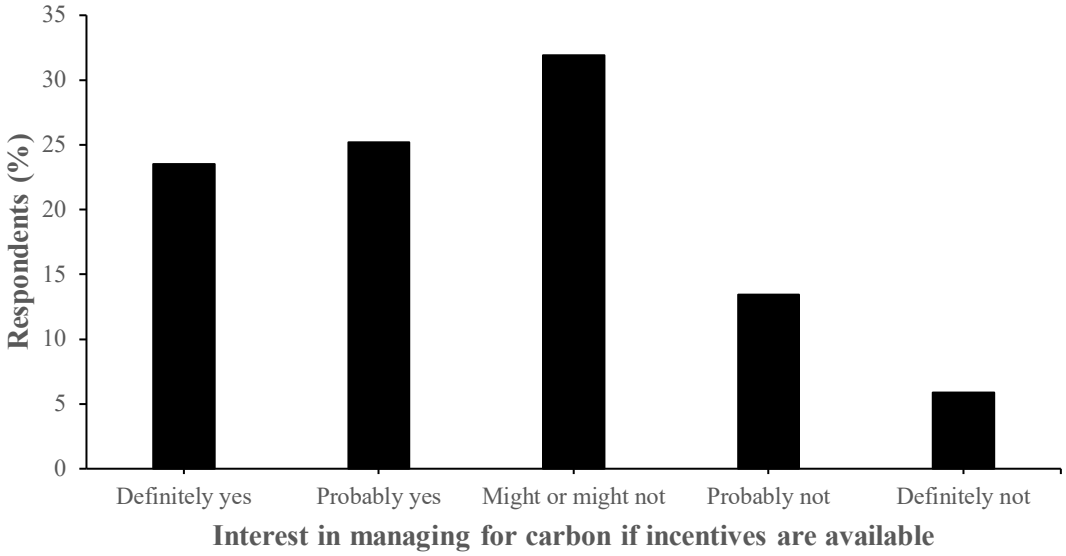

Figure 17: Interests in managing for carbon sequestration if incentives are available based on percent response from survey participants (n =119).

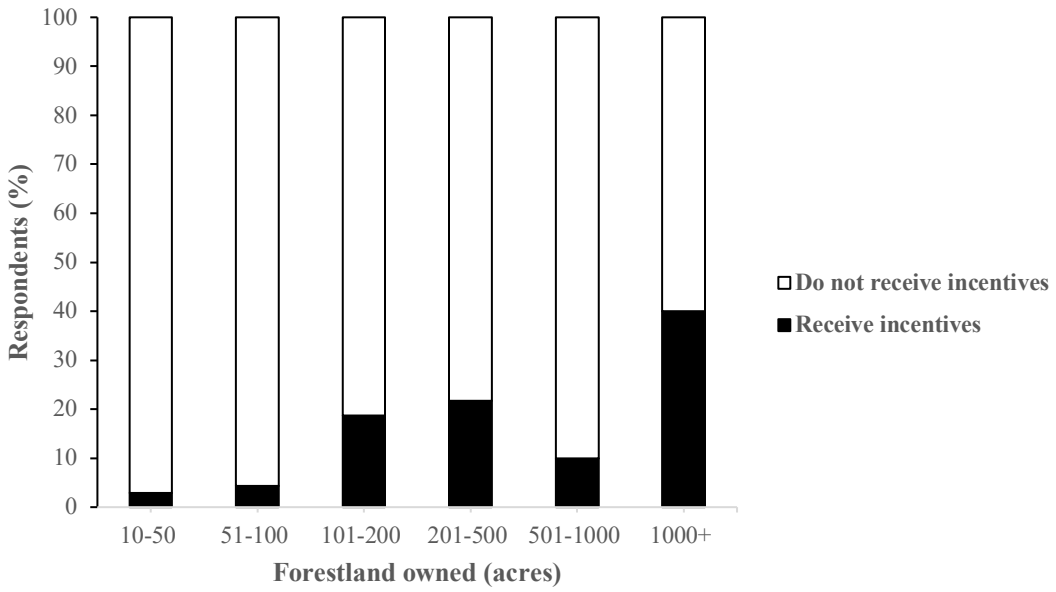

Figure 19: Proportion of FFLs from each forest acres ownership class that receive incentives from programs for their forestland based on percent response from survey participants (n =121).

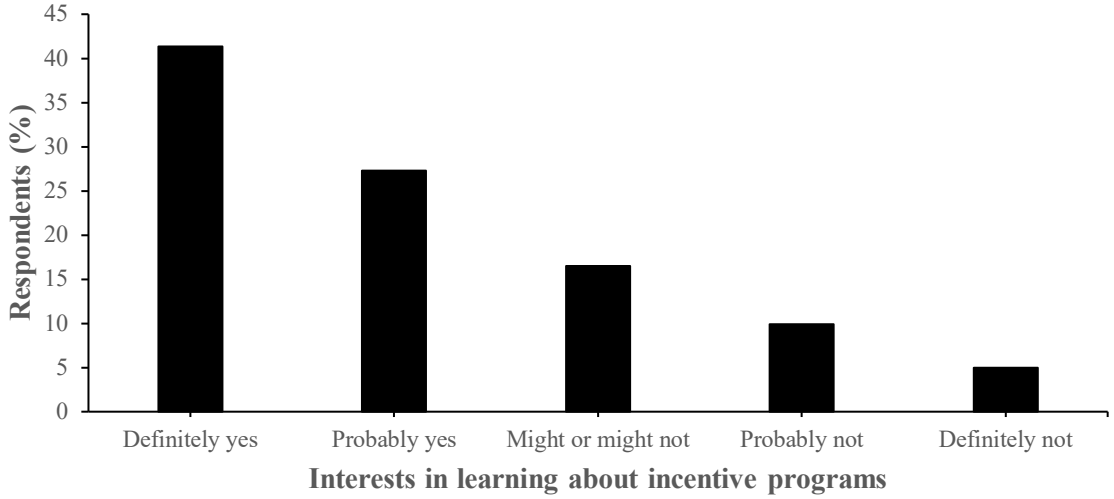

Figure 2018: Interest in learning about incentive programs based on percent response from survey participants (n =121).

Table 1: Mann-Whitney U test of differences in forestland acreage ownership between FFLs that generate income and FFLs that do not generate income from their forestland.

Income	N	Mean rank	U	P
Generating	46	84.93		
Not Generating	74	45.31	578	0.000***
Total	120			

***P ≤ 0.05, **P ≤ 0.01, *** P ≤ 0.001**

Table 2: Mann-Whitney U test of differences in rankings of importance of forest management between FFLs that generate income and FFLs that do not generate income from their forestland.

Income	N	Mean rank	U	P
Generating	44	73.61		
Not Generating	74	51.11	1007	0.000***
Total	118			

***P ≤ 0.05, **P ≤ 0.01, *** P ≤ 0.001**

Table 3: Mann-Whitney U test of differences in rankings of concern about forest health and resiliency between FFLs that generate income and FFLs that do not generate income from their forestland.

Income	N	Mean rank	U	P
Generating	46	64.24		
Not Generating	74	57.42	1474	0.269
Total	120			

***P ≤ 0.05, **P ≤ 0.01, *** P ≤ 0.001**

Table 4: Mann-Whitney U test of differences in forestland acreage ownership between FFLs that have received forest management advice and FFLs that have not received advice.

Management advice	N	Mean rank	U	P
Received advice	56	61.49		
Not received advice	40	30.31	392.5	0.000***
Total	96			

***P ≤ 0.05, **P ≤ 0.01, *** P ≤ 0.001**

Table 5: Mann-Whitney U test for differences in forestland acreage ownership between FFLs that currently manage their forestland and FFLs that do not currently manage their forestland.

Manage forestland	N	Mean rank	U	P
Currently manages	67	55.31		
Does not manage	29	32.76	515	0.000***
Total	96			

***P ≤ 0.05, **P ≤ 0.01, *** P ≤ 0.001**

Table 6: Mann-Whitney U test for differences in forestland acreage ownership between FFLs that have a written management plan and FFLs that do not.

Management Plan	**N**	**Mean rank**	**U**	**P**
Has written plan	24	84.93		
Does not have written plan	72	45.31	578	0.000***
Total	96			

***P ≤ 0.05, **P ≤ 0.01, *** P ≤ 0.001**

Table 7: Spearman Rho correlations of interests in income, importance of forest management, and concern about forest health and resiliency.

Comparison	P	ρ
Interests in Income vs. Importance of Management	0.001	0.478
Interests in Income vs. Concern about Forest Health and Management	0.003	0.269
Importance of Management vs. Concern about Forest Health and Management	0.001	0.601

2.4 Discussion and Conclusion

Forest Ownership and Reasons for Owning Forestland

Not accounting for forestland owners that hold fewer than 10 acres, the literature shows that the average forest ownership was approximately 67 acres (Buter et al. 2016). However, in our study, we found that the median ownership of 114.5 acres. The median was higher due to two outliers, one forestland owner holding 80,000 acres and another holding 21,000 acres. Additionally, we did not cap the maximum forest ownership to 500 acres. This allows for larger ownerships to be surveyed, which could play a role as to why the median was higher. When the forestland ownerships were categorized, the most common response was ownerships between 10 and 50 acres. This was consistent with previous literature, in which most forestland owners in that study also held 10-50 acres (Butler and Butler 2016). However, in our study, there was a higher distribution of ownerships of 50-100 acres, 101-200 acres, 201-500 acres, 501-1000 acres, and 1000+ acres in our survey. Many of the FFLs that participated in this survey were located in southern Alabama. This location factor, along with the higher distribution of larger ownerships, plays a role in the reasons for owning forestland. In Zhou (2010), southern Alabama tended to own their forestland for timber-based reasons.

This study supported that forestland owners in Alabama owned their land for a variety of reasons. Timber production was a higher priority relative to other reasons for owning. In this survey, we found that the top three reasons forestland owners owned their land were for timber production, hunting and/or fishing, and where they lived. The reason of hunting and/or fishing was consistent with previous literature (Butler and Leatherberry 2004, Butler 2008, Zhou 2010, Butler et al. 2016), as the literature indicated that hunting and/or fishing was within the top three reasons for owning forestland. However, timber production and where you live were not

consistent with previous literature (Butler and Leatherberry 2004, Butler 2008, Butler et al. 2016), in which passing land to heirs and beauty and scenery were ranked higher. Previous research has shown that southern Alabama FFLs are focused on timber-oriented goals (Kennedy and Roche 2003, Zhou 2010). Zhou (2010) noted that FFLs in the southern Alabama focused more on activities that was more timber oriented. Additionally, Alabama FFLs viewed the production of timber and wood products as the most important role for their land (Kennedy and Roche 2003). Within our study, a large portion of the FFLs surveyed were from central and southern Alabama. We did not have many FFLs from the western or northern parts of the state. This could contribute as to why timber production was the most common reason for owning forestland.

Generating income and interests in income generation

In this study, we found that 38% of forestland owners generated income from their land. This was higher than what has been found in previous literature, in which approximately 17% of forestland owners generated income (Butler et al. 2016). Since our survey had a distribution of FFLs that were located in the southern Alabama, landowners had timber oriented or financially goals. Other studies found that FFLs located in southern Alabama placed high importance on such objectives (Kennedy and Roche 2003, Zhou 2010). This could play a role as to having a higher number of FFLs generating income from their forestland. In terms of the method of income generation, we found that 93.3% of forestland owners currently generated or previously generated income by timber harvest.

Forest Health and Resiliency Concerns

Regarding forest health and resiliency concerns, we found that the top three concerns forestland owners had were insects and disease, invasive species, and severe storm damage. The concern of insects and disease followed previous literature, as this concern was also ranked the highest in a previous study (Butler 2011). However, the concerns of invasive species and severe storm damage were not consistent with previous literature, as they were ranked lower in that same study (Butler 2011). This could be attributed to the increase in catastrophic storms that impacted the Gulf Coast in recent years. Since 2016, four major Hurricanes have impacted Gulf Coast States (Isaac 2012, Hermine 2016, Matthew 2016, Irma 2017, Nate 2017, Michael 2018, Barry 2019), of which, the latest significant damage to Alabama and forestland in the state was hurricane Michael in 2018. This recent hurricane caused an estimated $20.8 million in timber damage in Alabama, all of which was located in southeast Alabama, where a significant percentage of survey respondents for our study were located (ACES 2018). Further, Alabama had significant tornado outbreaks in 2011, 2012, and recently in 2019 across the state. With more frequent severe weather events occurring, FFLs might be concerned as to what can be done to mitigate the impacts of such events.

Forest Management and Management Practices

Our study found that 58.3% of forestland owners received management advice and 25.0% have a written management plan. This is higher than what has been found in previous literature (Butler and Leatherberry 2004, Butler 2008, Butler et al. 2016). Regarding forestland owners that have received management advice, the literature suggested that between 13% and 20% have received management advice (Butler and Leatherberry 2004, Butler 2008, Butler et al. 2016). Regarding written management plans, the literature suggested that approximately 13% of forestland owners had a written management plan (Butler et al. 2016). This difference in FFLs

that have engaged in these forest management practices could be attributed to a larger distribution of forestland owners that held 50 or more acres in our study. This aligns with previous studies that has found that there is an increased likelihood of a forestland owner to have received management advice or have a written management plan with more forestland owned (Butler and Leatherberry 2004, Butler 2008).

Conclusion

FFLs are interested in generating income from their forestland. They recognize the importance of management and are actively searching information on other natural resource enterprises, beyond timber harvest alone. However, there is an information gap between them and what they want to achieve. Further research needs to be focused on the specifics of alternative income markets and the operation of these enterprises. Lack of knowledge is preventing FFLs from taking the next step. Additionally, the standards for such markets are lacking, which highlights the need to connect FFLs to professionals in taking the next step.

Chapter 3

Assessment of supplemental income generation by FFLs in Alabama

3.1 Introduction

While the initial questionnaire addressed reasons for owning, income generation, and forest management practices, alternative income generation and the management and operation of these enterprises were not fully addressed. Additionally, we wanted to target more FFLs that are operating non-timber microenterprises on their forestland. The preliminary data from the first questionnaire also yielded some interesting results. The need to look further into these results and further address alternative income generation created the need for a follow up questionnaire.

3.2 Methods

The second questionnaire was developed to specifically address alternative income generation and hone in on some of the preliminary data from the first questionnaire. This survey was also administered using the Dillman's Tailored Design Method. In summer of 2019, the second survey process was initiated. Like the first questionnaire, a random sample of 700 FFLs in Alabama who own at least 10 acres of forestland was obtained from county tax roll records. This sample was in addition to first 1,000 FFLs. No FFL participated in both surveys. FFLs selected for the sample were mailed a pre-notice letter in August of 2019. Within approximately 10 business days from mailing the pre-notice letter, a cover letter, the main questionnaire, and prepaid return envelope were mailed to all addresses deemed valid. Within approximately 15 business days from mailing the cover letter and questionnaire, a reminder letter and another copy of the questionnaire were mailed. An on-line version of the questionnaire was also available, and the link was included in the cover letter and reminder letter mailed to each FFL. The information

letter provided further details about the study, the IRB protocol number and dates, and explanation that participation within this study was completely voluntary. Invalid addresses were accounted for, and incomplete surveys and surveys with missing data were excluded from analysis.

This survey was expected to take approximately 15 minutes to complete. The survey questions consisted of multiple choice and fill in the blank. Questions in the survey were formed and guided by the need to better understand how many FFLs generate alternative income from their forestland, how they manage such practices or businesses, and the financial aspects involved in their decision making. The second survey is found in Appendix E. Its pre-notice letter is found in Appendix F, the cover letter is found in Appendix G, and the reminder letter is found in Appendix H.

3.3 Results

After adjusting for the 30 undeliverable addresses, there were 126 responses, which gave a 17.9% response rate. After removing respondents that wished not to participate, participants that did not provide how much land they owned, and forestland owners who did not own any forestland, there were 103 responses. Forestland owners were categorized into seven classes based on forest ownership. The largest category for forestland area owned was 101-200 acres (20.4%) (Fig. 21).

Participants were asked further questions to better describe their ownerships. Participants were asked which forest type best represented most of their ownership. It should be noted that several of these participants chose more than one choice to answer this question. The three most common forest types chosen among respondents were mixed pine and hardwood (46.9%), planted loblolly pine (32.7%), and natural hardwood (9.2%) (Fig. 22). They were then asked

location descriptive information about their forest ownership. Participants were asked where the majority of their forestland was located on a county basis. For counties where the majority of the forestland was located, the three most selected were Butler (15.8%), Houston (7.3%), and Chambers, Covington, Crenshaw, Dale, and Russell (6.32% each) (Fig. 23). The majority of FFLs (57.1%) lived in the same county where the majority of their forestland is located. Participants were then asked if their primary residence was located on their forestland. Most (56.1%) did not have their primary residence located on their forestland. Lastly, for the descriptive information about these FFLs, the primary reason for owning forestland was asked. For the primary reason for owning timberland, the top three responses were timber production (38.4%), land investment (16.2%), and Hunting/Fishing (14.1%) (Fig. 24).

Alternative Income Generation

After the descriptive information, the questionnaire addressed alternative income generation. First, relative interest in alternative income generation was addressed. The majority of forestland owners (58.8%) were interested in generating income from means other than timber harvest. Next, alternative income generation was addressed. Most FFLs (63.7%) did not generate income from means other than timber harvest. Most FFLs (59.0%) did not plan to generate income from means other than timber harvest.

This split FFLs into two groups, those that generate alternative income and those that do not. The next series of questions addressed FFLs that generated alternative income. Most FFLs (78.8%) that generated alternative income, the alternative income activity generated about 25% or less of the yearly income generated from their forestland (Fig. 25). For forestland owners that generated income, most (71.0%) do so by hunting and fishing leases (Fig. 26). The majority of FFLs that generated alternative income (83.33%) manage their alternative income enterprise by

themselves (Fig. 27). For the primary concern, most FFLs viewed impacts to timber production and liability issues (19.4% each) as the top concerns (Fig. 28). Regarding how they sell their alternative income products, most (78.6%) that generated income sell their products by contracting it out (Fig. 29). Many forestland owners (48.5%) engaged in alternative income activities to help pay for property and management costs (Fig. 30).

The last question addressed FFLs that do not generate alternative income. FFLs that did not generate income stated that lack of knowledge (50.0%) and wildlife damage (31.5%) are top barriers to pursuing alternative income opportunities (Fig. 31).

Figures and Tables

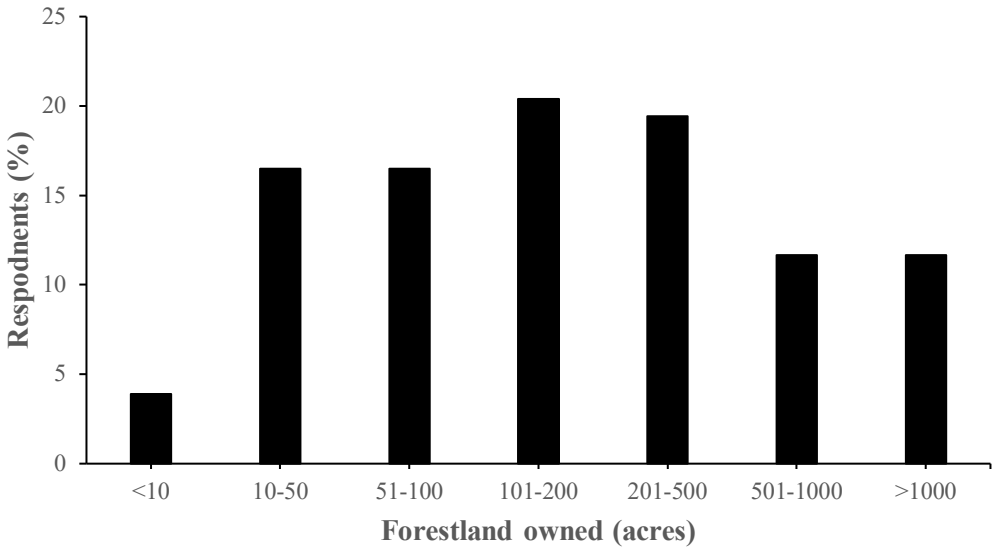

Figure 19: Forestland acres owned based on percent response from survey participants (n =103).

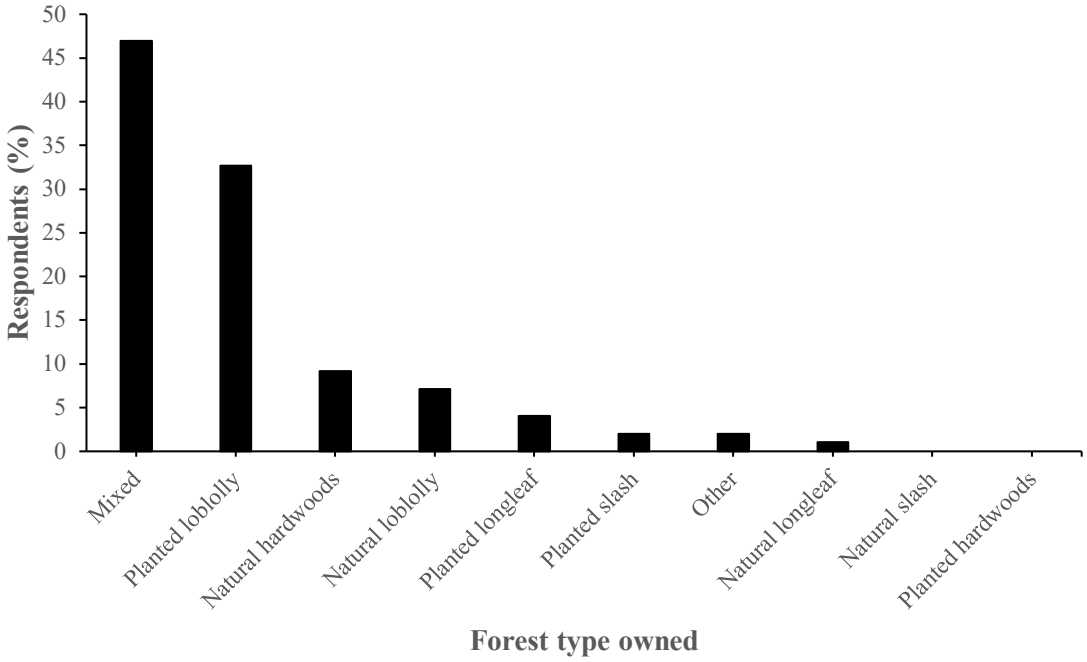

Figure 20: Forest type owned based on percent response from survey participants (n = 98).

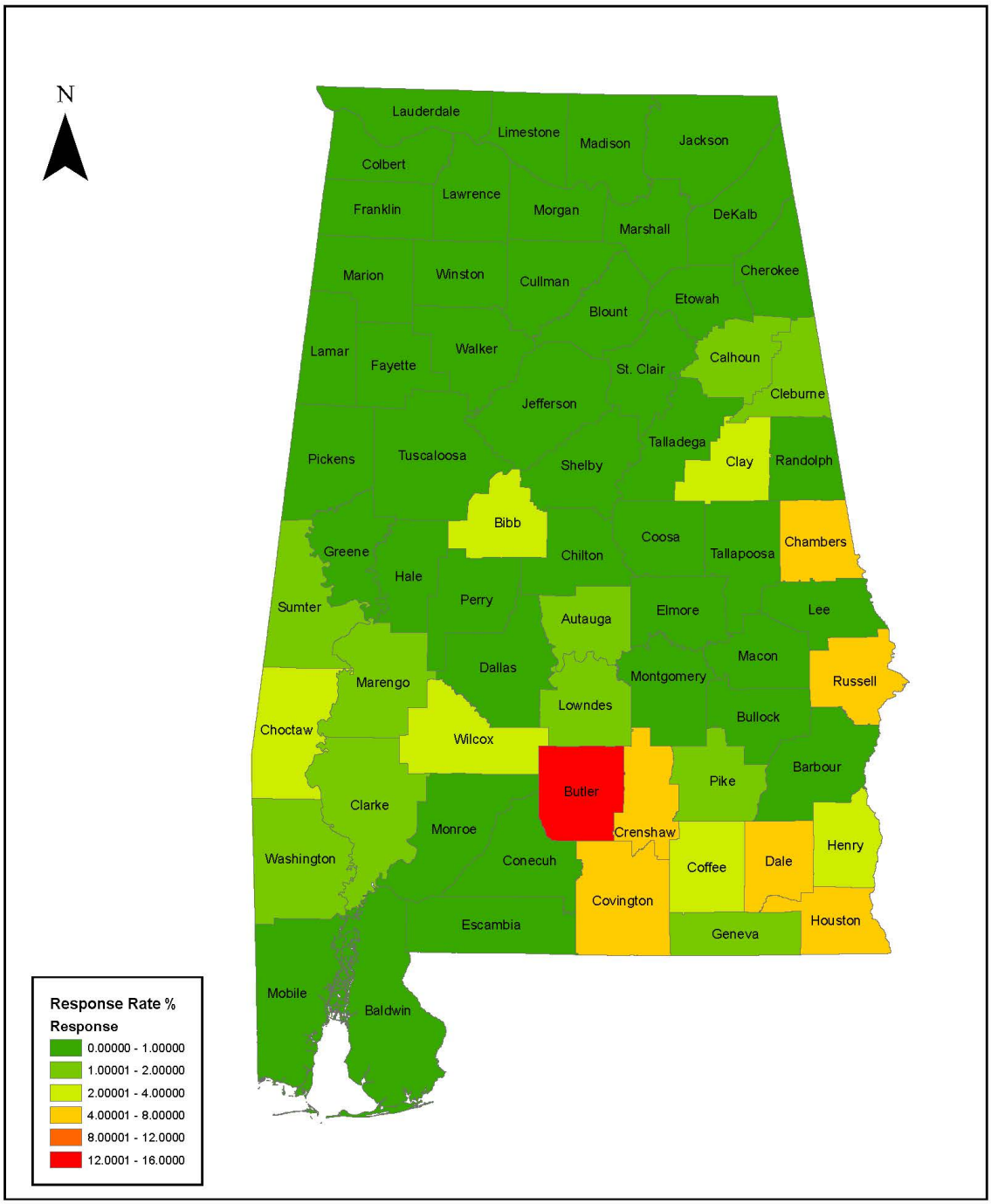

Figure 21: Response rate per county based on percent response from survey participants (n = 93).

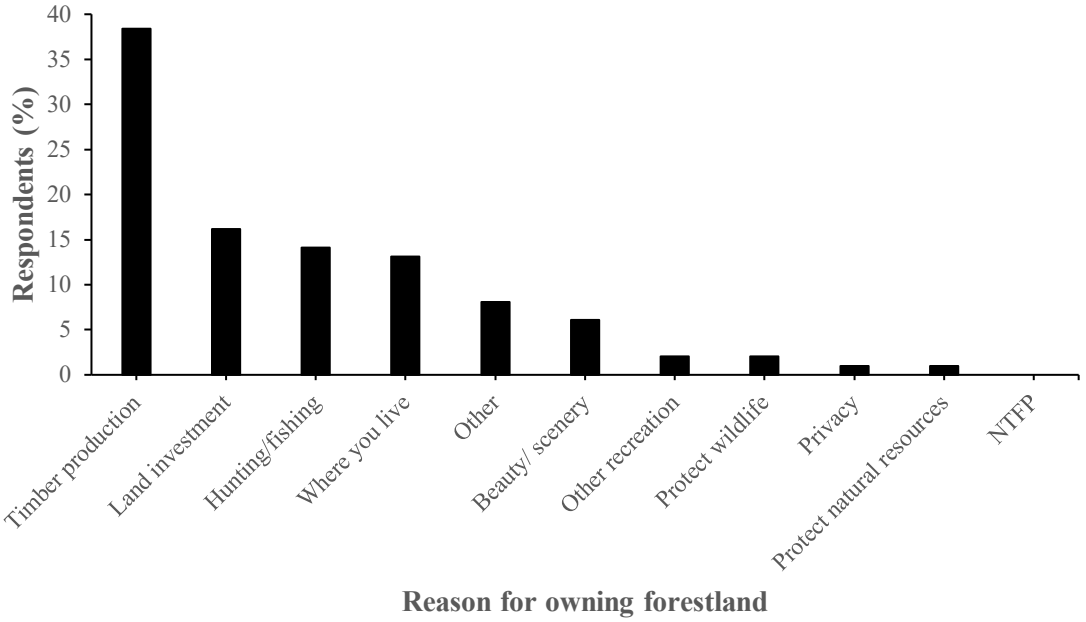

Figure 22: Primary reasons for owning forestland based on percent response from survey participants (n = 99).

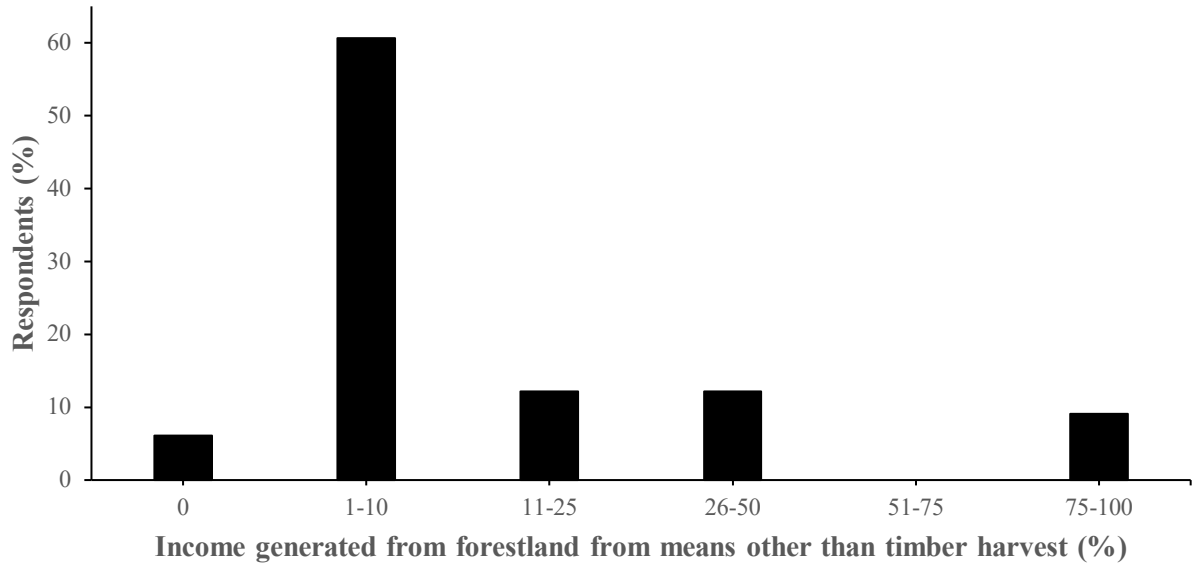

Figure 25: Percent of yearly income generated from forestland by sources other than timber harvests based on percent response from survey participants (n = 33).

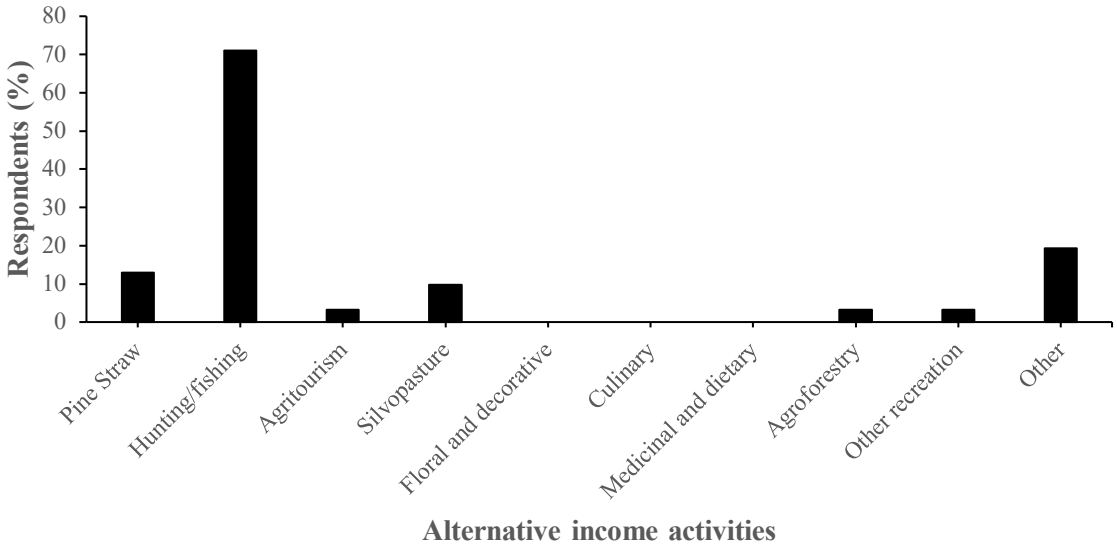

Figure 23: Alternative income activities that FFLs are participating in based on percent response from survey participants (n =31).

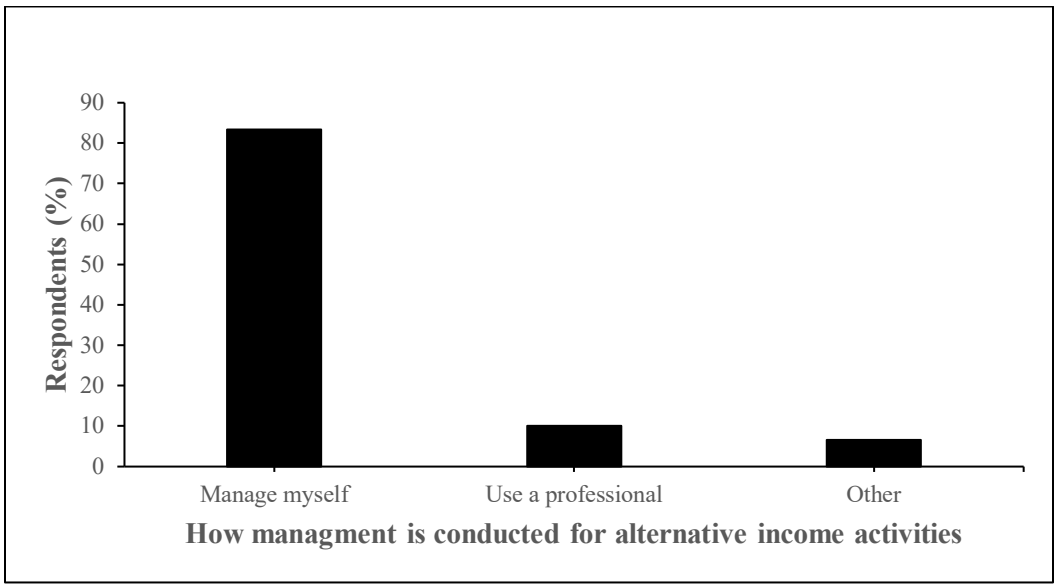

Figure 24: How FFLs manage their alternative income activities based on percent response from survey participants (n = 30).

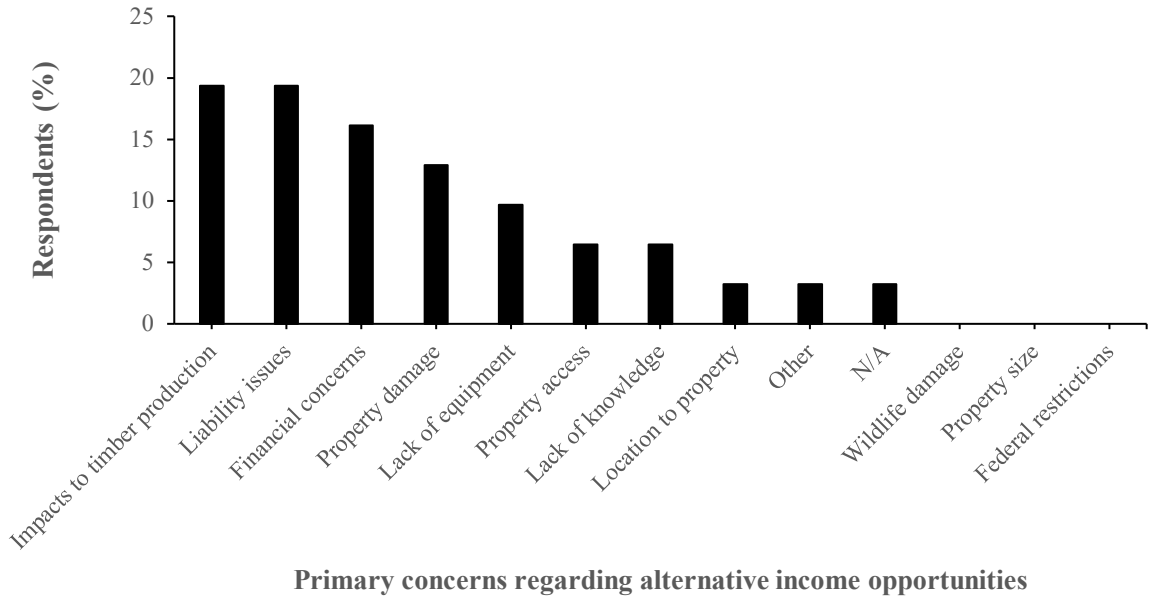

Figure 25: Primary concerns regarding alternative income opportunities based on percent response from survey participants (n = 31).

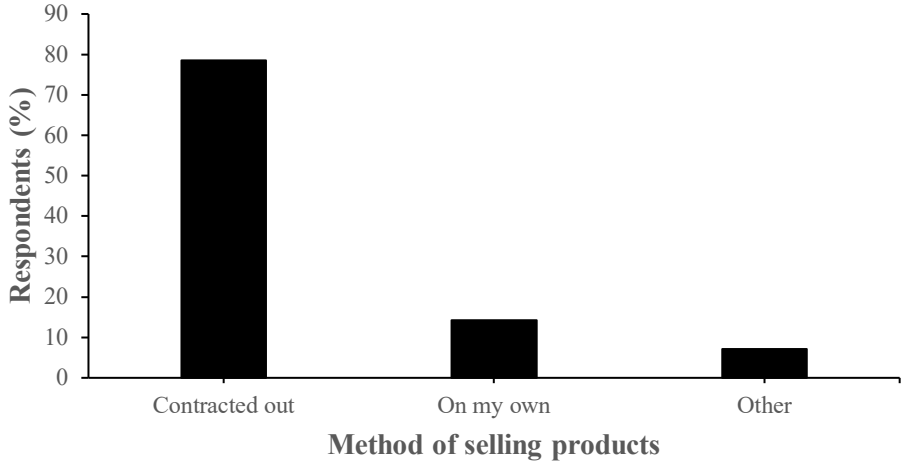

Figure 26: How FFLs sell their forest products other than timber based on percent response from survey participants (n = 28).

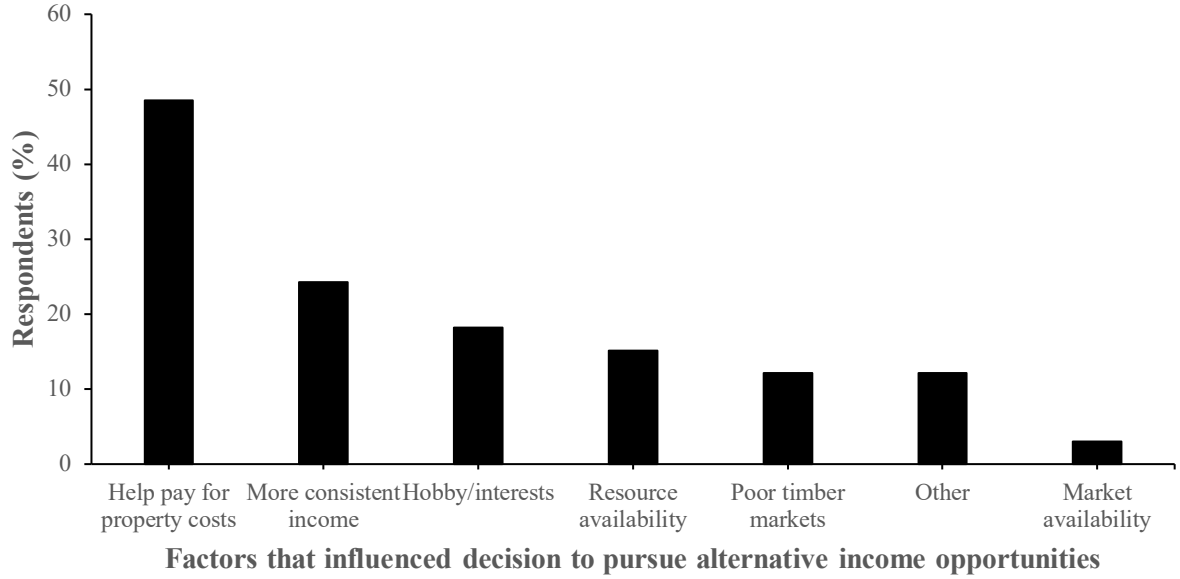

Figure 27: Factors that influenced the decision for FFLs to pursue alternative income opportunities based on percent response from survey participants (n = 33).

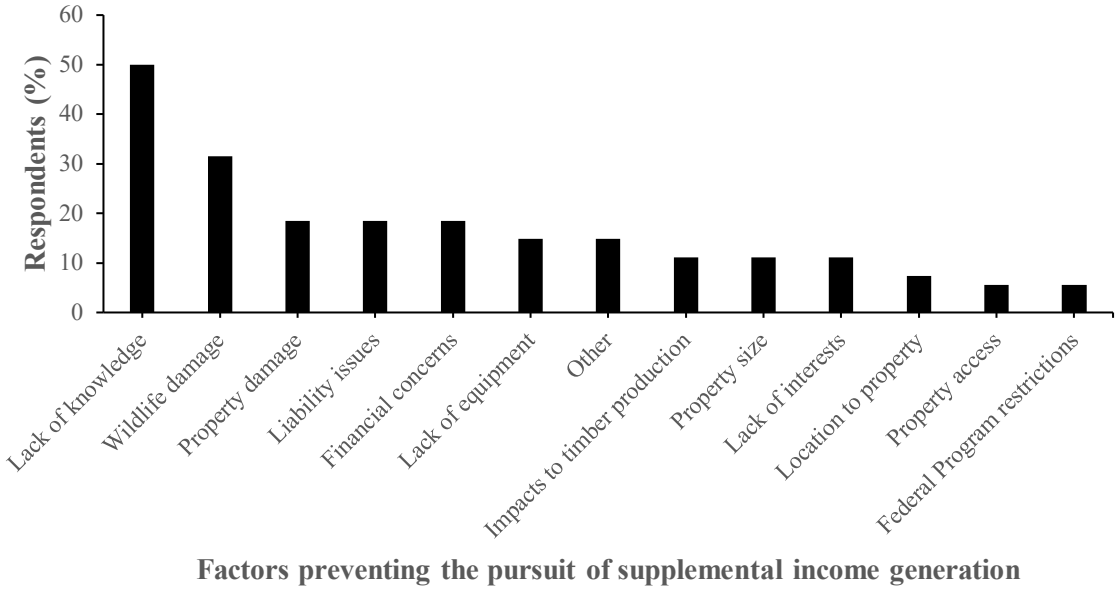

Figure 28: Factors that are preventing FFLs from pursuing alternative income opportunities based on percent response from survey participants (n = 54).

3.4 Discussion and Conclusion

Forest Ownership and Reasons for Owning Forestland

In our survey, we found that the most common response for forestland ownership was 101-200 acres. This is not consistent with previous literature (Butler and Butler 2016), nor was it consistent with our first survey, in which 10-50 acres was the most selected response. This could be attributed to the survey distribution. A large proportion of participants were located in the Southeastern region of Alabama. This was especially prevalent since we knew what county the majority of their forestland was located. Historically, larger forest ownerships tend to be closer to the markets. Within Alabama, a large proportion of the timber markets are located within the southern part of the state.

This survey also supported that forestland owners in Alabama owned their land for a variety of reasons. In this survey, we found that the top three reasons forestland owners owned their land was for timber production, land investment, and hunting and/or fishing. Like that of the first survey, hunting and/or fishing was consistent with previous literature (Butler and Leatherberry 2004, Butler 2008, Zhou 2010, Butler et al. 2016). Timber production was a common reason for owning between both surveys. Timber production and land investment were not consistent with previous literature, as both were ranked lower (Butler and Leatherberry 2004, Butler 2008, Butler et al. 2016). Specifically, for Alabama, Butler and Butler 2016 found that the top three reasons for owning forestland were legacy, beauty, and home. The differences in reasons for owning could be attributed to most of the forestland owners that participated had their forestland located in southern Alabama. Zhou (2010) and Kennedy and Roche (2003) found that FFLs located in southern Alabama were more focused on timber motivated reasoning for owning their land.

Income Generation and Supplemental Income Opportunities from Forestland

In Alabama and much of the United States, the markets of NTFPs, recreation activities, and other alternative income opportunities have not been well documented. This poses information gaps for FFLs that are interested in this enterprise but are not currently engaging in it. There is not a standard or guidelines readily available. In our survey we found that 36.3% of forestland owners generated income from their forestland from means other than timber harvest. In terms of the alternative income activity, hunting leases and pine straw leases were among the most popular. This was similar compared to the first survey. In terms of operations of alternative income activities, about 83.3% of these landowners managed their alternative income activity themselves and 78.6% sold their products by contracting it out. Further research is needed to address these information gaps to both help FFLs and professionals in reaching them.

For the forestland owners that do not generate income from means other than timber harvest, the most common responses as the prevention of pursuing alternative income opportunities was lack of knowledge. This reiterates the fact that further research is needed to address these FFLs' desires through landowner's engagement, education, and improved knowledge of markets, owning and operating microenterprises, and suitability and sustainability of opportunities for landowners.

Conclusion

FFLs show high interest in income enterprises beyond that of timber harvests. However, the majority of these FFLs do not generate alternative income due in large part to the lack of knowing what to do and how to do. This highlights that further research should be conducted to fill the information gaps for both the landowners. This also highlights the need to connect these

FFLs to professionals to help them overcome their barriers. For those that do generate alternative income, they do so by hunting/fishing leases or pine straw leases, with hunting leases, by far, being more popular. In terms of the operation side of alternative income enterprises, the majority manage their enterprise by themselves but contract their alternative income product to a third party in order to sell it. In terms of potential, further knowledge about alternative income and its practices can help FFLs eventually offset or reduce the cost of management. In turn, this can lead to healthier forests in the future.

Chapter 4

A comparison of the attributes of pine straw from southern pine species

4.1 Introduction

The southeastern United States consists of approximately 205 million acres of forestland, in-which 39 million acres is planted pine (Wear and Greis 2012). This region is often referred to as the "wood basket" of the United States (Schultz 1997), as it produces approximately 60% of all timber in the country (Fox et al. 2007; Smith et al. 2009). Followed by harvesting these trees for use of timber products, non-timber forest products from these forests create opportunities for many alternative markets.

NTFPs are comprised of plants, fungi, and other flora materials (Chamberlain and Predny 2003) and can be classified into five categories, which are the following: culinary, decorative, dietary and medicinal, nursery stock and landscaping, and fine arts and crafts (Barlow et al. 2015). Many parts of plants and fungi, such as roots, tubers, branches, sap, pine needles, and small diameter wood, are harvested for monetary gain or personal enjoyment (Chamberlain et al. 2018). An emerging NTFP category is nursery stock and landscaping. In the Southeast, a common enterprise within in this NTFP category is pine straw.

A common NTFP is pine straw, and it is commonly used in a landscape setting as an organic mulch. Within the Southeast, three pine species, longleaf (*Pinus palustris* M.), slash (*Pinus elliottii* E.), and loblolly (*Pinus taeda* L.), produce commercially harvestable foliage commonly used for mulch in landscape settings. The use of pine straw as a mulch is a growing market in the Southeast. For example, in Georgia, revenues from pine straw paid to landowners grew from approximately $15.5 million in 1999 to approximately $60-$80 million between 2010 and 2017 (Dickens et al. 2018). However, despite having all three species native and present in

the state, Alabama's pine straw market has been lacking. Further awareness and education about this NTFP enterprise could motivate landowners to participate in such enterprises, as well as, to help develop additional market opportunities, and standards, and educate them on managing their land for pine straw.

Pine straw is collected from the forest floor and is commonly used for mulch in landscaping. In the Southeast, there are three common pine species that are used for producing pine straw mulch: longleaf pine (*Pinus* palustris Mill.), slash pine (*Pinus elliottii* Engelm.), and loblolly pine (*Pinus taeda* L.). The natural range for longleaf pine is from southeastern Virginia to eastern Texas and to the majority of central and northern Florida (Boyer 1990). Its needles occur in three per fascicle and are approximately 20 to 46 cm long, which is the longest of the three species (Samuelson and Hogan 2006). Slash pine ranges naturally from southernmost part of South Carolina west to the easternmost part of Louisiana and south to much of central Florida (Lohrey 1990). Its needles occur in two to three needles per fascicle and are approximately 15 to 28 cm long (Samuelson and Hogan 2006). Loblolly pine, considered to be the most commercially important forest species in the South, occurs naturally from the southernmost part of New Jersey south to central Florida and west to eastern Texas (Langdon 1990). Its needles occur in three or four needles per fascicle and are approximately 12 to 23 cm long, which is the shortest of the three species (Samuelson and Hogan 2006).

Organic mulches, such as pine straw, are commonly used in landscaping applications for households and businesses. They can offer an array of benefits, such as improved soil moisture, maintenance of soil temperatures, and weed suppression. When exposed to the elements, bare soil loses water by evapotranspiration, but, when mulched, it has a higher soil moisture content due to increased percolation and retention and decreased evapotranspiration (Chalker-Scott

2007). Mulch can also provide benefits in regard to the maintenance soil temperature. Compared to a mulched soil, non-mulched soils have been reported as much as 10°C warmer (Greenly and Rakow 1995). Mulch can also affect nutrient availability by way of decomposing or leaching. As pine straw decomposes, nutrients such as potassium (K), nitrogen (N), and phosphorus (P) are released into the soil (Blevins et al. 1996). Mulch can impact weed suppression, and the size of the mulch can play an important role in determining the effectiveness of weed suppression as courser mulch is found to be more effective than finer mulch (Billeaud and Zajicek 1989, Greenly and Rakow 1995, and Maggard et al. 2012).

A popular organic mulch in the southern United States, pine straw, has also increased in demand. Across much of the southern United States, the value of pine straw as a forest product has increased greatly since the early 2000's as income received by landowners has increased by as much as 80% from the product, even though timber revenues decreased over much of the same time period (Dickens et al. 2018). Pine straw provides landowners the opportunity to generate a more consistent revenue stream from their forestland and there is a significant opportunity in Alabama for timberland owners to pursue this opportunity.

Pine straw can provide a revenue source for many forestland owners, through pine straw leases and direct sales. The use of pine straw as a mulch is a growing market in the Southeast. Pine straw markets are especially dominant in Florida, Georgia, and North Carolina (Mills and Robertson 1991). For example, in Georgia, revenues from pine straw paid to landowners grew from approximately $15.5 million in 1999 to approximately $60-$80 million between 2010 and 2017 (Dickens et al. 2018). In North Carolina, longleaf pine straw revenues were estimated to exceed $34.8 million annually in 2016 (Megalos et al. 2019). However, despite having all three species native and present in the state, Alabama's pine straw market has been lacking.

Longleaf pine straw seems to be the preferred pine straw species for sellers and is typically sold at a premium. Anecdotally, reasons for this are said to be due to longer needles, better color retention, and slower rate of decomposition of longleaf pine straw compared to other commonly used species (McConnell 2016). However, there is a lack of scientific information that can support or reject these statements

To the best of our knowledge, the mulching attributes of pine straw produced by the three most popular species has not been scientifically compared in a landscape setting. Further, information about these attributes can help provide better context in regard to pine straw markets and the financial and economic aspects of the benefits associated with the common pine straw types produced in the Southeast.

The primary objective of this study was to obtain information on and compare the attributes of pine straw mulch produced by longleaf, slash, and loblolly pine. To accomplish this, longleaf, slash, and loblolly pine straw were compared by measuring soil moisture content, soil nutrients, soil pH, growth and survival of planted trees, pine straw decomposition, pine straw color change, and pine straw depth change overtime. Further, an economic analysis was conducted to compare each mulch's market demand relative to the attributes each provides and assess the current and future market opportunities for pine straw producers in Alabama and the Southeast.

4.2 Methods

The research site was located at Mary Olive Demonstration Forest (MOTDF) (N 32° 34' 42.9", W 85° 25' 24.4") located in Auburn, Alabama, approximately five miles from Auburn University. Soils consisted of very deep, well drained, moderately permeable fine sandy loam in the Pacolet series (USDA- NRCS 2019). The 20-year annual precipitation for Auburn, AL was

143.51 cm. The average precipitation over the study period was 9.44 cm. The average temperature was 18.39 ˚C and ranged from a mean minimum temperature of 12.67 ˚C to a mean maximum of 24.17 ˚C. The study period occurred over the 2019 growing season (March-September).In March 2019, three locations, which included non-tilled full sun (full-sun), non-tilled shade (shade), and tilled full sun sites (tilled), were located. Within each of the three locations, a randomized complete block consisting of three treatment replicates were established (15 plots per location). Using a walk-behind rotary tiller (Honda model FC600, Alpharetta, GA), plots were tilled to a depth of 7.6 cm and a width of 66 cm. Three passes, equaling 198 cm, prior to mulch application were applied. Existing vegetation at all sites were cut at ground level before mulch application. Within each replication, five circular 1.5 m diameter plots (1.77 m^2) were established and randomly assigned one of the following treatments: longleaf pine (Southeast Straw Company, Inc., Opelika, AL), slash pine (Southeast Straw Company, Inc., Opelika, AL), loblolly pine (hand raked near the research site due to lack of availability), a non-mulched control where weeds were killed with herbicide, or a non- mulched plot without weed control (45 total plots).

On 14 March 2019, within each 1.5 m diameter plot, two trees were planted, one 1.2-1.5 m tall, bareroot Shumard oak (*Quercus shumardii*) and one 1.2-1.5 m tall, bareroot eastern redbud (*Cercis canadensis*) (TyTy Plant Nursery, LLC, TyTy, GA). These trees were selected because both species are native and commonly used within landscape and mulched settings across the Southeast. On 18-19 April 2019, an estimated 6.0 liters of mulch was applied to their respective treatments to a depth of approximately 7.6 cm.

After planting, the plots were undisturbed. Plots were watered every three to four days for the first several weeks and then only as needed during extended periods without precipitation.

Roundup ® (2% glyphosate, Monsanto Company, St. Louis, MO) was used to kill weeds within the non-mulched herbicide plots.

Measurements were conducted from April 2019 to September 2019. Soil measurements included volumetric soil moisture content, soil nutrients, soil pH, and soil temperature. Soil moisture content and soil temperature were measured every seven to ten days throughout the study duration at a depth between 0 and 12 cm (Hydrosense II, Campbell Scieintific, Inc., Logan, UT). Soil temperature was measured at a depth 10-12 cm and coincided with volumetric soil moisture measurements (Vee Gee Scientific, Model 83210-12 digital thermometer). Soil was collected from between 0- 7.6 cm using a 1.9 cm diameter probe on 17 April 2019 before the application of mulch and on 6 September 2019 at the end of the study. Four samples per plot were combined into one composite sample. All soil pH and nutrient samples were analyzed by the University of Georgia's Agriculture & Environmental Services Lab (AESL). Soil nutrients were analyzed using Acros and Thermo iCAP 7000 inductive coupled plasma optical emission spectrometers (ICP-OES) (Thermo Fisher Scientific, Waltham, MA), and the nutrients analyzed included the following: calcium (Ca), magnesium (Mg), manganese (Mn), phosphorus (P), potassium (K), and zinc (Zn). Soil pH was analyzed using a Labfit AS-3000 (Labfit, Bayswater, Western Australia) with Thermo Fisher double junction electrodes (Thermo Fisher Scientific, Waltham, MA). Soil nitrate-nitrogen was measured on a cadmium reduction continuous flow analyzer (OI Analytical FS3100, OI Analytical, College Station, TX).

Pine straw color changes were measured weekly by visual assessment of the top layer using a Munsell soil book of color (Munsell Color ®, model M50215B, Grand Rapids, MI). Pine straw depth change was measured by measuring depths in four quadrants around each plot using a ruler and taking the average.

Tree height growth was measured from soil to the tree tops at time of planting and at the end of the study. Tree diameter was measured approximately 2-4 mm above ground level to the nearest millimeter at time of planting and at the end of the study. Weed suppression was measured by harvesting plant biomass at mulch level and dried at a temperature of 65˚C. Harvesting dates occurred on June 26-28, July 8-12, and August 14-17.

Mulch decomposition was measured by determining the weight loss of mulch subsamples. For each mulched plot, two mesh bags with known weight of oven dried pine straw were placed above the soil but below mulch level. Mesh bags were collected at the end of the study and died at a temperature of 65˚C. Percent loss was then calculated and averaged for the two bags per plot.

The experimental design was a generalized randomized complete block design (n=3) with subblock (n=3) and treatment (n=9). For volumetric soil moisture content, soil temperature, depth change, and color change, a repeated measure analysis was conducted for 15 sampling dates (Proc Mixed, SAS Inc., Cary, NC, USA) with block as a random factor and treatments as fixed factors. When there was a significant block by treatment interaction, each block was analyzed separately with treatment (n=3).

4.3 Results

Decomposition

Loblolly pine straw decomposed significantly faster than slash pine and longleaf pine straw (treatment effect $p = 0.005$) (Fig. 32). Across all pine straw treatments, decomposition was greatest in the shaded environment than the open or tilled environment (block effect $p = 0.04$).

Soil Moisture

For volumetric soil water content (VWC), there was a block x treatment interaction (block*treatment <0.0001). Therefore, each block was analyzed separately. For the open environment, there was a date by treatment interaction ($p = 0.01$) (Fig. 33). For significant dates, as soil conditions became drier from the end of June through the end of August, all pine straw treatments increased VWC compared to the CNH and CWH treatments. There were no significant differences among pine straw treatments during significant dates within that period of time.

For the tilled environment, there was a treatment effect (treatment = 0.04). The CWH treatment had significantly greater VWC than the CNH treatment ($p = 0.01$) and longleaf pine straw treatment ($p = 0.005$) (Fig. 34). There was no significant difference among pine straw treatments.

For the shaded environment, there was a treatment effect (treatment = 0.002). The loblolly pine straw treatment ($p = 0.05$) and slash pine straw treatment ($p = 0.04$) significantly decreased VWC compared to the CNH treatment (Fig. 35). All pine straw treatments (loblolly = 0.0005; longleaf = 0.03; slash = 0.0004), significantly reduced VWC compared to the CWH treatment (Fig. 41).

Soil Temperature

Like VWC, there was a block by treatment interaction for soil temperature (block*treatment <0.0001). Therefore, each block was analyzed separately. For the open environment, there was a date by treatment interaction (date*treatment < 0.0001) (Fig. 36). When soil temperatures increased, all pine straw treatments moderated, and decreased soil temperature compared to CNH and CWH treatments. There were no significant differences among pine straw treatment types.

For the tilled environment, there was a date by treatment interaction (date*treatment < 0.0001) (Fig. 37). As soil temperatures increased throughout the growing season, all pine straw treatments moderated, and decreased soil temperature compared to CNH and CWH treatments. There were no significant differences among pine straw treatment types.

For the shaded environment, there was a date by treatment interaction (date*treatment = 0.001) (Fig. 38). Except for several dates with decreased soil temperatures and all treatments were equal, all pine straw treatments moderated, and decreased soil temperature compared CNH and CWH treatments when soil temperature increased.

Weed Growth

Due to an environment by treatment interaction, each environment was analyzed separately (env*treatment < 0.0001). For the open environment, the presence of pine straw significantly reduced weed growth (treatment = 0.0007) and there was no significant difference in the plots containing pine straw. Further, the CWH plots had significantly less weed growth than the longleaf ($p = 0.006$) and slash ($p = 0.03$) pine straw plots (Fig. 39). Similarly, pine straw significantly reduced weed growth compared to the CNH plots (treatment <0.0001) and there was no significant difference in the plots containing pine straw in the tilled environment. Further, the CWH plots had significantly less weed growth than the slash pine straw plots ($p = 0.01$) (Fig. 40). For the shaded environment, the presence of pine straw significantly reduced weed growth (treatment = 0.007) and there was no significant difference in the plots containing pine straw (Fig. 41).

Soil Nutrients

Initial soil pH across all plots had a mean of 5.08 ± standard error (SE) 0.04 and there was a significant initial difference among environment types (env < 0.0001). The shaded

environment with a mean of 5.46 ± SE 0.06 was significantly greater than the tilled environment with a mean of 4.97 ± SE 0.04, which was significantly greater than the open environment with a mean of 4.79 ± SE 0.02. During the study, soil pH increased in all plots and treatments did not significantly alter pH (treatment = 0.59) (Fig. 42).

Initial soil nitrate concentrations across all plots had a mean of 1.13 ± SE 0.07 $mg \cdot kg^{-1}$ and there was a significant initial difference among environment types (env = 0.0005). The shaded environment with a mean of 1.33 ± SE 0.10 $mg \cdot kg^{-1}$ was significantly greater than the tilled environment (1.10 ± SE 0.06 $mg \cdot kg^{-1}$) and open environment (0.96 ± SE 0.05 $mg \cdot kg^{-1}$). An environment by treatment interaction occurred during the study for soil nitrate (env*treatment < 0.0001). Therefore, each environment was analyzed separately. Mean soil nitrate across all plots decreased in the open environment and treatments did not significantly alter soil nitrate in the open environment (treatment = 0.89) (Fig. 43). For the tilled environment, mean soil nitrate across all plots increased and increased significantly greater in the CWH plots ($p < 0.0001$). Further, soil nitrate was significantly greater in the slash pine straw plots than in the longleaf pine straw plots ($p = 0.02$) or the CNH plots ($p = 0.01$) (Fig. 44). Mean soil nitrate across all plots decreased in the shaded environments and treatments did not significantly alter soil nitrate shaded environment (treatment = 0.06) (Fig. 45).

Initial phosphorus (P) concentrations across all plots had a mean of 19.32 ± SE 2.77 $mg \cdot kg^{-1}$ and there was a significant initial difference among environment types (env < 0.0001). The shaded environment with a mean of 34.66 ± SE 4.65 $mg \cdot kg^{-1}$ was significantly greater than the tilled environment (15.85 ± SE 2.59 $mg \cdot kg^{-1}$) and open environment (0.7.43 ± SE 1.08 $mg \cdot kg^{-1}$). During the study, P concentrations decreased in all plots and treatments did not significantly alter P concentration (treatment = 0.90) (Fig. 46).

Initial potassium (K) concentrations across all plots had a mean of 49.97 ± SE 3.41 $mg \cdot kg^{-1}$ and there was a significant initial difference among environment types (env = 0.0004). The shaded environment with a mean of 57.51 ± SE 3.97 $mg \cdot kg^{-1}$ and open environment with a mean of 53.08 ± SE 4.33 $mg \cdot kg^{-1}$ was significantly greater than the tilled environment with a mean of 39.31 ± SE 1.93 $mg \cdot kg^{-1}$. During the study, K concentrations increased in all plots and increased significantly greater in the loblolly pine straw plots (treatment = 0.0035) (Fig. 47).

Pine Straw Depth

Longleaf pine straw maintained a greater depth than loblolly and slash pine straw and slash pine straw maintained a greater depth than loblolly pine straw throughout the study period (treatment = 0.0006) (Fig. 48). Across all pine straw treatments, depth was significantly lowered in the tilled environment type compared to the open and shaded environment types (environment < 0.0001).

Tree Growth

Redbud and Shumard Height and Diameter Growth

Height growth was greatest in the shaded environment for redbud trees (environment = 0.0004). No environment by treatment interaction occurred for redbud height growth (p = 0.33). Pine straw did not affect height growth during the study for redbud (treatment = 0.72) or Shumard oak trees (treatment = 0.69) (Fig. 49) (Fig. 50). Similarly, pine straw did not affect diameter growth during the study for redbud (treatment = 0.70) or Shumard oak trees (treatment = 0.47) (Fig. 51) (Fig. 52). Diameter growth for Shumard oaks was greater in the open environment compared to the tilled environment (environment = 0.02). No environment by treatment interaction occurred for Shumard oaks diameter growth (p = 0.10).

Figures and Tables

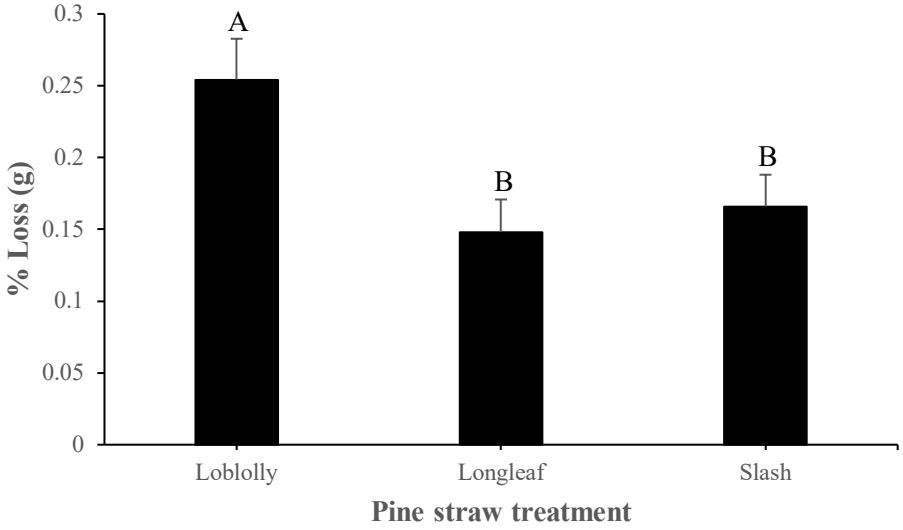

Figure 29: Mulch decomposition rate measured as percent loss (g). Means with the same letter are not significantly different. LL = longleaf pine straw, LB = loblolly pine straw, SL = slash pine straw (n = 9).

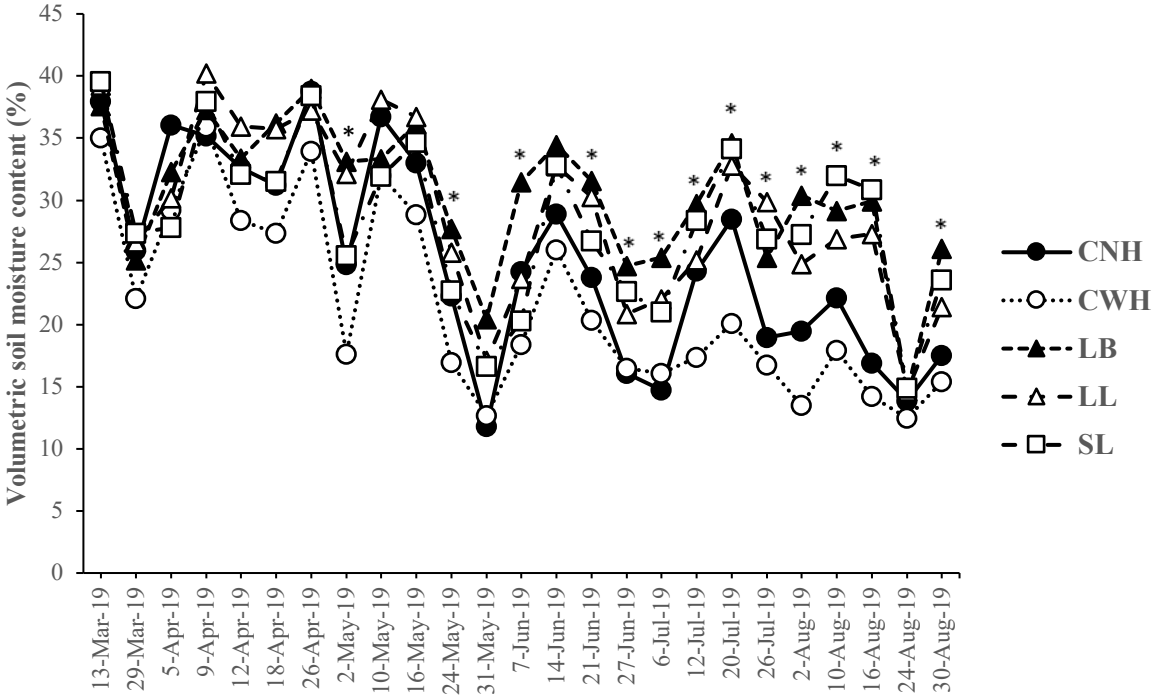

Figure 30: Volumetric soil moisture content (%) for open environment measured between 0-12cm. An asterisk (*) above the data represents dates when mulch treatment effect is significant ($p < 0.05$). CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL = slash pine straw (n = 3).

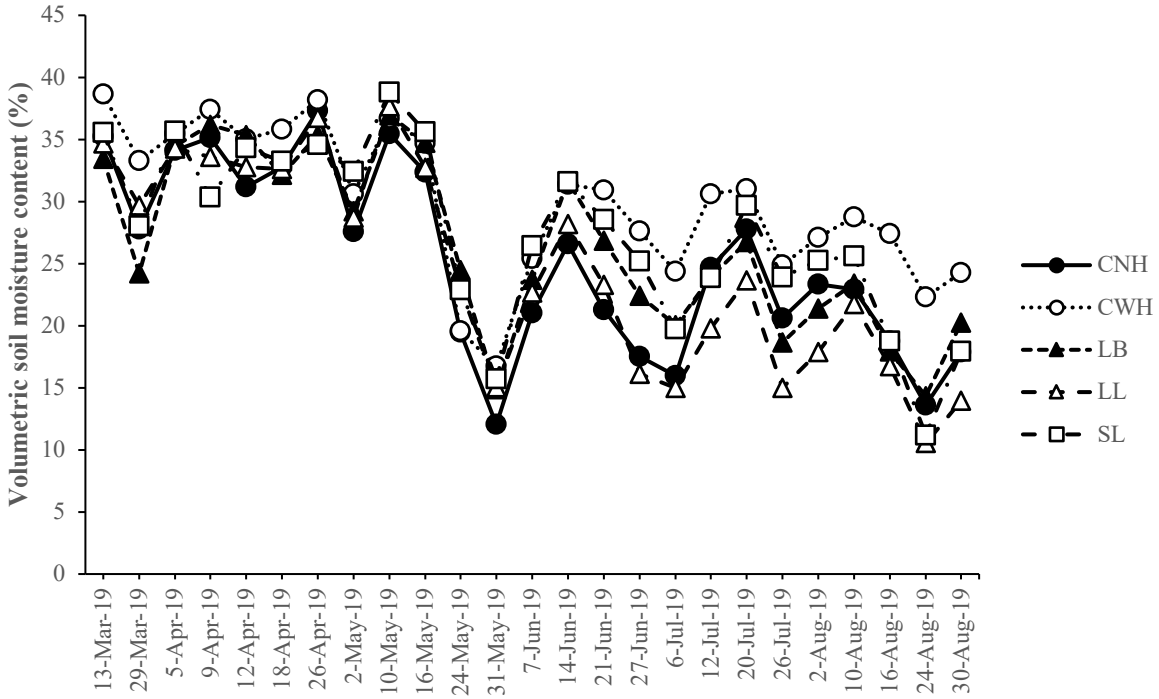

Figure 31: Volumetric soil moisture content (%) for tilled environment measured between 0-12cm. An asterisk (*) above the data represents dates when mulch treatment effect is significant ($p < 0.05$). CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL = slash pine straw (n = 3).

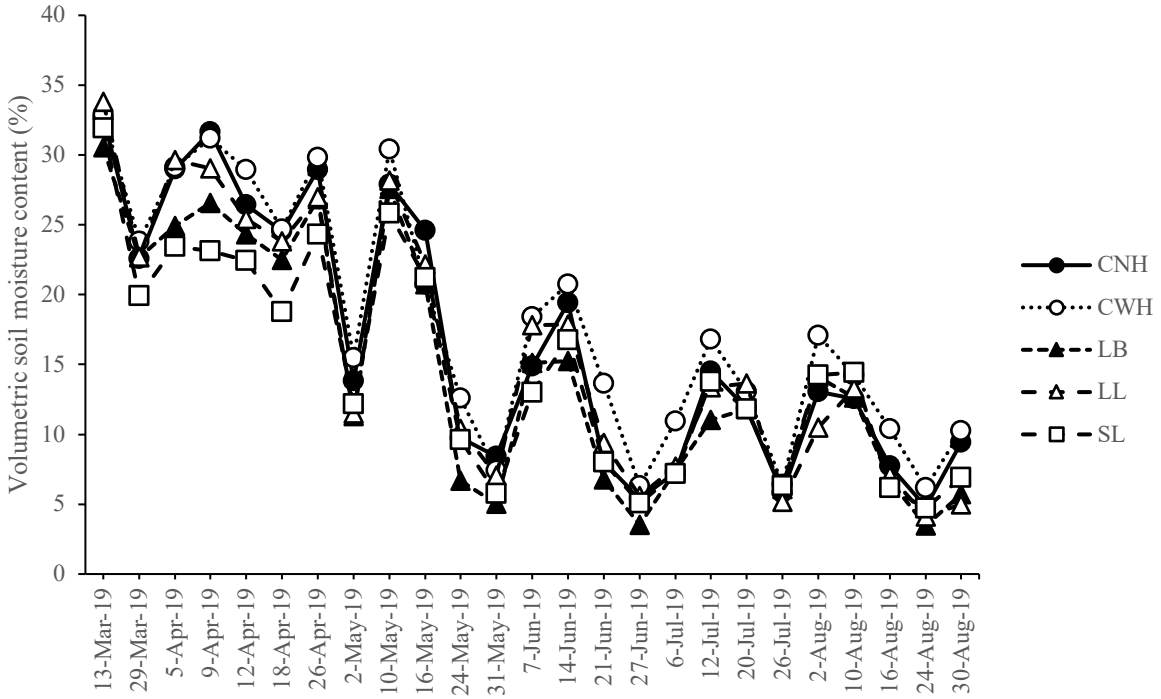

Figure 32: Volumetric soil moisture content (%) for shaded environment measured between 0-12cm. An asterisk (*) above the data represents dates when mulch treatment effect is significant ($p < 0.05$). CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL = slash pine straw (n = 3).

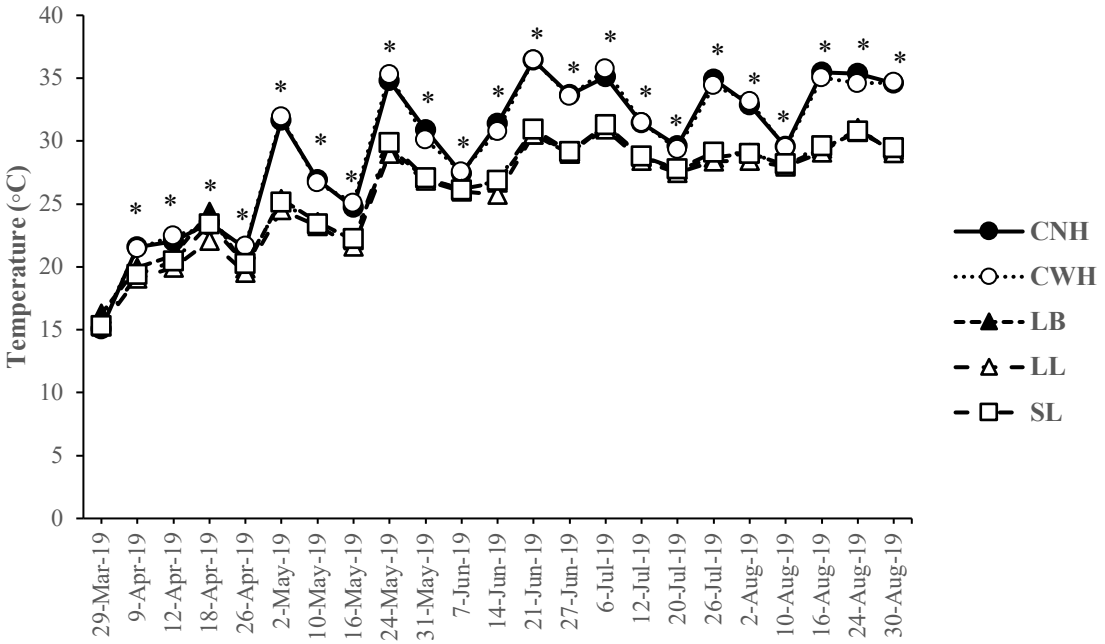

Figure 33: Soil temperature (˚C) for open environment measured between 0-12cm. An asterisk (*) above the data represents dates when mulch treatment effect is significant ($p < 0.05$). CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL = slash pine straw (n = 3).

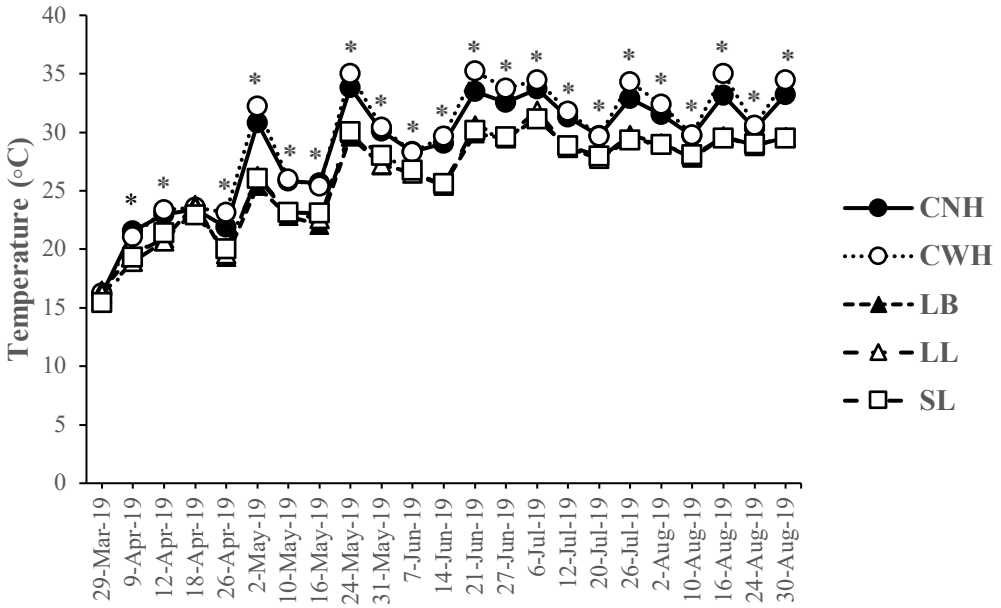

Figure 34: Soil temperature (˚C) for tilled environment measured between 0-12cm. An asterisk (*) above the data represents dates when mulch treatment effect is significant ($p < 0.05$). CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL= slash pine straw (n = 3).

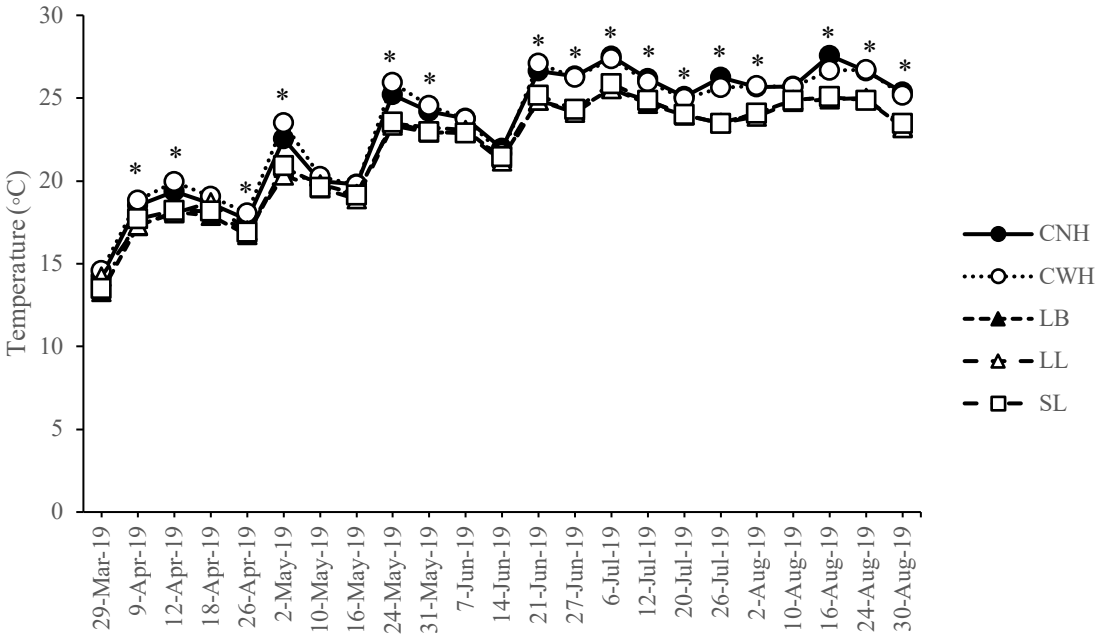

Figure 35: Soil temperature (˚C) for shaded environment measured between 0-12cm. An asterisk (*) above the data represents dates when mulch treatment effect is significant ($p < 0.05$). CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL = slash pine straw (n = 3).

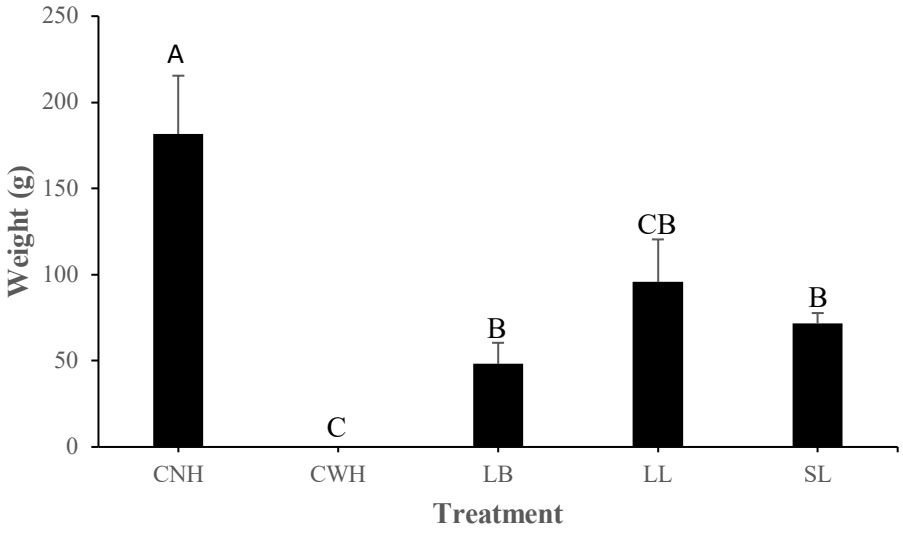

Figure 36: Weed growth for treatment over the course of the study in open environment. Means with the same letter are not significantly different ($p < 0.05$). CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL= slash pine straw (n = 3).

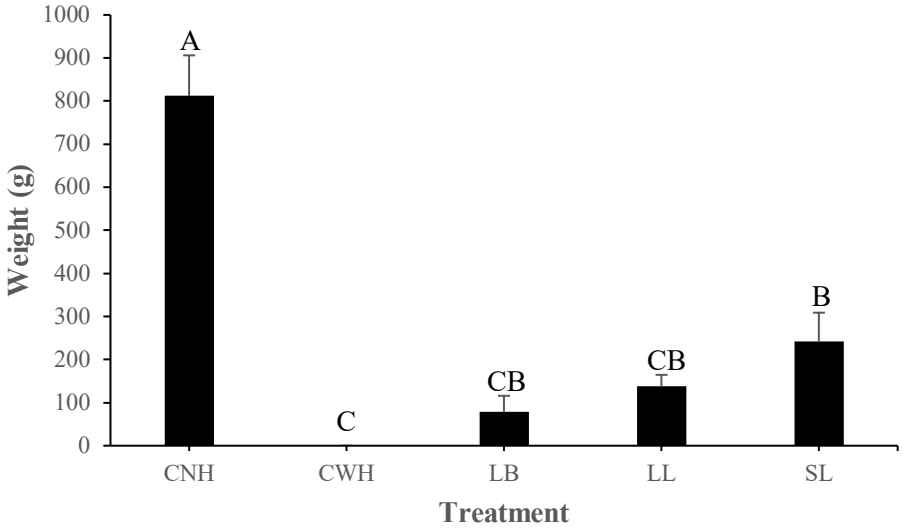

Figure 37: Weed growth for treatment over the course of the study in tilled environment. Means with the same letter are not significantly different ($p < 0.05$). CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL = slash pine straw (n = 3).

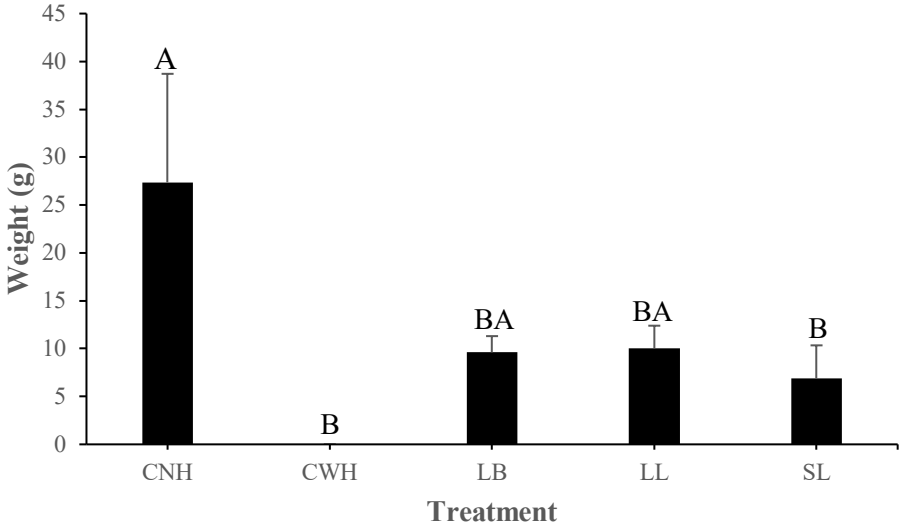

Figure 38: Weed growth for treatment over the course of the study in shaded environment. Means with the same letter are not significantly different ($p < 0.05$). CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL = slash pine straw (n = 3).

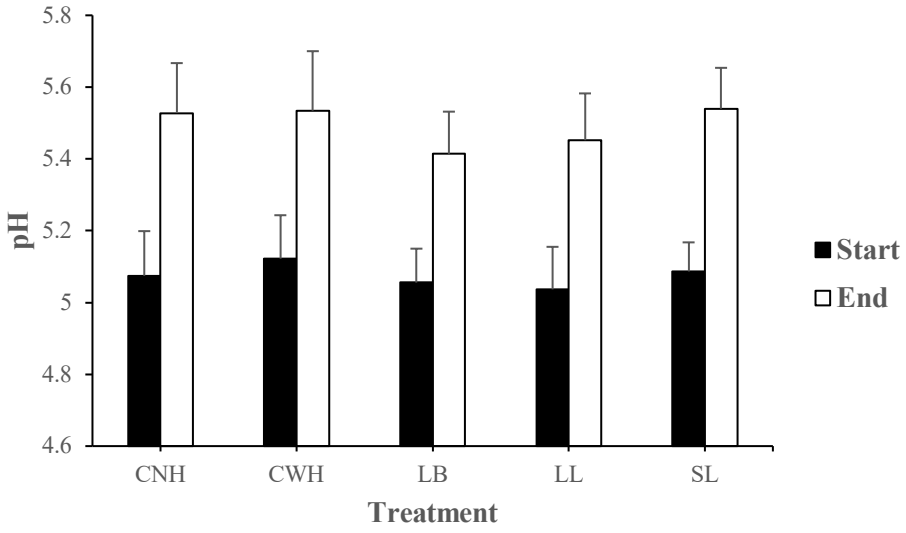

Figure 39: Soil pH. Soil measurements before treatment application at the beginning of the growing season and end of the growing season, which included treatment application. CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL =longleaf pine straw, SL = slash pine straw (n = 9).

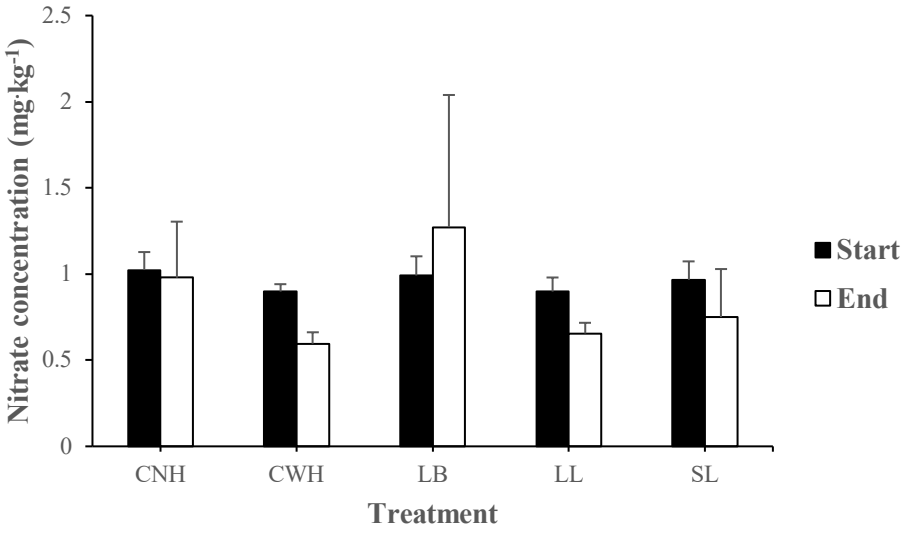

Figure 40: Soil nitrate concentration in open environment. CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL =longleaf pine straw, SL = slash pine straw (n = 3).

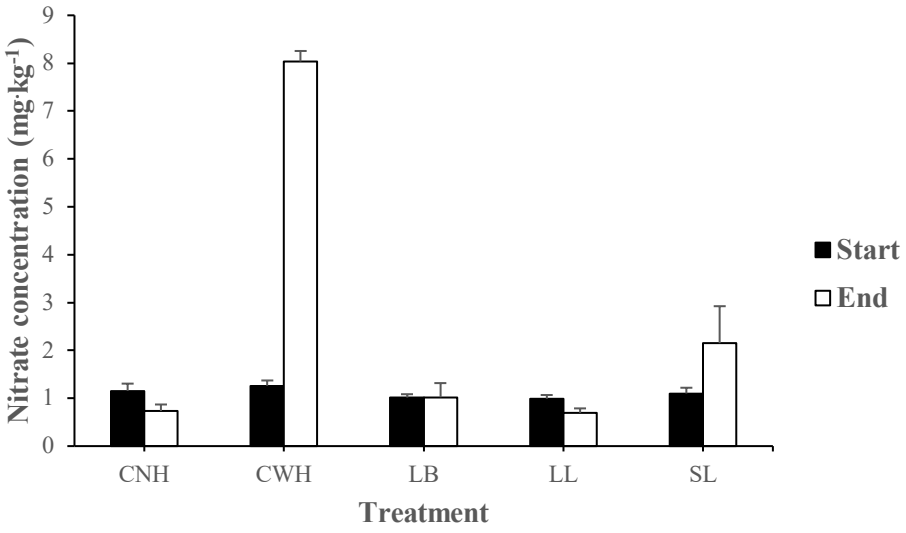

Figure 41: Soil nitrate concentration in tilled environment. CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL =longleaf pine straw, SL = slash pine straw (n = 3).

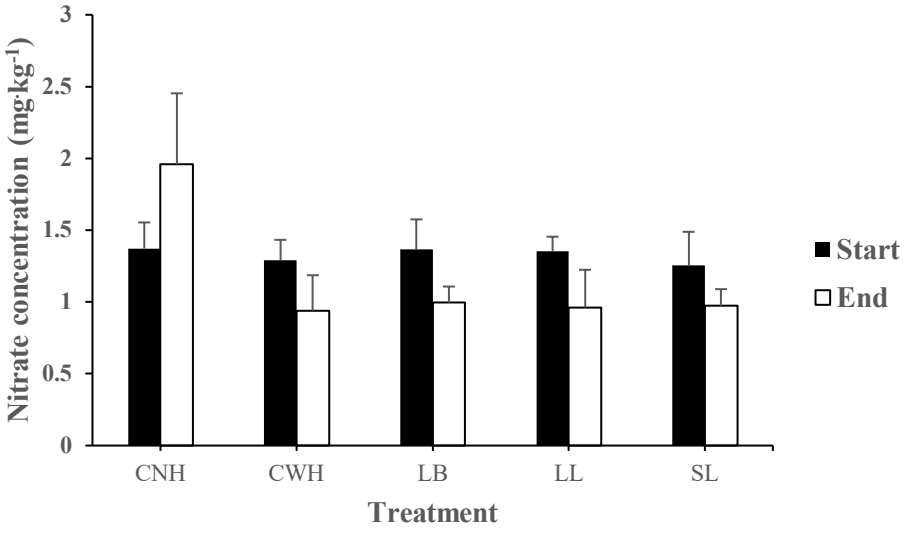

Figure 42: Soil nitrate concentration in shaded environment. CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL =longleaf pine straw, SL = slash pine straw (n = 3).

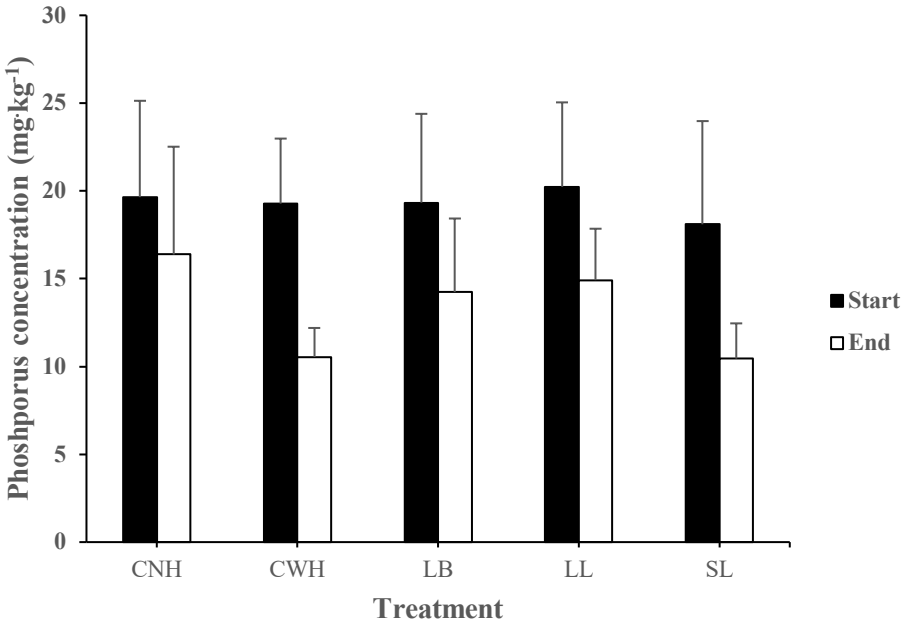

Figure 43: Soil phosphorus concentration. Soil measurements before treatment application at the beginning of the growing season and at the end of the growing season, which included treatment application. CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL = slash pine straw (n = 9).

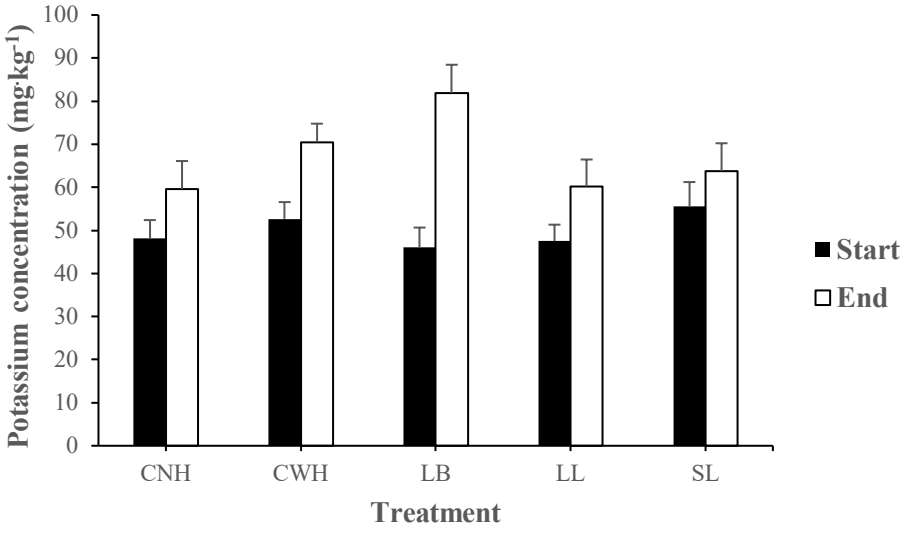

Figure 44: Soil potassium concentration. Soil measurements before treatment application at the beginning of the growing season and at the end of the growing season, which included treatment application. CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL = slash pine straw (n = 9).

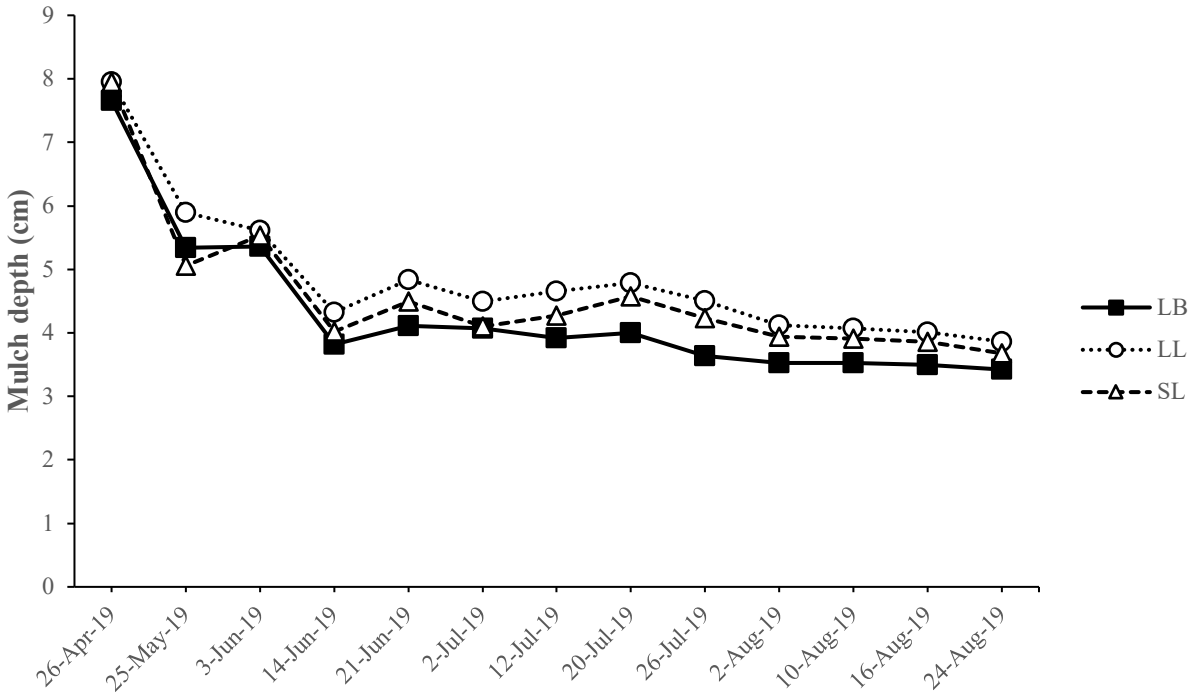

Figure 45: Pine straw treatment depth change. CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL = slash pine straw (n = 9).

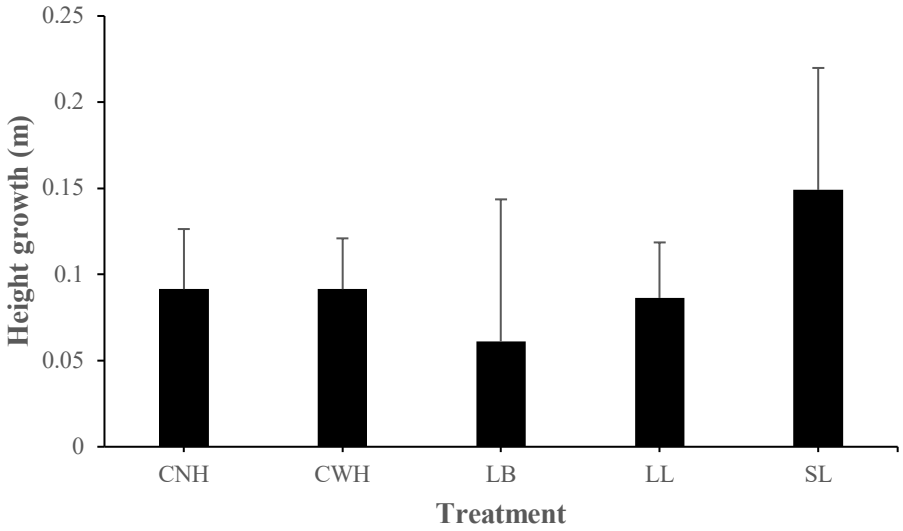

Figure 46: Height growth of eastern redbud (*Cercis canadensis*). CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL = slash pine straw (n = 9).

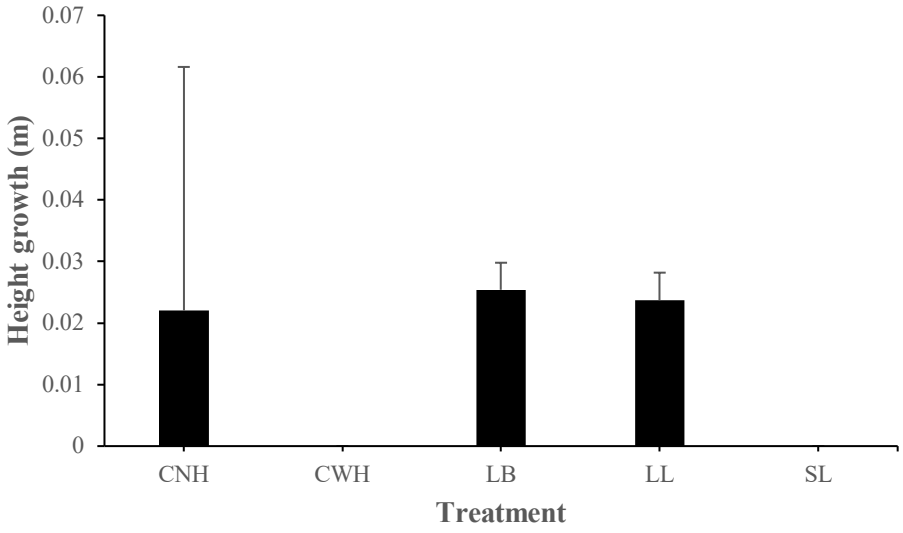

Figure 47: Height growth of Shumard oak (*Quercus shumardii*). CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL = slash pine straw (n = 9).

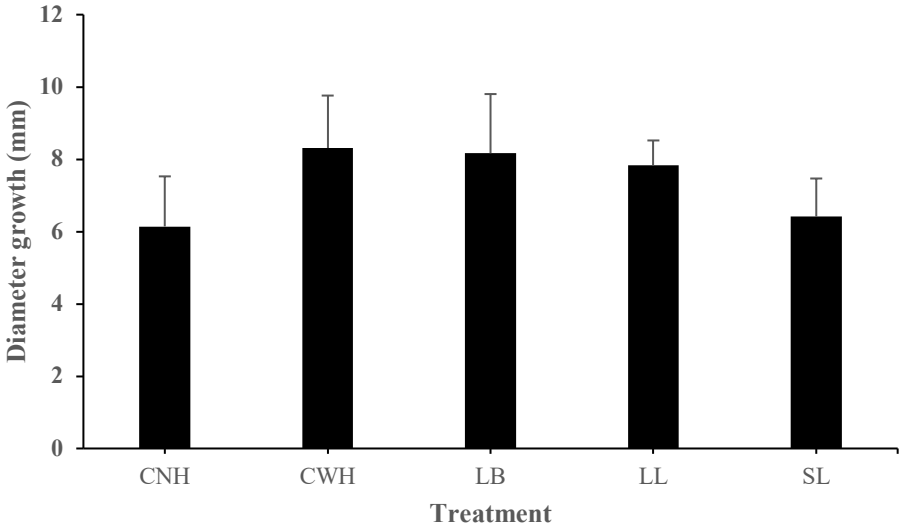

Figure 48: Diameter growth of eastern redbud (*Cercis canadensis*). CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL = slash pine straw (n = 9).

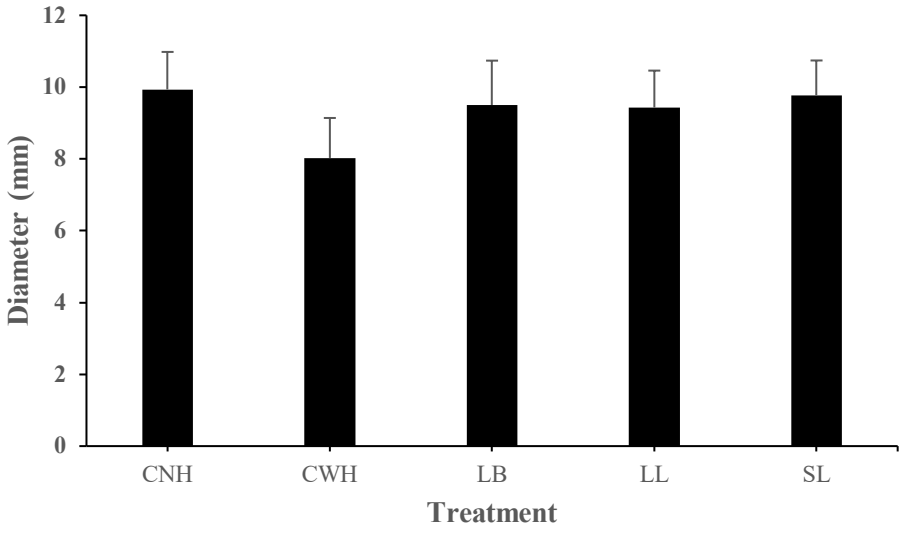

Figure 49: Diameter growth of Shumard oak (*Quercus shumardii*). CNH = control no herbicide, CWH = control with herbicide, LB = loblolly pine straw, LL = longleaf pine straw, SL = slash pine straw (n = 9).

4.4 Economic price differential analysis between longleaf and slash pine straw

The pine straw industry is largely without standards for bale size and prices per bale. Pine straw is typically either sold as square bales or round bales. Round bales are much larger and claim to be approximately twice the size of square bales. The pine straw used in our study was purchased in square bales and had average weight of 6.5 kg for longleaf pine straw and 5.4 kg for slash pine straw. We omitted loblolly pine from this analysis as no bales were found for purchase. It clearly seems that longleaf pine straw and slash pine straw are the two dominant straw types available on the market in Alabama. Longleaf pine straw is commonly sold at a premium compared to slash pine straw and is often marketed as such. For our study, longleaf pine cost $4.25 and slash pine $3.75 per square bale.

Due to the lack of such standards, we decided to research prices for pine straw bales sold at various locations across Alabama to determine if there was a large price differential. To do so, pine straw vendor contacts were collected and were messaged about their pine straw. It was clear that longleaf pine straw is the most common as we were able to obtain prices from 26 different businesses across the state. Slash pine straw prices were much harder to obtain as only six different business were found that were able to provide a price. The overall average price per square bale for longleaf pine straw was $4.78 and $4.18 for slash pine straw. That is a 14.35% higher price per bale for longleaf compared to slash pine straw. For longleaf pine straw, it was found that there is a considerable price differential across the state for square bales. The largest price differential was 78% between the highest and lowest price obtained through our research and had an average price differential of 36%. For slash pine straw, a similar result was found, however, we do have account for much smaller sample size. The largest price differential was 79% between the highest and lowest price obtained through our research and had an average

price differential of 43.5%. Due to lack of data obtained on prices across the state it is not possible to analyze the data by region or county in the state. However, Baldwin County in southern part of the state, Tuscaloosa County in the central part of the state, and Madison County in the northern part of the state produced the highest prices per bale we received. Each of these areas of the state are some of the more populated. Further research could find that more densely populated urban areas would have higher prices per bale for either species of straw.

For the attributes tested in this study, longleaf and slash pine straw performed equally as well. Both straw types had similar decomposition rates, maintained soil moisture, regulated soil temperature, and controlled weed growth. Longleaf pine straw did maintain significantly higher depth than slash pine straw over the duration of the study. Color change was recorded and both species behaved similarly, as recorded for the end of each month (Table 8). So, based on the attributes expected to receive from purchasing pine straw for landscaping, it begs the question of whether longleaf pine straw is worth the premium price compared to slash pine straw? From an attributes stand point, there does not appear to be any reason for it. Based on our decomposition and color change results, you will need to replace or replenish the straw types around the same time, regardless of which you choose. So, it appears the willingness to pay the premium price for longleaf pine straw will come down to its aesthetics value. If you like the way longleaf pine straw looks in your landscaping compared to slash pine straw, it may be worth the extra cost, but in-terms of the attributes of using pine straw as a mulch compared to not using any mulch for the attributes we studied, slash pine performs just as well.

Figures and Tables

Table 8: Monthly pine straw color change by environment type and treatment over the course of the study.

Plot	Rep	Environment	Treatment	26-Apr-19	31-May-19	27-Jun-19	26-Jul-19	10-Aug-19
1	1	Open	Loblolly					
10	2	Open	Loblolly					
15	3	Open	Loblolly					
4	1	Open	Longleaf					
7	2	Open	Longleaf					
13	3	Open	Longleaf					
2	1	Open	Slash					
9	2	Open	Slash					
12	3	Open	Slash					
35	1	Shade	Loblolly					
39	2	Shade	Loblolly					
41	3	Shade	Loblolly					
32	1	Shade	Longleaf					
37	2	Shade	Longleaf					
44	3	Shade	Longleaf					
34	1	Shade	Slash					
36	2	Shade	Slash					
42	3	Shade	Slash					
18	1	Tilled	Loblolly					
21	2	Tilled	Loblolly					
26	3	Tilled	Loblolly					
20	1	Tilled	Longleaf					
22	2	Tilled	Longleaf					
30	3	Tilled	Longleaf					
19	1	Tilled	Slash					
25	2	Tilled	Slash					
28	3	Tilled	Slash					

4.5 Discussion and Conclusion

Use of pine straw treatments in this study increased soil moisture, moderated soil temperature, reduced weed growth. Benefits were associated with the use of pine straw as a compared to not using any mulch, rather than by specific pine straw treatments. Other studies found similar results with the use of mulch (e.g., Iles and Dosmann 1999, Cook et al. 2006, Johansson et al. 2006, Maggard et al. 2012).

Effects of Pine Straw on Soil Properties

It has been well observed that the use of mulch increases soil moisture (Watson 1988, Greenly and Rakow 1995, Zhang et al. 2008, Maggard et al. 2012). However, the effect of pine straw as a mulch on soil moisture has not been well documented. In our study, the use of pine straw as a mulch increased soil moisture and is consistent with these other studies on mulch. This could be attributed to the mulch reducing the soil temperature, which lowers evapotranspiration. Additionally, it could be attributed to reduction of weed growth, which reduces the transpiration. Similar to Maggard et al. (2012), after heavy rainfall, soil moisture did not differ between pine straw treatments and control treatments. As soils dried out, a difference between pine straw treatments and control treatments was observed, however, no differences were observed among different pine straw treatments alone.

Like soil moisture, it has been well observed that the use of mulch moderates and can decrease soil temperature (Cook et al. 2006, Maggard et al. 2012). In our study, pine straw moderated soil temperature throughout the growing season and decreased soil temperature. As soil temperatures increased throughout the growing season, the pine straw treatments moderated and decreased soil temperature relative to the control treatments. Other studies on various mulch

types found that shading and insulation provided by mulch moderates soil temperature (Cook et al. 2006, Maggard et al. 2012), keep soil cooler during the day and warmer overnight (Maggard et al. 2012), and have found that mulch color can impact soil temperature (Cook et al. 2006). Our study did not detect differences in soil temperature among different pine straw types, which could be due to the depth of our straw treatments as each treatment plot had a depth of 7.6 cm. Another likely cause could be that each pine straw type treated had close similarities in color. The effect of mulch on soil pH is inconsistent. Mulches have been found to increase, decrease, and not alter soil pH. Studies have reported that mulch decreased soil pH (Billeaud and Zajicek 1989, Duryea et al. 1999). However, Iles and Dosmann (1999) found that soil pH increased in mulched environments. Regarding pine straw, a study found that longleaf pine straw decreased soil pH by 0.56 units (Makus et al. 1994). Duryea et al. (1999) also found similar findings in that pine straw decreased soil pH. However, Binkley (2002) found that loblolly pine did not have a large affect soil pH, as it decreased from 3.1 to 3.5. There is much confliction as to what effects mulch has on soil pH. In our study, soil pH increased in all plots and treatments did not significantly alter it. In terms of pine straw as a mulch, our results were comparable to that of Iles and Dosmann (1999), who used shredded bark and wood chips mulch where the use of mulch increased soil pH.

Mulches can affect soil fertility by way of decomposition or leaching. In our study, there were mixed results regarding soil nitrate. For the tilled environment, soil nitrate increased across all plots and increased significantly greater in the CWH plots. Additionally, within the tilled environment, soil nitrate in slash pine straw plots were significantly greater than longleaf pine straw plots and CNH plots. However, mean soil nitrate decreased across all plots in the open and shaded environments. In times of heavy rainfall, the shaded environment in our study would

become saturated and was slower to dry out compared to the two full-sun, open environment types. This could cause denitrification, which could lower the soil nitrate levels.

Effects of Pine Straw on Weed Growth

Mulches, in general, have been known to suppress weed growth. It has been well observed that the use of mulch, rather than the type of mulch, reduces weed growth (Broschat 1997, Abouziena 2008, Maggard 2012). In our study, similar results were found. The use of pine straw, as opposed to not using it, decreased weed growth. Likewise, there were no differences among the three pine straw treatments. Weeds that did penetrate the mulch layer, tended to be courser, creating a path of sunlight for additional weed growth. This has also been noted in a previous study (Maggard 2012).

Effects of Pine Straw on Tree Growth

The use of mulch provides several benefits, such as increased soil moisture and weed suppression, which can benefit tree growth. It has been observed that the use of mulch can increase tree diameter or height growth (Greenly and Rakow 1995, Maggard 2012). However, in our study, the use of pine straw did not affect height growth or diameter growth. This is inconsistent with other literature (Greenly and Rakow 1995, Maggard et al. 2012). In our study, we used bareroot trees to eliminate any potting soil effects. Therefore, establishment of trees in our study was prolonged and likely caused a delay in mulch effects, if any were to be observed. An additional growing season would likely be needed to encompass the full effects of pine straw on tree growth.

Decomposition

There have been several studies that have monitored decomposition among southern pine species needle fall (e.g. Gholz et al. 1985, Sanchez 2001, Binkley 2002). Gholz et al. (1985) found that over the course of two years the average decay rate for slash pine was about 15% mass loss per year. Regarding loblolly pine straw, Binkley (2002) found that loblolly pine litter lost approximately 80% of its organic matter over the course of 10 years, and Sanchez (2001) found that loblolly pine litter had lost 45% of its mass after 3 years. However, to the best of our knowledge, pine straw decomposition rates have not been studied in a landscape setting as a mulch. In our study, we found that loblolly pine straw decomposed faster than both slash and longleaf pine straw. On a year to year basis, the literature shows that loblolly and slash pine had somewhat similar decomposition rates. However, a potential influence for our results could be related to the age of the pine straw. The loblolly pine straw in our study had to be raked as it was unavailable for purchase. It was raked fresh about a week prior to mulching. However, the ages of the longleaf and slash pine straw that was purchased was unclear and the time from harvesting to purchase and use could not be determined.

Pine Straw Depth

The depth change over time for pine straw has not been well documented. In our study, we found that longleaf pine straw plots maintained a greater depth than both loblolly and slash pine straw plots. We also found that slash pine straw plots maintained a greater depth than loblolly pine straw plots. This could be attributed to the length on the pine needle and how the needles interlock and rest on the ground. Further research could help answer this question.

Conclusion

This study indicates that the use of pine straw as a mulch increased soil moisture, moderated soil temperature, reduced weed growth. This provides evidence that the use of pine straw as a mulch can provide benefits as a horticultural practice in a landscape setting. In relation to our objective to compare the attributes among longleaf, loblolly, and slash pine straw, each of the southern straw types performed similarly and provided benefits over not using a mulch type. As anecdotal information on the benefits, qualities, and markets for consumers appear to favor longleaf pine straw, from the major attributes we studied, slash and loblolly pine are worthy options and should be considered. It appears whether the premium often paid for longleaf pine straw is worthy or not should be considered based on the consumers appearance preference of the pine straw types.

Chapter 5

Conclusion

The questionnaire, Supplemental income opportunities and forest management practices, provided insight into FFLs ownerships, reasons for owning forestland, income generation, and forest management practices of Alabama FFLs. These FFLs are interested in income generation, and they are aware and understand the importance of forest management practices. However, many face the barrier of lack of knowledge, which can deter them from taking the next step in forest management. This highlights the importance of effectively reaching and engaging these landowners to better understand their wants and needs. It also highlights the need to connect professionals to these landowners so they can assist landowners in making decisions.

Further looking into the alternative income side of things, the questionnaire, Assessment of supplemental income generation by family forest owners in Alabama, provided more information about FFLs and further information about the relative interests about alternative income generation. It also provided more information about the methods, management, operations, and barriers of alternative income enterprises. With these alternative income opportunities, the standards for many of these opportunities on forestland are lacking. This is where further research can benefit, as many FFLs are looking to engage in these opportunities but they lack the knowledge of how to start and implement this enterprise. This reiterates the importance of connecting these FFLs with professionals to help them make decisions for their forestland's future but also highlights a knowledge gap in this area for professionals that needs to be addressed through expanded research on markets, owning and operating microenterprises, and creating specific standards for such opportunities. There are opportunities for landscape scale improvements of native ecosystems that arise from both of these surveys. Through the education

and engagement with these FFLs on the importance of good forest management practices and better business practices, it can create income opportunities through natural resource enterprises. In turn, it can help improve the economic well-being of the landowners, but also improve the health and sustainability of native ecosystems.

One way to help these FFLs understand more about alternative income opportunities is to fill information gaps that exist within the literature or available media. To achieve this, we looked at a common NTFP, pine straw. Anecdotally, longleaf pine straw was regarded as the best species of the three southern pine species used for mulch. However, by performing this field study, we were able to show that all three species of pine straw provide similar benefits when used as a mulch. Regarding the preference of one species over another or paying the premium associated with longleaf could be based on consumer preference. Further research needs to focus on standards for pine straw freshness and bale sizes, needs or requirements for refreshing pine straw when used as a mulch and the aesthetic values they provide.

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Appendix A

Survey – Supplemental income opportunities and forest management practices

Dr. Adam O. Maggard
Assistant Professor & Forestry Extension Specialist
3301 School of Forestry and Wildlife Sciences
Auburn University, AL 36849
Phone: 334-844-2401
Email: adm0074@auburn.edu

Please make corrections to name, address, and Zip Code, if necessary.

The information you provide will be used for statistical purposes only. In accordance with the Confidential Information Protection provisions of Title V, Subtitle A, Public law 107-347 and other applicable Federal Laws, your responses will be kept confidential and will not be disclosed in identifiable form to anyone other than employees or agents. By law, every employee and agent has taken oath and is subject to a jail term, a fine, or both if he or she willfully discloses ANY identifiable information about you or your operation. Response is voluntary.

The time required to complete this information collection is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Q1. How many acres of forestland do you own in Alabama?

Q2. What is the primary reason for owning your forestland?

- ○ Timber production
- ○ Hunting and/or fishing
- ○ Other recreation
- ○ Land investment
- ○ Non-timber forest products (NTFP)
- ○ Beauty/scenery
- ○ Protect or improve wildlife habitat
- ○ Privacy
- ○ Where you live
- ○ Protect natural resources including water
- ○ Other (please specify): _____

Q3. Do you have interests in generating income from your forestland?

- ○ Definitely yes
- ○ Probably yes
- ○ Might or might not
- ○ Probably not
- ○ Definitely not

Q4. Do you currently generate any income from your forestland? ***(If you select No, please skip to Q14.)***

- ○ Yes
- ○ No

Q5. Do you plan to continue generating income from timber harvest from your forestland in the future?

- ○ Definitely yes
- ○ Probably yes
- ○ Might or might not
- ○ Probably not
- ○ Definitely not

Q6. How much total income in dollars (per acre) do you generate from your forestland annually? ***(including from harvesting timber)***

Q7. Do you currently or have you ever generated income from harvesting timber on your forestland? ***(If you select No, please skip to Q9.)***

- ○ Yes
- ○ No

Q8. Approximately, what percentage (%) of income generated from your forestland comes from harvesting timber?

Q9. Do you currently or have you ever generated income from your forestland other than from harvesting timber? ***(If you select No, please skip to Q14.)***

- ○ Yes
- ○ No

Q10. Approximately, what percentage (%) of income generated from your forestland comes from means other than harvesting timber?

Q11. For income generated from your forestland other than timber harvest, ***please select all that apply below.***

- ○ Pinestraw
- ○ Hunting/fishing lease
- ○ Agritourism (please specify) _____
- ○ Silvopasture (please specify) _____
- ○ Floral and decorative (please specify) _____
- ○ Culinary (edibles) (please specify) _____
- ○ Medicinal and dietary (please specify) _____
- ○ Agroforestry crops (please specify) _____
- ○ Recreation other than hunting/fishing (please specify) _____
- ○ Other (Please specify) _____

Q12. Please answer the following. For those you did not select, please answer N/A.

	What is your opinion of the market availability for your products?						How do you sell your products?			Please list yearly revenues in dollars and acres for each of your selections	
	Very strong	Strong	Moderate	Weak	Very weak	N/A	Contract with third party	Sell them on your own	N/A	Revenue ($)	Acres
Pinestraw	○	○	○	○	○	○	○	○	○		
Hunting/fishing lease	○	○	○	○	○	○	○	○	○		
Agritourism	○	○	○	○	○	○	○	○	○		
Silvopasture	○	○	○	○	○	○	○	○	○		
Floral and decorative	○	○	○	○	○	○	○	○	○		
Culinary (edibles)	○	○	○	○	○	○	○	○	○		
Medicinal and dietary	○	○	○	○	○	○	○	○	○		
Agroforestry crops	○	○	○	○	○	○	○	○	○		
Recreation other than hunting/fishing (please list)	○	○	○	○	○	○	○	○	○		
Other (please list)	○	○	○	○	○	○	○	○	○		

Q13. Please describe any issues, concerns, or needs you have or may face from sources of or opportunities to generate income other than from timber harvest on your property. (This information will be used as a needs assessment)

Q14. How important is managing your forestland to you?

- ○ Extremely important
- ○ Very important
- ○ Moderately important
- ○ Slightly important
- ○ Not at all important

Q15. Are you concerned about the health and resiliency of your forestland? ***(If you select None at all, please skip to Q17.)***

- ○ A great deal
- ○ A lot
- ○ A moderate amount
- ○ A little
- ○ None at all

Q16. If you are concerned about your forestland's health, please indicate your level of concern about each of the following:

	A great deal	A lot	A moderate amount	A little	None at all
Damage from animals	○	○	○	○	○
Drought or water availability	○	○	○	○	○
Invasive species	○	○	○	○	○
Pollution (air/water)	○	○	○	○	○
Climate change	○	○	○	○	○
Wildfire	○	○	○	○	○
Insects and/or diseases	○	○	○	○	○
Severe storm damage (wind, lightening, ice/snow)	○	○	○	○	○
Poor forest management decisions	○	○	○	○	○
Other (please specify)	○	○	○	○	○

Q17. Please answer Yes or No to each of the questions below. ***(If you select No for "Do you currently manage your forestland?", please skip to Q20.)***

	Have you ever received management advice for your forestland?	Do you currently manage your forestland?	Do you have a written management plan?
Yes	○	○	○
No	○	○	○

Q18. Do you get assistance managing your forestland? ***(please select all that apply)***

- ○ Private consultant
- ○ State or local government employee
- ○ Extension forester or other university employee
- ○ Another landowner
- ○ Federal government employee
- ○ Friend or family
- ○ I don't get assistance managing my forestland, I do it myself
- ○ Other (please specify) _____

Q19. What do you manage for on your forestland? ***(please select all that apply)***

- ○ Timber
- ○ Wildlife or wildlife habitat
- ○ Insects and/or diseases
- ○ Conservation
- ○ Fire protection
- ○ Invasive species
- ○ Non-timber forest products (NTFP)
- ○ Recreation
- ○ Other (please specify) _____

Q20. If you do not manage your forestland, what is keeping you from doing so? ***(please select all that apply)***

- ○ Not interested (please specify) _____
- ○ Interested, but too expensive
- ○ Interested, but not sure what to do or how to do it
- ○ Interested, but do not have the time to do it
- ○ Other (please specify) _____

Q21. Are you familiar with carbon sequestration? ***(If you select Yes, please skip to Q23.)***

- ○ Yes
- ○ No

Q22. ***(If you selected No for Q21)*** Would you be interested in learning about carbon sequestration?

- ○ Definitely yes
- ○ Probably yes
- ○ Might or might not
- ○ Probably not
- ○ Definitely not

Q23. ***(If you selected Yes for Q21)*** Do you currently or have you ever managed to increase carbon sequestration?

- ○ Yes
- ○ No

Q24. Would you be interested in managing for carbon sequestration on your forestland if there were incentives available?

- ○ Definitely yes
- ○ Probably yes
- ○ Might or might not
- ○ Probably not
- ○ Definitely not

Q25. Do you currently receive incentives of any type from different programs for your forestland?

- ○ Yes
- ○ No

Q26. Are you interested in learning about incentive programs available for your forestland?

- ○ Definitely yes
- ○ Probably yes
- ○ Might or might not
- ○ Probably not
- ○ Definitely not

Q27. Thank you for taking the time to complete the survey. Please list any comments or further information below that you may have regarding your forestland, forest management, or generating income from your forestland.

For an online version of this survey, contact Dr. Adam Maggard by email. adm0074@auburn.edu

Please return your completed survey by month day, year

Thank you again for your willingness help with this important survey!

Appendix B

Dr. Adam O. Maggard
Forestry Extension Specialist
3301 School of Forestry and Wildlife Sciences
Auburn University, AL 36849
Email: adm0074@auburn.edu
Phone: 334-844-2401

Dear Sir or Madam,

You are invited to participate in a research study to obtain information on producing income and forest management practices on family forestland in Alabama. The objective of this study is to gain knowledge about alternative income generating opportunities for family forest landowners and to better understand their motivation or lack thereof for managing their forestland. The study is being conducted by Dr. Adam O. Maggard, Alabama Cooperative Extension System Specialist, in the Auburn University School of Forestry and Wildlife Sciences. You were selected as a possible participant because you are a family forestland owner and are age 19 or older.

In a few days you will receive a copy of the survey in the mail. If you decide to participate in this research study, you will be asked to fill out a questionnaire reporting income generating practices other than timber on your forestland and information regarding current forest management practices on your forestland, and return your responses in the postage-paid envelope provided. If you would prefer, responses may also be emailed to me using the address above.

Your total time commitment will be approximately 10-15 minutes. Your participation is completely voluntary and your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University, the School of Forestry and Wildlife Sciences, or the Alabama Cooperative Extension System. Any information obtained in connection with this study will remain anonymous. Information obtained through your participation will be used to fulfill and educational requirement, published in a professional journal, presented at a professional meeting, and used to develop outreach materials. If you change your mind about participating you can withdraw at any time during the study. If you choose to withdraw, your data can be deleted as long as it is identifiable.

If you have questions about this study, please contact me using the information above. If you have questions about your rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone at (334)-844-5966 or email at hsubjec@auburn.edu or IRBChair@auburn.edu.

This research can only be successful with the generous help of people like you.

Sincerely,

Dr. Adam O. Maggard
Forestry Extension Specialist
Alabama Cooperative Extension System

The Auburn University Institutional Review Board has approved this Document for use from 04/25/2018 to ---
Protocol # 18-123 EX 1804

Appendix C

Dr. Adam O. Maggard
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Email: adm0074@auburn.edu
Phone: 334-844-2401

(NOTE: DO NOT AGREE TO PARTICIPATE UNLESS AN IRB APPROVAL STAMP WITH CURRENT DATES HAS BEEN APPLIED TO THIS DOCUMENT.)

INFORMATION LETTER
For a Research Study entitled
"Beyond the timberline: Assessment of supplemental income opportunities and forest management practices of family forest owners in Alabama"

Dear Sir or Madam,

You are invited to participate in a research study to obtain information on alternative income generating opportunities other than timber, and current forest management practices or lack thereof on family forestland in Alabama. The study is being conducted by Dr. Adam O. Maggard, Alabama Cooperative Extension System Specialist, in the Auburn University School of Forestry and Wildlife Sciences. This study is made possible in cooperation with the Alabama Forests Forever Foundation. You are invited to participate because you are a family forestland owner and are age 19 or older.

What will be involved if you participate? If you decide to participate in this research study, you will be asked to fill out the enclosed questionnaire reporting income generating practices other than timber on your forestland and information regarding current forest management practices on your forestland, and return your response in the postage-paid envelope provided. If you prefer, you can fill out the survey using the following link: https://auburn.qualtrics.com/jfe/form/SV_aVrNdICUpE9JPXD. Your total time commitment will be approximately 10-15 minutes depending on the availability of your information.

Are there any risks or discomforts? The risks and discomforts associated with participating in this study are minimal but may include taking an extended period of time to complete the survey.

Are there any benefits to yourself or others? The information collected will be made available for landowners and resource professionals through national extension websites, professional publications, presentations, and a thesis. The readily available information will be used to assist family forest landowners with income generating opportunities, business management, and forest management and planning to enhance the health and resiliency of their forests. This will benefit landowners and resource professionals by better understanding the importance managing forests, helping them make more informed management decisions, and better understand opportunities to generate income from forests. I cannot promise you any or all of the benefits described will be received.

Will you receive compensation for participating? No, there is no compensation for completing this survey.

Are there any costs? If you decide to participate, costs should be minimal. Postage-paid return envelopes are provided for your use. The primary cost to you will be in time expended to complete the survey.

If you change your mind about participating you can withdraw at any time during the study. Your participation is completely voluntary. If you choose to withdraw, your data can be deleted as long as it is identifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University, the School of Forestry and Wildlife Sciences, or the Alabama Cooperative Extension System.

Any data obtained in connection with this study will remain anonymous. We will protect your privacy and the data you provide will never connected your name to your responses once it is returned. The data will be anonymous. We ask that you do not write your name or other information associated with your or your business on the questionnaire. Any information obtained in connection with this study will not be connected to the participant at any time during data collection or storage.

If you have any questions about this study please contact Dr. Adam Maggard by phone at (334)-844-2401 or by email at adm0074@auburn.edu.

If you have any questions about your rights as a research participant you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone at (334)-844-5966 or email at hsubjec@auburn.edu or IRBChair@auburn.edu.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE THE DATA YOU PROVIDE WILL SERVE AS YOUR AGREEMENT TO DO SO. THIS LETTER IS YOURS TO KEEP.

Sincerely,

Dr. Adam O. Maggard
Forestry Extension Specialist
Alabama Cooperative Extension System

The Auburn University Institutional Review Board has approved this Document for use from 04/25/2018 to ---
Protocol # 18-123 EX 1804

Appendix D

Dr. Adam O. Maggard
Forestry Extension Specialist
3301 School of Forestry and Wildlife Sciences
Auburn University, AL 36849
Email: adm0074@auburn.edu
Phone: 334-844-2401

Dear Sir or Madam,

Several days ago you received a survey about alternative income generating opportunities and current forest management practices on family forestland in Alabama.

I am writing again because of the importance that your response holds for helping to get accurate results. If you have already completed and returned the questionnaire, thank you for your valuable time! We rely on research participation from people like you to help guide outreach programming statewide.

If for any reason you prefer not participate, please let me know by sending a note or blank survey. If you have any questions about this survey, please feel free to contact me from the information listed above.

Sincerely,

Dr. Adam O. Maggard
Forestry Extension Specialist
Alabama Cooperative Extension System

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE THE DATA YOU PROVIDE WILL SERVE AS YOUR AGREEMENT TO DO SO. THIS LETTER IS YOURS TO KEEP.

Appendix E

Assessment of supplemental income generation by family forest owners in Alabama

Dr. Adam O. Maggard
Assistant Professor & Forestry Extension Specialist
3301 School of Forestry and Wildlife Sciences
Auburn University, AL 36849
Phone: 334-844-2401
Email: adm0074@auburn.edu

Please make corrections to name, address, and Zip Code, if necessary.

The information you provide will be used for statistical purposes only. In accordance with the Confidential Information Protection provisions of Title V, Subtitle A, Public law 107-347 and other applicable Federal Laws, your responses will be kept confidential and will not be disclosed in identifiable form to anyone other than employees or agents. By law, every employee and agent has taken oath and is subject to a jail term, a fine, or both if he or she willfully discloses ANY identifiable information about you or your operation. Response is voluntary.

The time required to complete this information collection is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Q1. How many acres of forestland do you own?

- o < 10 acres
- o 10-50 acres
- o 51-100 acres
- o 101-200 acres
- o 201-500 acres
- o 501-1000 acres
- o > 1000 acres
- o None. ***(Thank you for your time. Please leave remainder of survey blank, and return it in the envelope provided).***

Q2. Which of the following best represents the ***majority*** of your forestland?

- o Natural loblolly pine
- o Natural longleaf pine
- o Natural slash pine
- o Planted loblolly pine
- o Planted longleaf pine
- o Planted slash pine
- o Natural hardwoods
- o Planted hardwoods
- o Mixed pine and hardwood
- o Other (*Please specify*) _____

Q3. In which Alabama County is the ***majority*** of your forestland located?

_____

Q4. Do you live in the same county where the ***majority*** of your forestland is located?

- o Yes
- o No

Q5. Is your primary residence located on your forestland?

- o Yes
- o No

Q6. What is the main reasons for owning your forestland? **(If more than one applies, please list a primary reason and then up to two secondary reasons. If less than three reasons apply, select N/A for secondary reason #1 and/or secondary reason #2).**

- o Timber production
- o Hunting and/ or fishing
- o Other recreation
- o Land investment
- o Non-timber forest products
- o Beauty/ scenery
- o Protect or improve wildlife habitat
- o Privacy
- o Where you live
- o Protect or improve natural resources including water
- o Other (Please specify)

  _____
- o N/A

Primary Reason
_____
Secondary Reason #1
_____
Secondary Reason #2
_____

Q7. Do you have interests in generating income from your forestland from sources other than timber harvests?

- o Yes
- o No

Q8. Do you currently generate any income from your forestland from sources other than timber harvests?

- o Yes
- o No

Q9. Do you plan to or have you ever generated income from your forestland from means other than timber harvest? (i.e. hunting lease, pinestraw, conservation easements, etc.) ***(If you select no please SKIP to question #16)***

- o Yes
- o No

Q10. Approximately, what percentage (%) of your yearly income generated by your forestland comes from sources other than harvesting timber?

- o 0%
- o 1-10%
- o 11-25%
- o 26-50%
- o 51-75%
- o 76-100%

Q11. For income generated from your forestland other than timber harvest, ***please select all that apply below.***

- o Pinestraw (Please specify what type) _____
- o Hunting/ fishing lease (Please specify what type) _____
- o Agritourism (Please specify) _____
- o Silvopasture (Please specify) _____
- o Floral and decorative (Please specify) _____
- o Culinary (edibles) (Please specify) _____
- o Medicinal and dietary (Please specify) _____
- o Agroforestry crops (Please specify) _____
- o Recreation other than hunting/ fishing (Please specify) _____
- o Other (Please specify) _____

Q12. Do you manage your supplemental income activity/activities, or do you use a professional service (***i.e., consultant***)?

- o I do
- o Professional manages it
- o Other (Please specify) _____

Q13. Based on your answer from Q8, what is the most concerning to you? **(If more than one applies, please list a primary concern and then up to two secondary concern. If less than three reasons apply, select N/A for secondary concern #1 and/or secondary concern #2).**

- o Property Access
- o Property Damage
- o Lack of equipment
- o Impacts of timber production
- o Wildlife damage
- o Liability issues
- o Property size
- o Location to property (i.e. Live too far)
- o Lack of knowledge (i.e. Not sure what to do or how to do it)
- o Federal Program Restrictions
- o Financial concerns (i.e. Costs, profitability, markets, etc.)
- o Other (Please specify) _____
- o N/A

Primary Concern
_____
Secondary Concern #1
_____
Secondary Concern #2
_____

Q14. How do you sell your products?

- o Contracted out
- o On my own (***Please explain how;*** farmers market, roadside, storefront, from home, etc.)

  _____

- o Other (Please specify) _____

Q15. What influenced your decision to pursue alternative income opportunities from your forestland?

- o Poor timber markets
- o More consistent income stream
- o Resource availability
- o Market availability
- o Help pay for property and management costs
- o Hobby or interests (not financially driven)
- o Other (please specify) _____

Q16. (If you selected No to Question #9) What is preventing you from pursuing alternative income opportunities on your forestland? (***Please select all that apply below***)

- o Property access
- o Property damage
- o Lack of equipment
- o Impacts to timber production
- o Wildlife damage
- o Liability issues
- o Property size
- o Location to property (i.e. I live too far away)
- o Lack of knowledge (i.e. Not sure what to do or how to do it)
- o Federal program restrictions (if applicable)
- o Financial concerns (i.e. costs, profitability, markets, etc.)
- o Lack of interests
- o Others (please specify) _____

Q17. Thank you for taking the time to complete the survey. Please list any comments or further information below that you may have regarding your forestland or generating supplemental income from your forestland.

For an online version of this survey, contact Dr. Adam Maggard by email. adm0074@auburn.edu

Please return your completed survey by month day, year

Thank you again for your willingness help with this important survey!

Appendix F

Dr. Adam O. Maggard
Forestry Extension Specialist
3301 School of Forestry and Wildlife Sciences
Auburn University, AL 36849
Email: adm0074@auburn.edu
Phone: 334-844-2401

Dear Sir or Madam,

You are invited to participate in a research study to obtain information on assessing supplemental income generation by family forestland owners in Alabama. The objective of this study is to gain knowledge about supplemental income generated by family forest landowners. The study is being conducted by Dr. Adam O. Maggard, Alabama Cooperative Extension System Specialist, in the Auburn University School of Forestry and Wildlife Sciences. You were selected as a possible participant because you are a family forestland owner and are age 19 or older.

In a few days you will receive a copy of the survey in the mail. If you decide to participate in this research study, you will be asked to fill out a questionnaire reporting information about income generating practices other than timber on your forestland and return your responses in the postage-paid envelope provided. If you would prefer, responses may also be emailed to me using the address above.

Your total time commitment will be approximately 5-10 minutes. Your participation is completely voluntary and your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University, the School of Forestry and Wildlife Sciences, or the Alabama Cooperative Extension System. Any information obtained in connection with this study will remain anonymous. Information obtained through your participation will be used to fulfill and educational requirement, published in a professional journal, presented at a professional meeting, and used to develop outreach materials. If you change your mind about participating you can withdraw at any time during the study. If you choose to withdraw, your data can be deleted as long as it is identifiable.

If you have questions about this study, please contact me using the information above. If you have questions about your rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone at (334)-844-5966 or email at hsubjec@auburn.edu or IRBChair@auburn.edu.

This research can only be successful with the generous help of people like you.

Sincerely,

Dr. Adam O. Maggard
Forestry Extension Specialist
Alabama Cooperative Extension System

Appendix G

Dr. Adam O. Maggard
Forestry Extension Specialist
3301 School of Forestry and Wildlife Sciences
Auburn University, AL 36849
Email: adm0074@auburn.edu
Phone: 334-844-2401

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INFORMATION LETTER
For a Research Study entitled
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Will you receive compensation for participating? No, there is no compensation for completing this survey.

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Sincerely,

Dr. Adam O. Maggard
Forestry Extension Specialist
Alabama Cooperative Extension System

Appendix H

Dr. Adam O. Maggard
Forestry Extension Specialist
3301 School of Forestry and Wildlife Sciences
Auburn University, AL 36849
Email: adm0074@auburn.edu
Phone: 334-844-2401

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