

# FINAL REPORT

Title: Determining public influences on managers' decisions regarding prescribed fire in longleaf pine ecosystems

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## **KEYWORDS**

Longleaf pine, Gulf Coast, Southeastern United States, ecosystem restoration, prescribed fire

## ABSTRACT

Previous literature has reported perceptions among private forest landowners regarding prescribed fire. However, less is known about the attitudes of the general public, as well as nonindustrial private forest (NIPF) landowners, regarding prescribed fire in the context of ecosystem restoration. This research examined the general public's and NIPF landowners' attitudes towards prescribed fire, and how those attitudes relate to the social and ecological opportunities and challenges to longleaf pine (*Pinus palustris*) restoration.

Although once covering 92 million acres in the southern coastal plain of the United States, longleaf pine currently covers less than 5 percent of its native range. As a result of this large-scale loss, the longleaf pine habitat ecosystem is considered at high risk of disappearing. Restoration of longleaf pine is important not only because of environmental benefits, but also because of its unique characteristics that translate into potential economic benefits to landowners such as longleaf pine produces a higher proportion of poles than other southern pines.

Longleaf pine preservation and restoration has become an important policy and management objective for public entities and organizations such as the Longleaf Alliance and the USDA Forest Service. A substantial amount of longleaf pine restoration has occurred on public lands; however, to continue its expansion, restoration goals must include private lands. The range-wide conservation plan for longleaf pine calls for increasing longleaf pine to eight million acres by 2025. In response, there has been an increased effort to proactively manage and restore longleaf pine with using the application of fire since it was a historical aspect of the longleaf landscape. In short, restoration of the longleaf pine ecosystems is closely connected to land managers' decisions to implement this silvicultural tool.

Seeking to understand perceptions of using prescribed fire with longleaf pine leads to several questions that drive this research. How common is NIPF landowners' prescribed fire use? How familiar are landowners with longleaf pine and its benefits? What motivates private forest landowners to apply burning in longleaf restoration? Answering these questions will contribute to efforts promoting the expansion of longleaf pine on appropriate sites within its historical range.

Results demonstrate forest landowners' and the general public's interest in reestablishing the longleaf pine ecosystem within its historical range given that prescribed fire is an important tool toward achieving this goal. Results suggest that respondents were interested in reestablishing longleaf pine – as explained by age, knowledge in longleaf pine and prescribed fire, some landowner objectives, and place attachment. Implementation of prescribed fire is challenging. This research identified “liability”, “capacity”, and “cost-related issues” as the major reasons for not using prescribed fire in the study region. This study revealed smoke issues as only the fourth most important reason for not implementing prescribed fire.

In addition, results underscore various factors influencing the decision process for the use of prescribed fire in longleaf pine forest management among NIPF landowners in the U.S. Gulf Coast region. The study explored why or why not NIPF landowners are applying prescribed fire on their property. Findings demonstrate interest in ecological restoration, although this interest was tempered by challenges associated with complex land management practices. Such challenges included, prescribed fire costs, lack of knowledge, and concerns over regulatory issues. Still, informants expressed some interest in collaborative landscape management

activities, whereby landowners would bundle expenditures and opportunities to conduct management activities.

## OBJECTIVES

This research was in response to the JFSP FON-16-0001 task statement regarding social barriers and facilitators to prescribed burning:

*Social barriers and facilitators:* What level of public opinion regarding prescribed fire actually impacts prescribed fire implementation? What is the role of collaborative efforts or advocacy groups in facilitating or limiting prescribed fire?

The study's objectives were to: (1) assess the amount of post-Hurricane Katrina long-leaf pine planting on private lands motivated by disaster mitigation decisions; (2) describe the extent prescribed burning is implemented in privately owned longleaf pine stands, and constraints to burning; and (3) identify landowners' interest in prescribed burning programs.

The research was driven by the following hypotheses related to our objectives: (1) landowners are increasingly planting longleaf pine in order to mitigate the effects of future disaster events; (2) legal concerns and costs have the strongest effects on social constraints to prescribed burning in longleaf stands; (3) interest in prescribed burning increases among landowners who seek out collaborative activities; (4) interest in prescribed burning increases with appropriate economic incentive; (5) interest in application of appropriate prescriptions for longleaf pine restoration will vary geographically reflecting projected long-term gains or losses in longleaf pine.

## BACKGROUND

Longleaf pine (*Pinus palustris*) was once one of the most ecologically important tree species throughout the southeastern United States with an estimated coverage of 92 million acres (Brockway et al. 2005; Frost 2006). Even though preservation and restoration of the longleaf pine ecosystem has become a top conservation priority, only 4.3 million acres of longleaf pine remain, with much of its acreage in poor or degraded condition (Oswalt 2012). In most parts of the southeastern region, the longleaf pine landscape was largely converted to loblolly pine (*Pinus taeda*) or slash pine (*Pinus elliotii*), which were favored because of their fast growth and associated economic benefits. The once massive longleaf pine ecosystem now nearly disappeared (Brockway et al. 2005).

The greatest loss in longleaf pine occurred on what are now nonindustrial private forest (NIPF) lands (Outcalt and Sheffield 1996). Restoration and management of longleaf pine ecosystems is necessary if society values the variety of benefits associated with the habitat, including biodiversity, threatened and endangered species, recreation, aesthetics, and timber among others. In response, longleaf pine restoration has become an important policy and management objective for public entities and organizations such as the Longleaf Alliance and America's Longleaf (Knott 2001). Previous literature has documented the status of longleaf pine and biological restoration procedures (Frost 2006; Oswalt et al. 2012); however, this literature has failed to address how restoration can be achieved in the social science context.

A substantial amount of longleaf pine restoration has occurred on public lands; however, restoration cannot be fully realized without NIPF landowners (Outcalt and Sheffield 1996). Approximately, 87 percent of forests in the southern United States are owned by private companies (27%) and NIPF landowners (60%) (Hanson et al. 2010). Within these southern forests, NIPF landowners and private companies own more than 61 percent of the longleaf pine (America's Longleaf Restoration Initiative 2014). Following catastrophic storm events, such as Hurricane Katrina, there has been a growing interest in the management and restoration of longleaf pine forests (Guldin 2006). Falling timber prices, dominated by other southern yellow pine species, may also contribute to this increased interest in longleaf pine. Further there has been some interest among NIPF landowners in establishing longleaf in previously planted loblolly and slash pine tracts (Browning et al. 2009). Conservation of the remaining acres and restoring degraded remaining longleaf pine ecosystems is a top conservation priority for the National Fish and Wildlife Foundation, U.S. Forest Service, U.S. Department of Defense, and other organizations. To succeed in restoration and conservation of these ecosystems, there needs to be more understanding about the attitudes, knowledge, and motivations of NIPF landowners to successfully restore and manage longleaf pine ecosystems (Fischer 2011; Harr et al. 2014; Kreuter et al. 2008). To ensure long-term restoration success, private landowners must benefit from recovery of the longleaf pine ecosystem. Research is needed that examines how landowners will benefit from ecosystem restoration programs, other than through the traditional form of government rental payments- a short-term, expensive, and unsustainable conservation tool (Glenna 1999).

Historically, longleaf pine was a fire-dependent species and application of prescribed fire is a key component to the success of restoring longleaf pine's ecological landscape processes (Barnett 1999; Brockway 2002), with a suggested burning rate of every two to four years (Loudermilk et al. 2011). Studies have revealed that prescribed fire is an effective land

management practice that promotes environmental and economic values (Kreuter et al. 2008; Piatek and McGill 2010). To develop successful longleaf pine restoration efforts, policy-makers must understand NIPF landowners' attitudes, perceptions, and beliefs about implementing prescribed fire (Harr et al. 2014; Morton et al. 2010; Piatek and McGill 2010). Understanding attitudes and perceptions is a complex process of ever-evolving decisions and selecting the alternative that is most appropriate given the cognitive beliefs and values of an individual (Brunson and Shindler 2004). To ensure landowner support for longleaf pine restoration, substantial efforts must be made to link the importance of and necessity for prescribed fire, while mitigating the negative perceptions of its use (Burke et al. 2012). This may be accomplished, in part, through landowner cooperative networks, as evidenced in Oklahoma, Texas, and northern Mississippi (Fawcett, March 3, 2017, personal communication). Building a positive peer network for private landowners that supports prescribed fire efforts is essential to overcome cost-related issues, lack of knowledge with prescribed burning, and permitting issues associated with available burn days (Knott 2001). Other key impediments include liability concerns over smoke emissions and escaped fires (McCaffrey and Olsen 2012).

Prescribed fire on NIPF lands is also hampered by increasingly restrictive federal air quality standards, multiple ownership patterns or small tract sizes, financial limitations, and lack of landowner understanding of fire's value (Brennan 1991; Brennan et al. 1998; Izlar 2000; Johnson 1984). Researches have considered the influence of financial assistance programs on longleaf pine restoration activities with general agreement that landowners are more likely to conduct prescribed fire if these programs are available (Fischer 2011; Gunter et al. 2001; Jarett et al. 2009; Zhang and Flick 2001). Research has found that although most NIPF landowners reforested their land out of a feeling of responsibility to keep its productivity, incentives helped lessen a real or perceived increase in transaction costs associated with restoration (Royer and Kaiser 1983; Doolittle and Straka 1987). As Zhang and Flick (2001) noted, assistance programs are valuable in the short-term; however, they may be inappropriate in the long-term because they require political support.

Literature on the human dimensions of restoration also informed this study. Gobster (1997) and others have found generally positive public attitudes towards restoration as an overall goal with societal benefits. Opposition and controversy have emerged over specific practices of restoration such as using herbicides, harvesting trees, applying prescribed fire, or reintroducing wildlife (Ostergren et al. 2008). Many of these studies examining social conflict in restoration have been limited to public lands and/or volunteer efforts. By contrast, private lands restoration has often applied some type of contingent valuation effort such as assessing willingness to pay for nonmarket goods applied to government cost-share programs. Such studies assume a primary economic rationale as the driving factor in individual conservation efforts (Amacher et al. 2004).

Individual background factors have also been influential on support for restoration, although it is important to consider the interactions of socioeconomic factors with the restoration goal of interest and the importance of the issue (Bright et al. 2002). For example, Bowman et al. (2004) found support for black bear (*Ursus americanus*) reintroduction diminished by rural residency and proximity to public land. In contrast, Alam (2011) found proximity to be a poor indicator of support, while knowledge about the river was important. Other studies have found income, property size, region, property ownership objectives, education, and direct experience with conservation issues as predictors of support for restoration (Solecki 1998; Connelly et al. 2002; Buijs 2009). Rural/urban residency is an important factor to consider in the longleaf pine range, three-quarters of which is urban (U.S. Census Bureau 2012).

In addition, several studies have explored the underlying causes of attitudes towards restoration. Recreation benefits, physical landscape characteristics, aesthetic values, interference with nature versus human utility of the landscape, concern about the state of the ecosystem, and biodiversity conservation have been cited as key influences (Alam 2011). Westling et al. (2014) also noted historical relationships and cultural values between residents and the landscape feature of interest for restoration influenced attitudes towards restoration projects. As such, some attitudes may be place-dependent rather than universal such that public opinion may vary substantially between projects.

Perhaps because of the place-dependent nature of attitudes towards restoration, place attachment (the emotional bond between a person and a place), or some similar measure of connectivity with the landscape, should be considered in predicting support. Place attachment is a multi-dimensional construct that emerges from the physical setting, psychological and social processes of the person who interacts with the place, and the activities performed in the place (Stedman 2002). In the context of place attachment, a place is more than just a general space or a commodity – it becomes emotionally and symbolically significant when a person has experiences and finds meaning for that space. Thus, reducing a landscape such as longleaf pine ecosystems to a selection of goods or products ignores how places are linked to individual and group identity, including regionality, as well as the functional attributes of the place to support specific goals and activities (Williams and Vaske 2003). The importance of place may help explain why many studies concerning the social dimensions of ecological restoration have centered on micro-or-meso-scale sites (e.g. rivers, parks) rather than macro-scale landscape restoration such as the longleaf pine historical range (Bangs and Fritts 1996).

## METHODS

### Key Informant Interviews

Eight case study sites were selected for the qualitative phase of key informant (KIs) interviews along the U.S. Gulf Coastal Plain from eastern Texas to the Florida panhandle. Sites for this research were selected based on longleaf pine basal area addition or removal as reported by Southern Forest Future Project (Wear and Greis 2013). According to the Southern Forest Future Project (2013), gains and losses of longleaf pine reflect rural, slow growing counties or fast-growing counties (with associated longleaf pine forest fragmentation and loss), respectively. Sites included: Jasper County, Texas; Evangeline County, Louisiana; Marion and Forrest Counties, Mississippi; Clarke and Coffee Counties, Alabama; Decatur County, Georgia; and Gadsden County, Florida.

The purpose of KIs were to collect information from a wide range of individuals, representative of relevant interest groups and social status levels (Bryman 2012). Key informant interviews were conducted to assess the extent landowners were interested in planting longleaf pine, as well as attitudes of implementing prescribed fire, including risk perceptions and concerns about reasons to fire implementation. These interviews enabled identification and understanding of landowners' influence on forest management decisions.

Initial KIs were identified by using local directories and Internet sources and included interests representing: (1) NIPF landowners; (2) government natural resource agencies; (3) consulting foresters; (4) landowners' associations; (5) other land managers; and (6) other knowledgeable individuals who did not fit into these categories. Following each interview, subsequent sampling was accomplished through the use of a snowball procedure based on nominations by initial informants (Weiss 1995). Data collection proceeded until saturation was reached (Morgan 2002). Each interview explored: (1) attitudes towards longleaf pine forest, forest values, and forest management practices; (2) the role longleaf pine forests and forestry play in fostering degraded landscapes; and (3) social and biological constraints to prescribed fire.

### Telephone Survey

The telephone survey was conducted using a dual-frame, cluster area probability sample of telephone numbers, that included cell phone and landline numbers of residents across 130 southeastern counties within longleaf pine's historic range along the Gulf Coast (Figure 1). The survey was conducted by a telephone marketing firm from March to June 2017. The average survey was completed in no more than ten minutes and the survey was piloted (N=50) during a four-day test period. Based on a sampling frame developed by the firm, the survey was initiated with 29,415 working telephone records. Of these, 1,201 were not eligible due to being underage, language barriers, living outside the eligible counties, or other reasons. Additional sampling considerations included almost 5,000 refusals before determination of qualification, 135 qualified respondent refusals, and 61 partial completions which did not include a response file.

Questions measured knowledge, attitudes, and place attachment, as well as account for socioeconomic statuses and forest ownership. Variables are described here in the order they appeared in the survey. Respondents were asked if they were familiar with longleaf pine. Responses included: (1) never heard of it; (2) I've heard of it, but don't know much about it; (3) I know the difference between longleaf pine and other pine species; (4) I have knowledge of the conditions longleaf pine needs to grow. These responses were recoded to a binary format: (0) no

(never heard of longleaf pine) and (1) yes. If the respondent had never heard of longleaf pine, the interviewer provided a brief explanation to facilitate response for a question asking about her/his support for longleaf pine restoration.

For those with knowledge of longleaf, a summative scale was created based on five items with (1) yes and (0) no responses to the question, “Were you aware of the following regarding longleaf pine forests”: longleaf pine was once the dominant forest ecosystem in the southeastern United States; longleaf pine forests have been increasing in the region since Hurricane Katrina (2005); longleaf pine ecosystems provide habitat for many plant and animals species; longleaf pine forests require fire to regenerate; some property owners are participating in conservation programs to reestablish longleaf pine within its historical range. A composite index (LLP Knowledge) was created with the previous question such that a knowledge score ( $\alpha = 0.701$ ) could range from zero (never heard of longleaf pine) to five, with five being most knowledgeable.

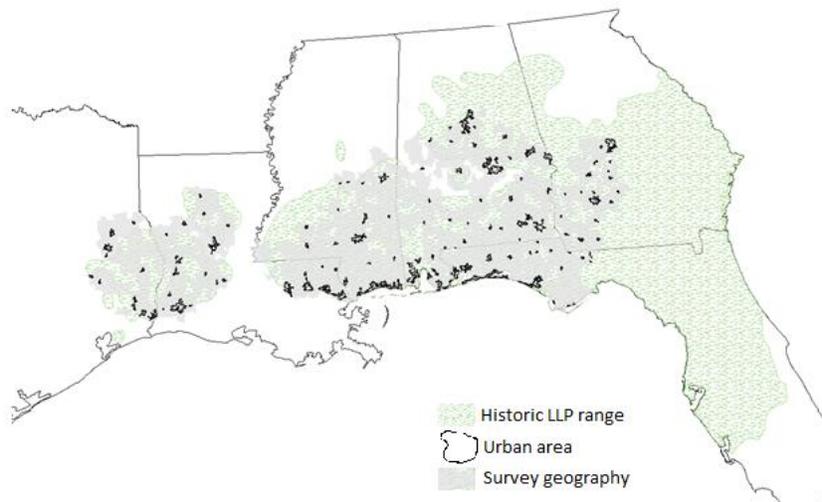


Figure 1. Survey area based on urban places and longleaf range in the southern United States.

Following measurement of LLP knowledge, respondents were asked to what extent they were interested in the reestablishment of longleaf pine forests (LLP Support), the dependent variable in the analysis. A five-point scale (not at all; not much; some; a lot; don't know) was recoded to (0) not supportive, (1) supportive, with don't know responses excluded from final analysis. After asking if respondents were familiar with prescribed fire, and providing an explanation if they had no knowledge, respondents were asked about their attitudes towards prescribed fire using four items – “Prescribed fire...”: endangers wildlife/ human life; removes accumulated material on the ground to prevent wildfire; improves conditions for longleaf pine establishment; maintains natural balance in the ecosystem. Responses were based on five-point Likert scales reflecting standard telephone survey methodology in which respondents were asked if they agreed or disagreed. Conversely, they could volunteer don't know or no opinion, then the interviewer probed if they strongly agreed, strongly disagreed, or somewhat agreed. Responses were recoded to (0) disagree/neither agree nor disagree/don't know/no opinion, and (1) agree (strongly agree and somewhat agree). The first item, reflecting a negative attitude towards

prescribed fire, was finalized as an independent binary response (Prescribed Fire Endangers). A summative scale was created from items two through four representing positive attitudes about prescribed fire (Prescribed Fire Benefits) with a minimum of zero and a maximum of three.

Place attachment has been measured using a variety of approaches and scales (Stedman 2003). Likert scales [(1) strongly agree; (2) somewhat agree; (3) neither agree nor disagree; (4) somewhat disagree; and (5) strongly disagree] were summed to measure agreement with ten statements. The scale (Place Attachment) included six emotional attachment measures and four functional attachment measures, and had a high level of internal consistency represented by a Chronbach's alpha of 0.942 (Williams and Vaske 2003):

*Emotional statements*

- (1) I feel strong, positive feelings for the Gulf Coast
- (2) I identify strongly with the Gulf Coast
- (3) I feel Gulf Coast is a part of me
- (4) I feel I can really be myself in the Gulf Coast
- (5) I feel happiest when I am at Gulf Coast
- (6) I really miss Gulf Coast when I'm away too long

*Functional statements*

- (7) I get more satisfaction out of visiting Gulf Coast than any other natural area
- (8) The Gulf Coast is my favorite place to be
- (9) The Gulf Coast is the best place for what I like to do
- (10) I wouldn't substitute any other area for doing the types of things I do at Gulf Coast

Socioeconomic statuses consisted of age (Age), race (Race), education (Education), amount of time the respondent had lived in the Gulf Coast (Residence Tenure), household income (Household Income), gender (Gender), and rurality (Rural/Urban). Age was the age of the respondents as a continuous variable in years. Race was the respondent's self-reported race/ethnicity with six different original categories (African American, Caucasian, Asian, Hispanic/Latino, Native American, and Other) recoded to (1) African American, (2) Caucasian, and (3) Other. Education was the respondent's level of education, originally with six categories ranging from less than high school to post college degree. To account for greater than 20 percent of expected cell values less than five respondents, and because this analysis was interested in whether or not advanced education impacted the dependent variable, education was recoded to a dummy variable: (0) less than a 4-year degree and (1) at least a 4-year degree.

Residence Tenure was coded as (1) less than 25 years; (2) 25-49 years; (3) 50-74 years; and (4) 75 or more years. Household Income originally had seven different categories ranging from less than \$15,000 to \$150,000 or more. Responses were recoded into (0) less than \$50,000 and (1) \$50,000 and above. Those who refused to answer or didn't know were removed from the analysis. Gender referred to the respondent's gender [(0) female and (1) male]. Rural/Urban was coded according to zip codes included with the sampling frame of phone numbers using the U.S. Census rural-urban identifier. A zip code was classified as (0) rural or (1) urban/suburban ("Urban") based on U.S. Census characterization of the majority area in the zip code.

Finally, we measured forest acreage owned (Forest Acres) and longleaf pine acres owned (LLP Acres). Respondents were initially asked if they owned forest land and, if so, the number of acres owned measured as interval data. If they were unsure of the number of acres, the interviewer prompted with nine categories of unequal ranges (1 to less than 5, 5 to less than 10,

10 to less than 25, and so on up to 5,000 acres or more). Coding used in the analysis included (1) do not own forest land), (2) 1 to 50 acres (0.40 to 20.23 ha), and (3) more than 50 acres. LLP Acres followed a similar approach. LLP Acres was recoded to (1) yes, respondent owns longleaf pine and (2) no/don't know/maybe. We were interested in longleaf pine ownership's clear influence on support for restoration; therefore, we treated uncertainty to the degree that a numerical response was unobtainable as equivalent to not owning longleaf pine. We used logistic regression to examine the relative importance of knowledge of longleaf pine, attitudes towards prescribed burning, place attachment, socioeconomic statuses, and forest ownership to explain support for longleaf pine restoration.

## RESULTS

### Study Participation

Seventy-four KI interviews were conducted in the study area while 2,700 surveys were completed. The majority of KIs and more than 80 percent of survey respondents were supportive of longleaf pine restoration. On a scale of zero to five, with zero indicating no knowledge of longleaf pine, the sample demonstrated some knowledge (mean = 2.00) based on the statements provided. A slight majority (53 percent) of respondents disagreed with the statement that prescribed fire endangered life, while tending to have positive attitudes towards prescribed fire (mean = 2.43). In addition, respondents demonstrated a strong attachment to place (mean = 2.94). On average, respondents were almost 51 years old, female (almost 52 percent), Caucasian (over 80 percent), had less than a 4-year degree, including an associated degree (55 percent), reported more than \$50,000 per year in household income (57 percent), had lived in the region for less than 25 years (55 percent), and tended to live in sub/urban places (63 percent). In accordance with the sampling approach, approximately 70 percent did not own forestland, while 16 percent owned longleaf pine.

### Longleaf pine restoration

Key informants were asked if landowners were interested in managing longleaf pine. Key informants regarded longleaf pine as a very important species, both ecologically and economically. When asked about whether or not landowners were managing their longleaf pine forest, one informant reported appealing attributes of the species makes longleaf important to manage and restore: “The most appealing [characteristics] is probably the legacy of where was all longleaf savannah and everything like that and continuing the legacy of what the land base used to look like” (Land manager, Mississippi).

There were mixed results when asked about whether there had been an increase or decrease in interest in planting longleaf pine. One informant responded: Increased. Because of two-fold, one is public perceptions so preaching that longleaf pine was natural and then landowners say well I want what’s natural and then number two would be government incentives programs. (Fuel coordinator, Texas)

By contrast another said: Definitely decrease without a doubt. Because the cost of the trees and the planting’s more expensive and even the cost of site preparation is more expensive. (Land manager, Mississippi)

Key informants were also asked whether landowners were knowledgeable about longleaf pine as a fire dependent species. The majority of responses answered there was widespread knowledge about longleaf pine as fire dependent species. Even if the landowner was not well informed, they had a forester who was. One informant responded: “Yes. I think for the most part they do. You may have a guy who owns the land, but he’s got a forester managing for him and the forester understands that situation” (Land manager, Texas). Another informant reported: “Most landowners who do research into [longleaf pine] whatsoever learn that quickly, yes” (Consulting forester, Louisiana).

Further, key informants reported that landowners who were interested in restoration of longleaf pine ecosystems frequently used fire as a restoration tool. One informant mentioned:

It's very common here. We use it a lot in our site prep. We use a lot of prescribed burning and you do see a lot more longleaf in this area, so you do have landowners that use prescribed burning when they do they get on the two- to three-year interval that they burn. (Soil conservationist, Texas)

This quote suggests an interest in prescribed fire, at least among some landowners. Also, the quote demonstrates positive attitudes towards prescribed fire's benefits.

Key informants were asked if landowners had more knowledge about the link between fire and longleaf pine would there be increased interest in prescribed fire. Most of the informants were in agreement that for continued expansion of longleaf pine, more landowner education is needed. One informant responded: "Yes, some of them would. Some of them would be really interested" (Timber land manager, Texas). Another informant qualified his statement:

Every landowner is different. Every landowner has their own goals as to what they want their property to be like. All of those factors combine to dictate a given landowner's choices so but yeah, the short answer I think is yes. (Consulting forester, Texas)

The information from these interviews suggests that increased knowledge would lead to increased interest in using prescribed fire for ecological restoration goals.

Of survey respondents supportive of restoration, 31.9 percent were forest landowners and 7.6 percent of landowners owning over 50 acres (20.23 ha) supported restoration (Chi-Square 7.984,  $p=0.18$ ) (Figure 3). Urban respondents tended to be more supportive than rural respondents (62.6 versus 37.4 percent), although this was not a significant distribution with 95 percent confidence. However, regarding knowledge of longleaf, rural residents had higher scores than urban residents (2.22 versus 1.87;  $t=4.952$ ,  $p < 0.001$ , equal variances assumed ( $p > 0.05$ ), and respondents with more than 50 acres (20.23 ha) scored higher than their counterparts (3.42 versus 2.65;  $t=5.456$ ,  $p = 0.000$ , equal variances assumed ( $p > 0.05$ )).

Rural residents also tended to score slightly more favorably in their attitudes towards the benefits of prescribed fire than their counterparts (2.48 versus 2.39;  $t=2.588$ ,  $p =0.010$ ), equal variances not assumed ( $p <0.05$ ). It is unlikely this slight difference would be noticeable outside of statistical analysis. By comparison, respondents with more than 50 acres (20.23 ha) of forestland perceived greater benefits from prescribed fire, on average (2.69 versus 2.59), although the difference was not statistically significant. Regarding the statement that prescribed fire can endanger life, landowners with less than 50 acres (20.23 ha) were more likely to agree than landowners with over 50 acres (20.23 ha) (71 percent versus 28.9 percent; Chi-Square 14.432,  $p = 0.001$ ); however, there was no statistical difference in distribution between urban and rural residence (36 versus 64 percent) regarding the statement.

### **Limiting factors to apply prescribed fire**

Interviews explored the factors influencing the decision to use prescribed fire as a management tool in the Gulf Coast region. Major factors that emerged from analysis were smoke management issues, potential liability concerns, and cost-related issues that influenced the decision to apply prescribed fire. Key informants mentioned the role of regulatory factors in the decision to use prescribed fire, whereas increasingly restrictive smoke management guidelines restricted landowners' abilities to conduct prescribed fire at the frequency and for the area they would prefer. This feeling was even more pronounced among NIPF landowners, as they all mentioned smoke management as a main reason for not using prescribed fire: "Smoke, yes the smoke. I don't think we are scared as much about the fire getting away from us it's, it's the

smoke getting on the roads and making people mad or causing a lawsuit” (Private landowner, Louisiana). In contrast, another informant did not rank smoke issues as the major reason: “Well most, most people that are burning don’t care about smoke” (Land manager, Texas).

Key informants indicated other factors such as liability issues, availability of training, and costs. In particular, key informants expressed concern with potential liability and public safety, especially near smoke sensitive areas:

Because of liability, it’s big here on all highways and all that’s going on they might burn their timber and when it crosses the road you have accidents and it burns your neighbors to death and you have a liability. (Forestry association staff, Florida)

There’s always a liability of burning and that’s always going to put, the fear of that’s always going to reduce the number of people that are willing to burn. (Landowner, Texas)

The fear of liability near major highways resulted in risk averse behavior of private landowners. As one informant mentioned, “because of living in a smoke sensitive area, [landowners] can’t burn because of liability issue” (Consulting forester, Florida).

Key informants also indicated cost as another reason for not applying prescribed fire: Yes, yes, yes. How expensive it is to burn would be, you know, and that’s why just about everyone I know that does burning they are doing it in partnership with some kind of government grant or something like that. (Consulting forester, Louisiana)

In contrast to cost, some informants thought: “I feel like the cost is pretty reasonable because prescribed burning is one of the cheapest tools in the toolbox of forestry” (Soil conservationist, Texas). This finding infers price relative to subjective value as defined by individual landowners. These findings suggest these limiting factors may influence landowners’ decisions regarding the use of prescribed fire.

### **Motivations to apply fire**

Results highlight incentive programs as an effective tool for initially motivating landowners. Incentives come in the form of cost share payments and annual payments that serve to offset the initial cost of what is usually long-term forestry investment. One informant mentioned:

I feel like prescribed fire is increasing due to a lot more of programs that the state and government agencies have been offering. So, there is definitely an increase in interests with the cost share money, so I do feel like that every time they throw money this way in this area people do take advantage of it, so I would like to see that continued. (Consulting forester, Texas)

Similarly, another informant mentioned: “Right. Cost-share programs be the bottom line, kind of. Money motivates folks” (Land manager, Louisiana). Some informant argued there should be more cost share programs. One of the informants mentioned: “Yeah if we had more cost share programs that would definitely help. But we have way more applications that we do money to give out for burning” (Consulting forester, Florida).

Another motivating factor for landowners was outreach programs educating landowners about personal safety and risk reduction, while preserving and enhancing the health of forests. Informants were aware of educational programs: “Longleaf Alliance has tours and everything

and I think a lot of that stuff is available to people” (State wildlife manager, Florida). Another informant added: “Texas Forest Service sends out e-mails all the time and has seminars on it. The Longleaf Alliance has really worked hard educating people...” (Landowner, Texas). For landowners to truly understand the role of prescribed fire, educational programs must communicate clearly and consistently across all areas where longleaf pine used to be a native habitat.

Results documented landowners were interested in collaborating with other landowners and various organizations at the regional, state, and local levels for applying prescribed fire. It was reported: “Landowners have a lot of lands out there and they actually do have burn associations, a co-op, they call it a burn co-op and they do [prescribed burn], it works good” (State forester, Texas). Another response similarly advocated burn cooperatives: “Most everyone I talk to about longleaf is interested in [collaboration]” (Land manager, Texas). Such collaboration has its own benefits and challenges. Reduction of cost was considered to be a benefit: “Collaborating with various organizations gets the costs down” (Consulting forester, Louisiana). These findings suggest that factors such as incentives, outreach, and collaboration are necessary to the success of prescribed fire programs.

### **Predicting support for longleaf pine restoration using fire**

The comprehensive regression model included all variables (Table 1). The Perceived Benefits of Prescribed Fire Scale was a significant predictor ( $p < 0.001$ ). As the perceived benefits increased, so did support for longleaf pine restoration. Place Attachment ( $p < 0.001$ ), LLP Knowledge scale ( $p < 0.001$ ), Age ( $p < 0.001$ ), Race ( $p < 0.05$ ), Education ( $p < 0.01$ ), and Gender ( $p < 0.001$ ) were also significant. These variables explained 34% of the variance in the dependent (Chi-Square = 503.977).

Table 1. Regression results for the support of longleaf pine restoration using fire.

<b>Measure</b>	<b>Exp(B)</b>
<i>Social-landscape</i>	
Pres. Fire End.	1.004
Pres. Fire Ben.	1.496‡
Place Attach.	1.965‡
LLP Know.	2.496‡
Forest Acres	0.999
LLP Acres	0.857
<i>Socioeconomic</i>	
Age	0.978‡
Race	1.498*
Education	1.700†
Residence Ten.	0.963
Household Inc.	1.225
Gender	0.356‡
Rural/Urban	0.892
Constant	12.882‡
-2(log-likelihood)	1390.272
Chi square	503.977
R <sup>2</sup>	0.341
n	2593

\* Significant at  $p < 0.05$

† Significant at  $p < 0.01$

‡ Significant at  $p < 0.001$

## CONCLUSIONS

Former Secretary of Agriculture of the United States John Vilsack said, “Hunters, anglers and multi-generational small private landowners are very important to the rural areas where longleaf restoration is most likely to occur” (Dennis 2010). With more than half of the existing longleaf pine on private lands, NIPF landowners are critical to restoring continuous and non-continuous habitat, which is important for the conservation of species within the longleaf pine ecosystem (Damschen and Brudvig 2012). As well, due to the large public and private investment in restoration, it is important to understand attitudes of the general public, who hold values and attitudes that influence restoration policy and NIPF landowners with whom they interact. In short, for restoration efforts to be socially accepted (and supported), as well as ecologically successful, they must align with social goals and values (Kellert 1996).

Restoration of longleaf pine was one of the important themes throughout the interviews and dominated how most informants valued longleaf pine and its restoration, which was consistent with previous studies (Brockway et al. 2005; Lavoie et al. 2011; Thomas 2013). Much of the interest in longleaf pine restoration has been the result of an increasing interest in ecological values (Barnett 1999). Also, KIs noted the products derived from longleaf pine can be more valuable than those of other southern pines. Knowledge and previous experience with fire was important for the acceptance of fire as a management tool (Kreuter et al. 2008; Morton et al. 2010; Piatek et al. 2010).

Implementation of prescribed fire was noted as often challenging (Kreuter et al. 2008; Kobziar et al. 2015; Morton et al. 2010) despite increasing interest in restoration of longleaf pine. Concerns of liability were a leading factor for landowners’ decisions to use prescribed fire. Another major reason cited for not using prescribed fire was smoke issues, similar to findings from Blanchard and Ryan (2007) and Morton et al. (2010). Landowners become discouraged because of air-quality guidelines which they found difficult to follow. If guidelines continue to expand, landowners will become increasingly less likely to use prescribed fire. A uniform, comprehensive system of data collection for burned area would facilitate to better understanding of the current status and trends of prescribed fire and future prescribed fire needs for longleaf pine restoration to mitigate the negative perceptions regarding smoke. Findings highlight cost of prescribed fire as another reason to its limited use which is consistent with Fischer (2011), Harr et al. (2014), Kobziar et al. (2015), and Yoder (2008). This is linked to a lack of funding for prescribed fire programs, presenting a barrier to private landowners. Also because of lack of liability coverage, the cost of private insurance proved to be too costly for private landowners.

Cost-share programs motivated forest landowners to manage their forest land. Cost-share programs were popular among landowners because it reduced initial investment costs, which may directly increase the number of landowners using prescribed fire in their forest land. This is consistent with discussions by Fischer (2011), Jarret et al. (2009), and Newman et al. (1996). As well, these incentives programs provided needed technical and/or financial assistance to private landowners for the benefit of conserving, managing, or enhancing longleaf pine habitat using prescribed fire.

This study also highlights collaboration as another motivating factor for the use of prescribed fire, which is similar to a study from Burke et al. (2012) and Kobziar et al. (2015). Collaboration can vary from information sharing, coordinating services, and sharing of services between landowners and agencies/organizations as well as among landowners (Bryson et al.

2006). One reason collaborative activities are important is because such activities make the best use of limited resources and produce a consistent system that could be used to track prescribed fire activity for longleaf pine restoration efforts. Some collaborative efforts are currently in place for prescribed fire outside the longleaf pine range; however, more resources are needed, such as technical assistance to develop burn associations. Although collaborative efforts have often been considered as helping initiatives to succeed (Gruber 2010; Moore 2011), little to no research has been conducted specific to prescribed fire collaboration.

When comparing the general public with forest landowner respondents to the telephone survey, forest ownership did not significantly influence the likelihood of supporting longleaf pine restoration controlling for other factors. Thus, as with previous research, the general goal of restoration appeals to the general public, even at the landscape level (Bright et al. 2002). This finding has implications for expanded public investment into restoration initiatives in order to meet the goal of eight million acres (3,237,485.14 ha) of longleaf pine by 2025 (ALRI 2019). Despite this, challenges continue to materialize in the form of NIPF landowners' marginal decision-making when deciding to convert their forest to longleaf pine as well as technical support for private landowners.

Theoretically, the most impressive, and anticipated, findings were the strong correlations of Place Attachment and positive attitudes towards prescribed fire with support for restoration of longleaf pine habitat. Thus, this study contrasts with previous efforts showing broad support for restoration dependent on specific activities applied in the restoration process (Gobster and Barro 2000). By employing an established place attachment scale, this study measured the contribution of place attachment on support for restoration but did not measure whether longleaf pine was a significant component in place attachment. However, like live oak (*Quercus virginiana*) and coastal wetlands, longleaf pine likely contributes to place identity as observed in a broad spectrum of media and literature (Dennis 2010). As a potential key feature informing attachment to place, widespread knowledge of longleaf pine, including its interactions with fire, unsurprisingly influenced support for restoration.

This finding also reflects human dimensions of fire research, which is fairly consistent in demonstrating the general public's knowledge, albeit coarse, of local ecology regarding fire (Gordon et al. 2018). That research, however, did not examine factors informing public ecological knowledge, and therefore findings here offer a future research avenue. Besides ecological knowledge, findings here coincide with studies of residents of the southeastern United States showing positive attitudes about prescribed fire and less concern about prescribed fire endangering well-fare compared with residents in other regions (Shrestha 2019). Along with broad support for restoration, support for prescribed fire offers opportunities to build public awareness and backing for future longleaf pine restoration efforts that simulate natural processes, particularly those occurring on private lands. As such, communication materials about restoration should contain principles of ecosystem management, species present, the role of fire in ecosystem functioning, and information on recreation and wildlife observation (also see Jacobson and Marynowski 1997).

Less expected was the finding that rural or urban residence did not influence support for restoration, while several other sociodemographic factors (age, race, education, and gender) were important. These sociodemographic findings reflect inconsistencies in the literature about the importance of socioeconomic statuses in predicting attitudes towards restoration and suggest the relative influence of the specific restoration goal of interest (Bright et al. 2002). Residence was expected to influence restoration support through value orientations. Rural residents may be

more closely associated with working rural landscapes, such as forests, than their urban counterparts (Flora et al. 1992). For rural residents, a forest's value may lie primarily in the income it can generate (often understood in a fungible economic context).

By contrast, urban and suburban residents might be more likely to view the value of forestland in the pleasure it provides as a place for hiking, hunting, fishing, and/or bird watching, or knowing that it exists even if they will never see or use it. Of course, value orientations were not operationalized per se, and the measure was simply a geographic variable, which could partially explain the lack of difference between rural and urban residence. This analysis was part of a larger project which limited space for explanatory measures. Nonetheless, future research should attempt to include a number of additional variables, including value orientations (e.g., environmental and political values), recreation preferences, physical landscape characteristics, aesthetic preferences, and behavioral measures (e.g., donating money for restoration, planting LLP).

In some ways, the direction of future research should focus on more in-depth examination of the public's definition and preferences regarding ecosystem restoration. This and previous studies have found support for restoration, but what the public perceives as desirable in terms of returning an ecosystem to a "natural" state is not well-understood (which could partially reflect disagreement among scientists about what constitutes a natural state). Although restoration initiatives often imply their need is inherently obvious, and their goals are honorable, the quality of restoration is mediated by alternative notions of restoration emergent through interactions with the landscape and various social actors over time. Because the lack of clarity in the terms "natural" and "historical" has led to confusion and debate over what constitutes a restored landscape, Landres et al. (1999) suggested that restoration will always depend on the ecological and social context of the area.

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## **APPENDIX A: CONTACT INFORMATION FOR KEY PROJECT PERSONNEL**

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## **APPENDIX B: LIST OF COMPLETED/PLANNED SCIENTIFIC/TECHNICAL PUBLICATIONS**

### **Conference presentations**

Thapa, S., Gordon, J. S., Grala, R. K., Willis, J. L., Grado, S. C., (Nov 15 – 19, 2017). "Perceptions regarding longleaf pine ecosystem restoration using prescribed fire." Oral Presentation. Society of American Foresters National Convention, Society of American Foresters, Albuquerque, NM.

Thapa, S., Gordon, J. S., Willis J., Grala R., Grado S. (May 30 – June 1, 2017) "Perceptions of nonindustrial private forest landowners regarding restoration of longleaf pine ecosystems using prescribed fire." Poster. Annual Meeting of the International Society of Forest Resource Economists, International Society of Forest Resource Economists, New Orleans, LA.

Thapa, S., Gordon, J. S., Willis, J. L., Grala, R. K., Grado, S. C., (March 19, 2018). Public attitudes regarding prescribed fire in longleaf pine ecosystem restoration. Poster presented at the 2018 Meeting of the International Society of Forest Resource Economics, International Society of Forest Resource Economics, Gatlinburg, TN.

Thapa, S., Gordon, J. S., Willis, J., Grala, R., Grado, S. (2018, Mar 19-21) Public attitudes regarding prescribed fire in longleaf pine ecosystem restoration. Presented at the 2018 Meeting of the International Society of Forest Resource Economics, International Society of Forest Resource Economics, Gatlinburg, TN

Gordon JS, Grala R, Grado S, Willis J (2018, Oct 3-7) Restoring the pine barrens: public attitudes towards ecosystem restoration. Presented at the National Convention Society of American Foresters, Society of American Foresters, Portland, OR

Gordon, J. (2019). Public attitudes towards longleaf pine ecosystem restoration using prescribed fire. At Society of American Foresters Annual Convention, Louisville, KY

### **Research Publications**

Thapa, S., Gordon, J. S., Willis, J., Grala, R., Grado, S. Perceptions regarding longleaf pine ecosystem restoration using fire. In Hodges, D., Brandeis, C. (eds.) Forest resource economics in transitional and emerging markets. Proceedings of the 2018 meeting of the International Society of Forest Resource Economics (ISFRE) Annual Meeting at the Edgewater Hotel and Conference Center, Gatlinburg, Tennessee, March 20-21, 2018.

Thapa, S., Gordon, J. S., Willis, J., Grala, R., Grado, S. Public attitudes regarding prescribed fire in longleaf pine ecosystem restoration. In Hodges, D., Brandeis, C. (eds.) Forest resource economics in transitional and emerging markets. Proceedings of the 2018 meeting of the International Society of Forest Resource Economics (ISFRE) Annual Meeting at the Edgewater Hotel and Conference Center, Gatlinburg, Tennessee,

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Gordon, J., Willis, J., & Grala, R. 2020. Public and forest landowner attitudes towards longleaf pine ecosystem restoration using prescribed fire. Canadian Journal of Forest Research <https://doi.org/10.1139/cjfr-2019-0415>

Gordon, J., Willis, J., & Grala, R. The role of place attachment in large scale landscape restoration of an iconic species. To be submitted to Rural Sociology.

### **Technical Publication**

Gordon, J.S., Willis, J.W. 2020. Bringing back an ecosystem: Public acceptance of fire and support for longleaf pine habitat restoration. Warnell School of Forestry and Natural Resources outreach publication WSFNR-20-39A.

### **Outreach Events**

Prescribed fire for longleaf pine short course. Conducted February 3, 2018. Pearl River County, MS. Contacts: 56.

Prescribed fire for longleaf pine short course. Conducted February 21, 2018. Baldwin County, AL. Contacts: 32.

### **Master's Thesis**

Samrajya, B.T. (2018) Perceptions regarding longleaf pine ecosystem restoration using prescribed fire (Unpublished master's thesis). Mississippi State University, Mississippi State, MS.

## **APPENDIX C: METADATA**

Data types include: recorded key-informant interviews; transcriptions of key-informant interviews; recorded feedback/comments from facilitated group discussions; database of responses from telephone survey. Recordings were saved as digital audio files; transcriptions and facilitated group discussion feedback were saved as word files; survey responses were saved in several formats including Access, R, and SPSS. Aggregated results will be stored in the archive, although the archive will not release the results up to two years have passed from the project end date and the publications are finalized.