THE INFLUENCE OF ATTITUDES AND PERCEPTIONS ON LONGLEAF PINE ECOSYSTEM RESTORATION USING PRESCRIBED FIRE

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Abstract

When restored to full ecological function, longleaf pine (*Pinus palustris*) forests are among the most diverse forest ecosystems in the world. Longleaf pine forests provide unique wildlife habitat and research because this forests are highly resistant to disturbance. While a substantial amount of restoration has taken place on public lands, comparably less work has been accomplished on private lands. This project employed a telephone survey to explore challenges and opportunities for restoring longleaf pine ecosystem on private lands. The survey examined the potential interest among NIPF landowners and the general public regarding longleaf pine restoration management, including perceptions of risk, liabilities, and economic constraints associated with prescribed fire. Findings demonstrate that, despite an interest in longleaf pine by the general public and forest landowners, landowners were wary of prescribed fire, an important element in the management of these forests. Conversely, results demonstrated widespread knowledge and interest regarding longleaf pine and prescribed fire's role in expanding the range of longleaf pine territory. Additionally, respondents expressed an interest in collaborative management with other landowners to take advantage of economies of scale. The chapter concludes with implications for future research and discusses ways to increase dialog among stakeholders to help them understand the risks and opportunities of appropriate longleaf pine management using fire.
Key words: Longleaf pine, prescribed fire, nonindustrial private forest landowners, restoration.

1. Introduction

A distinctive and long-lived species, longleaf pine (*Pinus palustris*) once covered 92 million acres throughout the southeastern United States (Brockway 2005; Frost 2006). However, longleaf currently covers less than 5 percent of its original native range (Oswalt et al. 2012). Decades of timber harvesting followed by conversion to agriculture, urban development, fire suppression, or planting other pine and hardwood species have reduced longleaf pine to less than 5 percent of its original range (Frost 2006; Oswalt et al. 2012). Driven by a rapidly expanding global economy, and promoted ardently by forest industry, loblolly pine (*Pinus taeda*) and slash pine (*Pinus elliottii*) were favored for their fast growth, timber quality, and associated economic benefits. Less than 5 million acres (about 5% of the original expanse) of longleaf pine remain (Frost 2006) since most mature longleaf pine stands are not being adequately regenerated after harvest (Oswalt et al. 2012). It should be noted that longleaf pine is historically a fire-dependent species, relying on fire to kill competing vegetation (Barnett 1999), and policies that encouraged fire exclusion also contributed to the decline. As a result, the longleaf pine habitat ecosystem has been considered at high risk of disappearing (Jose et al. 2006), and thus, restoration and

management of decreasing longleaf pine ecosystems are critical to the continued enjoyment of its ecological and economic benefits. Previous literature has documented the status of longleaf pine and biological restoration procedures (Frost 2006; Oswalt et al. 2012), but less research has addressed how restoration can be achieved in the social science context. More needs to be understood about human attitudes, knowledge, and motivations of NIPF landowner to successfully restore and manage longleaf pine ecosystems (Fischer et al. 2011; Harr et al. 2014; Kreuter et al. 2008).

To achieve this goal, researchers must start with an understanding of human attitudes towards prescribed fire. Prescribed fire is defined as the cautious application of fire to forest fuels under certain conditions to meet specific management objectives (Wade and Lunsford 1989), with suggested burning rates of every two to four years (Glitzenstein et al. 2003; Loudermilk et al. 2011). Attempting to mimic a low intensity wildfire, prescribed fire improves habitat and reduces the risk of catastrophic wildfire by diminishing fuel loads. While prescribed fire objectives can vary, maintaining, enhancing, or restoring an ecosystem is of primary importance to land managers. Frequent prescribed fire controls competing vegetation, a severely limiting factor in pine silviculture on most sites and has been successfully used in longleaf pine ecosystem restoration efforts (Brockway et al. 2005; Fischer 2011; Harr et al. 2014). Despite fire suppression, many remaining high-quality longleaf pine sites exist because of intensive management efforts to maintain savannah-like structure benefitting threatened and endangered wildlife species such as the gopher tortoise (*Gopherus polyphemus*) and bobwhite quail (*Colius virginianus*) (Frost 2006). Although fire was a historic part of landscape, prescribed fire is not the only management tool used to create high quality longleaf habitat. Longleaf habitat can be managed and enhanced using herbicide and mechanical treatments as well (Van Lear et al. 2005). Given the benefits of fire in silvicultural treatments, landowners' willingness to restore longleaf pine management may depend upon their specific management objectives (recreation, inheritance, enjoyment, timber sale, land investment, etc.). Familiarity with and knowledge about the prescribed fire as a forest management practice as well as emotional attachments to longleaf pine landscapes may also influence attitudes towards prescribed fire for ecological restoration goals.

Since little research has addressed prescribed fire perceptions (Fischer 2011; Harr et al. 2014; Kreuter et al. 2008) and longleaf pine ecosystems (Barnett 1999; Burke et al. 2012) as a whole, there is a need for further understanding of the relationship between attitudes towards prescribed fire and longleaf pine restoration. More generally, this study examines the nexus between attitudes and behaviors about ecosystem restoration given the risks inherent in silvicultural practices required for longleaf restoration. Prescribed fire offers an excellent example of a silvicultural practice involving risk. Other examples include mechanical site preparation, which risks soil and water quality, and using livestock or imported plants for bioremediation while risking landscape damage or introduction of invasive species. In sum, research is needed that measures the public's support of the positive benefits of such activities in light of the potential risks.

Following a brief review of the literature regarding perceptions and attitudes of fire and place attachment, a theoretical framework is presented to explain support for prescribed fire in the

context of ecosystem restoration. The paper concludes with a discussion of results as well as implications for policy, management, and future research.

2. Background

2.1. Attitudes regarding use of prescribed fire

Attitudes and risk perceptions involve a complex process of ever-evolving decisions (Shindler and Brunson 2004). Understanding attitudes about wildland fire is necessary to assess the social acceptability of the use of prescribed fire for restoration processes. Numerous studies have documented the human dimensions of prescribed fire (Kreuter et al. 2008; Morton et al. 2010; Piatek et al. 2010), however, the factors impacting public reactions to introducing prescribed fire into longleaf pine restoration are uncertain. This gap is noteworthy given the large amount of public and private funding dedicated to longleaf restoration over the last several decades. The social science of wildfire research has generally found that the public has a sophisticated understanding of fire's role in ecosystems; however, little is known about how the public perceives and uses fire as a restoration tool (Blanchard and Ryan 2007; Fischer 2011). While prescribed fire has increased in the southeastern U.S. (Melvin 2012), key public concerns limiting its use include costs of equipment and labor, health issues, and concerns over liability (McCaffrey and Olsen 2012). Given a relatively high level of understanding of fire's ecological role, Kobziar et al. (2015) suggests that an increased emphasis should be placed on increasing the public's understanding of the benefits versus costs of prescribed fire.

Although prescribed fire has ecological advantages, a successful fire program for landscape-scale restoration requires public support (Knotek et al. 2008; Loomis et al. 2001). Attitudes play a critical role in the formation of opinions that can create challenges related to use of prescribed fire for different management activities, including longleaf pine restoration. Prescribed fire has been seen as more than risk reduction and protecting endangered species (Brunson and Shindler 2004); rather, the public has also viewed it as restoring "working ecosystems" and supported the idea that restoration should promote "working ecosystems." By contrast, survey respondents of the U.S. Intermountain West stated that natural areas should be allowed to evolve "without any intervention" indicating a portion of the public refers to "let nature go wild" (Ostergren et al. 2008). The authors suggested that further investigations would reveal an acceptance of letting nature manage itself would depend on the state of the forest. For the most part, almost every study that has asked questions about prescribed burning has found that more than 80 percent of the respondents accept some level of use of the practice (McCaffrey and Olsen 2012). Several of the studies that found overall acceptance levels of more than 80 percent used the same two statements to assess acceptance levels: "a legitimate tool that can be used anywhere" and "a tool that can be used infrequently in selected areas".

Past research suggests that support for prescribed fire can vary by demographics (e.g., age, education, seasonal residents), situational characteristics (e.g., proximity to a forest), and psychological variables (e.g., beliefs and attitudes toward a management action or the managing agency; Absher and Vaske 2007). Education, for example, may be linked to knowledge about agencies initiating fire management actions (Vogt et al. 2005). Collaborating with these agencies continue to be a cornerstone in successfully accomplishing the objective of implementing prescribed fire because collaboration builds trust in persons implementing the prescribed fire

(Bright et al. 2007). Collaboration yields long-term benefits if participants maintain regular communication and active participation in the collaborative process and are committed to staying engaged through completion of the plan, project, or activity. Scale, zoning, and other situational factors define a given context and influence what the public believes is acceptable or feasible (Bright et al. 2007). For example, research has shown how public support for fire management has been linked to risk for private homes built in the wildland-urban interface (Jacobson et al. 2001). In other cases, support for preferences for fuel reduction has included prescribed fire over mechanical treatment, but the preference depends on whether the practice takes place in a rural area versus and site closer to the respondent's property (Brunson and Shindler 2004).

The two variables most commonly associated with acceptance of prescribed fire are knowledge of the practice and trust in managers to implement it (McCaffrey and Olsen 2012). Higher levels of knowledge or familiarity with prescribed fire have been significantly associated with higher levels of acceptance (Absher and Vaske 2006). Absher and Vaske (2006) found that an index created from familiarity with the practice, perception of aesthetics, and effectiveness of the treatment explained 39 percent of the variance in approval. Higher levels of knowledge have also been linked to less concern about smoke and other potentially negative outcomes and risks of prescribed fire (Blanchard and Ryan 2007). In addition to knowledge, the higher the level of reported trust and perceptions of competency (a form of trust) in the persons implementing prescribed fire have been related to higher acceptance of the practice (Shindler et al. 2011). Such findings, however, were dependent on location. Acceptance was more likely to be related to trust if the practice took place in a rural area than an urban area. Concerns about prescribed fire such as fire escape, impacts to wildlife, and aesthetics were mitigated by familiarity with the practice and trust in burners (Toman et al. 2013).

2.2. Place attachment

Multiple approaches have been developed to understand the complex relationships that exist between humans and landscapes (Davenport and Anderson 2005). In recent years the construct of place attachment has taken a prominent role in ecosystem management issues (Alam 2011). Place attachment is a complex concept that has been described as a collection of experiences, including social meanings, values, attachments, feelings, emotions, perceptions, attitudes, and characteristics that humans associate with a place (Davenport and Anderson 2005; Kaltenborn 1998; Stedman 2003). Humans derive meanings from places, which help them to make sense of themselves and their life experiences (Tuan 1997). Some meanings become anchors of attachment that affect attitudes and behaviors toward natural resources (Greider and Garkovich 1994). Although place attachment does not depend on social interactions, such processes are often the driver of effective attitudes towards a special place (Bricker and Kerstetter 2002; Jorgensen and Stedman 2006; Stedmand 2003).

The construct of place attachment addresses place importance, subjective assessments of well-being, satisfaction with landscape quality, attitudes towards the environment, and perceptions of forest management practices as they affect meanings and attachments to the landscape and individual well-being. A number of studies have examined the relationships between place attachment and environmentally responsible behavior (Ardoin 2006; Vaske and Kobrin 2001). For example, a substantial literature has studied place attachment within the context of nature-

based recreation and how this leads to positive attitudes towards the particular setting, repeated visitation, and opinions about the setting's management (Bricker and Kerstetter 2002; White et al. 2008).

Attitudes about prescribed fire in ecological restoration may also depend on the place-based attachments and meanings of the ecosystem in question. Attitudes towards landscape restoration are informed by interpretations of "naturalness" (Vining et al. 2000), perceptions of science (Helford 2000), as well as emotional attachments to a landscape (Findley et al. 2001). While several studies have addressed defensible space in landscaping activities, little research in the wildfire risk perception literature has focused on sense of place (exceptions are Brenkert-Smith 2006; Bihari and Ryan 2012). Sense of place is informed by knowledge of and emotional connections to the local landscape and is critical to facilitating collective definitions of risk (Kemmis 1990). Place attachment has become increasingly common in the examination of ecosystem management and place-based theories demonstrate relationships between the publics' attitudes towards prescribed fire and their environmental awareness (Alam 2011). For example, in the Kenai Peninsula, place attachment was key aspect to influencing local knowledge of biophysical factors and facilitating social interactions (Gordon et al. 2013). In particular, the disruption of a shared sense of place, resulting from dramatic sociodemographic and biophysical changes in the community, influenced diverse attitudes towards spruce bark beetle timber salvage, defensible space, and scenic vistas. Because place is a collection of physical attributes, values, and emotional attachments, its meaning varies across resident groups and communities. Like the role of residence status, there is a need to further study how sense of place influences collective wildfire risk perceptions and response. The place attachment literature suggests landowners may be willing to participate in landscape restoration given appropriate educational interventions and economic incentives, along with the influences of their individual value and attitude orientations. In short, on the landscape ability and willingness to implement prescribed burning programs as part of ecologically sound longleaf management.

2.3. Theoretical framework

This research is guided by the notion that implementation of prescribed fire towards successful restoration of longleaf pine's native range depends upon both the public acceptance of restoration as well as landowners' willingness to plant longleaf pine and implement restoration management practices. Building on the Theory of Reasoned Action (TRA), the Theory of Planned Behavior (TPB) is the concept of perceived behavioral control, or an individual's beliefs about their ability to carry out or perform a given behavior (Ajzen 1991). Hence, in trying to map behavioral intents, the TPB can be used as a basis for predicting public attitudes towards land management decisions. The TPB has been applied to a variety of fields (e.g., forestry, political science, marketing, and healthcare) examining beliefs, attitudes, and behavioral intentions.

According to the TPB, behavior depends on behavioral intentions, which are formed by attitudes and subjective norms, and perceived behavioral control (Ajzen 1991). Attitudes refer to an individual's subjective evaluation of a given behavior as good or bad. Individuals usually form positive attitudes towards behaviors believed to have positive consequences and negative attitudes towards behaviors associated with beliefs of negative consequences. Subjective norms refer to beliefs about how important others view a given behavior (Ajzen 1991). Perceived

behavior control can be defined as the perceived ease/difficulty of successfully performing a behavior, which can be influenced by past experience, expected support, and potential barriers. The main idea is that the best

predictor of future behavior is the intent of past behavior (Ajzen 1991). Behavioral intentions indicate an individual's willingness and readiness to perform a given behavior and are presumed to be related to their actual behavior. For example, just because a landowner has a positive attitude towards longleaf pine does not necessarily mean they will engage in prescribed burning activities which is important for restoration. The TPB states that the combination of landowner attitudes toward prescribed fire, risk perceptions, and how other landowners think about prescribed fire more strongly impact the decision toward restoring longleaf pine versus having a positive attitude alone.

A few human dimensions related natural resource studies have been based on the TPB. For instance, Hrubes et al. (2001) applied TPB to the prediction and explanation of hunting. This research found that broad values related to wildlife and life in general correlated weakly with hunting behavior, and their effects were largely mediated by TPB components. Floress et al. (2015) used TPB to explore farmers' interest in improving water quality. This study found that individual behavior is impacted by variety of social, psychological, institutional, and economic factors that need to be understood for successful implementation of watershed management strategies. Similarly, Leitch et al. (2013) used TPB to study private landowner intentions to supply woody feedstock for bioenergy. This study provided an initial evaluation of a landowner's intent to harvest wood for energy and also outlined barriers (which include lack of bioenergy markets and woodland access) that shaped those intentions.

Based on previous research and the context of prescribed fire in longleaf pine restoration programs, this research employs a TPB-based conceptual model to understand attitudes and behaviors regarding longleaf pine restoration (Figure 2.1.). This framework suggests that increasing knowledge, place attachment, and specific ownership objectives (which generally do not include income generation compared with timber management) increase landowners' interest in longleaf pine. These factors are mediated by landowner characteristics (i.e., sociodemographic, acreage, amount of longleaf pine planted and future intentions of planting). In turn, increasing interest in longleaf pine would increase intentions to apply prescribed fire, depending on the perceived reasons for not burning and collaboration with different organizations. Increased intent to apply prescribed fire would increase the likelihood of implementing prescribed fire, in line with the TPB.

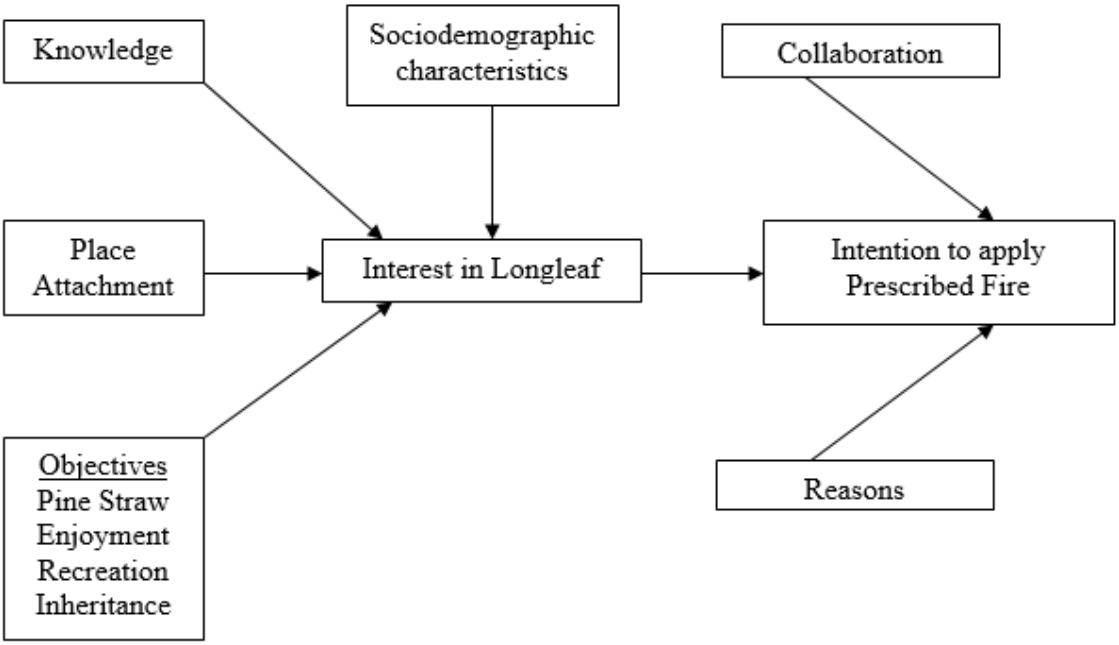

Figure 2.1 Conceptual model of landowner behavior regarding implementation of prescribed fire

The study objective was to identify interest in reestablishing longleaf pine ecosystems within its historical range given that prescribed fire mimics an important historical process in longleaf pine habitats. To this end, the following hypotheses were tested:

H1: There is significant interest in longleaf pine restoration among NIPF landowners and non-landowners;
H2: Place attachment increases the interest in longleaf pine restoration among landowners and the general public; and

H3: Intent to apply prescribed fire depends on interest in landowners' longleaf pine, place attachment, collaboration, reasons for not implementing, and knowledge.
Attitudes of both the general public and landowners were considered in this study because landowners do not make decisions in a vacuum. They influence and are influenced by their communities (Wilkinson 1991).

3. Methodology

3.1. Sample

Survey data collection occurred in the U.S. Gulf Coast region from Texas to Florida among individuals who lived on or owned property in 130 counties within longleaf pine's historical range (Figure 2.2.). The region has received extensive damage from recent extreme weather events, including Hurricane Katrina (2005), Rita (2005), Gustav (2008), and Matthew (2016), among others. A dual-frame, cluster area probability sample of 2,700 completed telephone interviews, that included cellphone and landline numbers, was employed. Sub sampling included

30 percent (n=821) of completed interviews with NIPF landowners (owning at least 20 acres or more acres of forestland). Sampling assured that geographic, race, gender, age, and income were included and represented. Mississippi State University's Institutional Review Board (IRB) reviewed and approved the survey questionnaire before interviewees were contacted (IRB approval number 16-632). The survey was conducted by Opinion America, an experienced telephone survey firm, from March to June 2017.

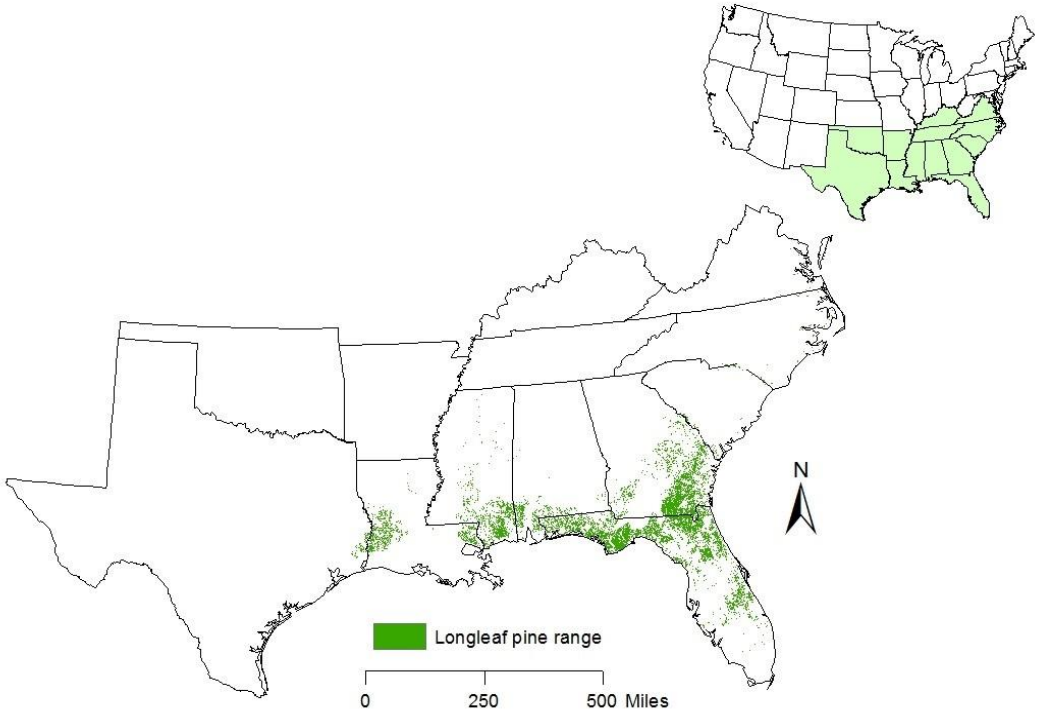

Figure 2.2 Telephone survey research area along the Gulf Coast region from eastern Texas to Florida panhandle

A standard telephone survey questionnaire was prepared (Appendix B). The survey was initiated with 21,903 telephone records of which 2,761 respondents were qualified, and, therefore, started the survey with 2,700 respondents completing the survey (Table 1). Among the 2,700 completed surveys, 30 percent of the respondents were NIPF landowners (n=821).

3.2. Measurements

Table 2.1. lists the variables used for testing the hypotheses. The sociodemographic group consisted of AGE, GENDER, EDUCATION, ANNUAL INCOME, and RACE. AGE was the age of the respondents in years (continuous). GENDER refers to the respondent's gender (1 = male and 0 = female). EDUCATION is the respondent's level of education, originally with six categories. EDUCATION and several other variables were recoded to combine their cells when greater than 20 percent of expected cell values were less than 5 (collapsing cells ensures an adequate number of distinct observations per cell and accurate p values). EDUCATION was recoded to a dummy variable (1 = "at least a 4-year college graduate education" and 0 = "all others"). "All others" included "Less than high school", "high school (or equivalent) graduate", "some college or post-high school trade school", and "other." ANNUAL INCOME refers to annual household income, which originally had seven different categories (1= less than $15,000, 2= $15,000 but less than $25,000, 3 = $25,000 but less than $50,000, 4 = $50,000 but less than $75,000, 5 = $75,000 but less than $100,000, 6 = $100,000 but less than $150,000, 7 = $150,000 or more, 8 = Refused, and 9 = Don't know) but was recoded into three categories (1= "Less than $50,000"; 2= "$50,000-$100,000"; and 3 = "More than $100,000"). Responses such as "refused" and "don't know" were removed from the analysis. RACE was the respondent's self-reported race/ethnicity with five different categories (1= African American; 2= Caucasian; 3= Asian; 4= Hispanic/Latino; and 5 = Native American).

OWNER measured whether the respondent owned forest land or not. Respondents were asked if they owned forest and how many acres did they own. A dummy variable was created from this response (1= "forest owners" and 0 = "non-forest owners").

To measure knowledge regarding longleaf pine and prescribed fire, questions were asked about how familiar were respondents with longleaf pine and prescribed fire. LLP KNOWLEDGE and PF KNOWLEDGE indicated landowners' and non-landowner's knowledge regarding longleaf pine and knowledge regarding prescribed fire, respectively. Separate binary response survey questions asked whether respondents were aware about longleaf pine and prescribed fire or not. Both variables were measured as binary (1 = "yes" and 0 = "no"). When required, survey interviewers provided a definition of longleaf pine and prescribed fire.

To measure ownership objectives, a question was posed with eight items for landowners to indicate their priority objectives. Items included: (1) land investment (to sell all or part of my forest land at a profit), (2) hunting opportunities, (3) camping, hiking, or other recreation, (4) growing trees for sale, (5) income from a recreation lease (e.g., hunting), (6) produce pine straw, (7) enjoyment of owning forest land, and (8) as an asset to pass on to my heirs. These items were measured with a 5-point Likert type scale (1 = very important; 2 = somewhat important; 3 = neither important nor unimportant; 4 = somewhat unimportant; and 5 = very unimportant). To determine which items would raise the interest in longleaf pine reestablishment, I ran bivariate correlation and among the eight items, PINE STRAW, RECREATION, ENJOYMENT, and INHERITANCE (described in Table 2.1.) were associated. I chose these four variables for regression analysis. Responses such as "very important" and "somewhat important" were categorized into "important" category and recoded "1". Similarly, responses such as "neither important nor unimportant", "somewhat unimportant", and "very unimportant" were categorized

into “not important” category and recoded as “0”. Responses such as “Don’t know” was removed from analysis.

Place attachment has been measured using a variety of approaches and scales (see Stedman 2003). In this study, a place attachment scale incorporated functional attachment and emotional attachment measures of landowners’ and non-landowners’ level of attachment to the Gulf Coast as a special place (Williams and Vaske 2003). Ten item Likert scales (1= strongly agree; 2= somewhat agree; 3= neither agree nor disagree; 4= somewhat disagree; and 5=strongly disagree) were used to ask “To what extent do you (1) Agree or (2) Disagree with the following statements, with a follow-up probe of (3) Strongly Agree (4) Strongly Disagree (9) (VOL) Don’t know/no opinion. Items included six emotional attachment measures and four functional attachment measures:

(1) I feel strong, positive feelings for the Gulf Coast (emotional attachment)
(2) I identify strongly with the Gulf Coast (emotional attachment)
(3) I feel Gulf Coast is a part of me (emotional attachment)
(4) I feel I can really be myself in the Gulf Coast (emotional attachment)
(5) I get more satisfaction out of visiting Gulf Coast than any other natural area (functional attachment)
(6) The Gulf Coast is my favorite place to be (functional attachment)
(7) The Gulf Coast is the best place for what I like to do (functional attachment)
(8) I feel happiest when I am at Gulf Coast (emotional attachment)
(9) I wouldn’t substitute any other area for doing the types of things I do at Gulf Coast (functional attachment)
(10) I really miss Gulf Coast when I’m away too long (emotional attachment)

From the original Likert scale responses, I computed the new variable by taking the average of these ten items for each respondent to create the PLACE ATTACHMENT score. Responses such as “don’t know” were removed from analysis.

LLP INTEREST represented landowners’ and non-landowners’ interest in longleaf pine reestablishment. The survey question asked respondents to indicate to what extent they were interested in longleaf pine restoration. Response was measured as a categorical variable: (1) not at all; (2) not much; (3) some; and (4) a lot. Responses were recoded into a binary variable (1 = “yes” and 0 = “no”) where responses “not at all” and “not much” were combined into “no” and responses “some” and “a lot” were combined to “yes”.

Reasons for not implementing prescribed fire included liability concerns, capacity (i.e., lack of technical knowledge/ technical assistance/ equipment), limited parcel size, cost (expenses related to labor and equipment), smoke issues, and preference for herbicides and/or mechanical treatments. Survey questions asked how important these factors were in decisions NOT to implement a prescribed fire. Responses were measured as 5-point Likert scales (1 = very important; 2 = somewhat important; 3 = neither important nor unimportant; 4 = somewhat unimportant; and 5 = very unimportant). I computed a new variable, REASONS, by taking the average of the seven items for each respondent. “Don’t know” responses were removed from analysis. Similarly, COLLABORATION measured landowners’ interest in participating in

a local landowner organization that facilitates the appropriate use of prescribed fire on the organization's members' land. Such an activity would create economies of scale and knowledge exchange that may surpass the reasons landowners have for not applying prescribed fire. Responses were measured as a 5-point Likert type scale (1 = very unlikely; 2 = somewhat likely; 3 = neither likely nor unlikely; 4 = somewhat likely; and 5 = very likely). These responses were recoded into a binary response. "Somewhat likely" and "very likely" were recoded to "likely", coded as "1", and all other response were categorized as "Unlikely" and recoded as "0". "Don't know" responses were removed from the analysis.

3.3. Data analysis

Hypotheses 1 and 2 considered the full set of respondents: landowners and non- landowners. Hypothesis 3 considered only landowners. A Chi-square test was used to test the first hypothesis i.e., to determine if there were significant associations between pairs of categorical variable. Chi-square tests provided a picture of the association between two variables. If the proportion of individuals in the different columns varied significantly, the two variables were dependent (i.e., there is contingency). If there was no contingency, the two variables were considered independent. To explore other two hypotheses i.e., effect of place attachment on interest in longleaf pine and effect of place attachment and interest in longleaf pine on intent to apply prescribed fire, a binomial logistic regression model based on Figure 2.1. was used. This model was used to predict the probability that an observation fell into one of the two categories of a dichotomous dependent variable based on one or more independent variables that was either continuous or categorical. A positive coefficient for an independent variable indicated a positive effect upon the probability of occurrence of the dependent variable while a negative coefficient indicated the independent variable had a negative effect upon the probability of the dependent variable. Data were analyzed through descriptive as well as statistical comparison method to search for differences. For analysis, all statistical procedures were carried out in IBM SPSS 22 (Statistical Package for Social Scientists) with statistical significance at the $p < 0.05$ level.

4. Results

The sample was initiated with 21,903 telephone records, of which 2,761 were qualified (Table 2.2; full disposition table in Appendix C). In total, 2,700 respondents completed the survey (Table 2.2) for a maximum margin of error ± 2.7% at the 95% confidence interval. Appendix C contains the response disposition table. Excluding partial interviews and estimated proportions of cases of unknown eligibility that are eligible (e=37.3 percent; for each of the following, one e was assigned for immediate hangups, always busies, and always ring no-answers), the survey resulted in a 33.1 percent minimum response rate. The cooperation rate of 34.4 percent included partial interviews and those unable to do the interview as also incapable of cooperating. The refusal rate of 64.5 percent is analogous to the cooperation rate.

Table 2.2. Survey response and cooperation rates

I = Complete Interviews	2,700.0
P = Partial Interviews	61.0
R = Refusal and break off	5,264.0
O =Other (language barrier)	140.0
Minimum Response Rate [I/(I+P) +R+O)]	0.331
Cooperation Rate [(I+P)/((I+P) +R))]	0.344
Refusal Rate [R/((I+P) + (R+O))]	0.645

4.1. Non-response bias

To check for potential non-response bias, respondents were compared with general population among the surveyed states. Current Population Survey Supplements (CPS) provided data on selected socio-demographic variables (age, gender, education level, and annual household income) of entire population. Data were taken from six different states and aggregated. These data show that, overall, survey respondents were older than the general population (however, this study purposefully sampled respondents over 18 years of age and NIPF landowners, which tend to be older (Table 2.3). Median annual income of survey respondents was greater than the general population. Similarly, respondents tended to have more education than the population. Respondents were similar to general population in terms of gender.

Table 2.3 Mean values for population and net sample

Variable	Population	Net sample
Age (years)	37.45	50.77
Gender		
Male	48.83%	48.20%
Female	51.17%	51.80%
Education		
For all others	65.8%	56.00%
More than college education	34.2%	44.00%
Annual Household Income	$47,901	$50,000- $100,000

4.2. Respondent characteristics

Respondents' characteristics are presented in Table 2.4. The average age of the respondents was 50 years (median = 51 years). Female and male respondents were fairly evenly distributed with 51.8 percent females. Forty-four percent reported they had more than a college education. Median annual household income was in between $50,000 - $100,000. Two thirds (66.2%) reported they have lived less than 25 years in the Gulf Coast region. Eighty-one percent of the respondents reported they were Caucasian, leaving less than 20 percent distributed among the other categories.

Table 2.4 Sociodemographic characteristics (N = 2,700)

Variables	Mean	Standard Deviation	Percent (%)
Age (median = 51)	50.77	17.805	
Gender	0.48	0.500	
Male			48.2
Female			51.8
Education	0.44	0.496	
Less than 4-year degree			56.0
At least 4-year degree			44.0
Income (median = $50,000-$100,000)	1.67	0.748	
Less than $50,000			49.8
$50,000-$100,000			33.2
More than $100,000			16.9
Length of residence (median = 1)	1.41	0.627	
Less than 25 years			66.2
25-50 years			26.3
More than 50 years			7.5
Race	1.98	0.631	
African American			13.2
Caucasian			81.3
Asian			1.4
Hispanic/Latino			2.4
Native American			1.7

Forest landowners owned their forestland for a variety of reasons (Figure 2.3.). Thirty-four percent of landowners reported passing their land to their heirs as the most important reason for ownership. This was followed by the enjoyment of owning forestland as the priority ownership objective (28 percent). Ten percent of landowners reported various recreational purposes (e.g., camping, hiking, etc.) as important reasons. Similar to the National Woodland Owner Survey, which reports between 10 and 17 percent of landowners own their land as an investment or to grow timber (Butler et al. 2018), just over 6 percent of landowners in this study reported growing trees for sale as their most important objective. Survey results also highlighted the status of

longleaf pine on respondents' forest land. Fifty-three percent of landowners reported their property contained one or more longleaf pine trees, with a median of 6 acres of longleaf pine ($\bar{X}$ = 75). Fifty-six percent of landowners were likely to plant longleaf pine in the future.

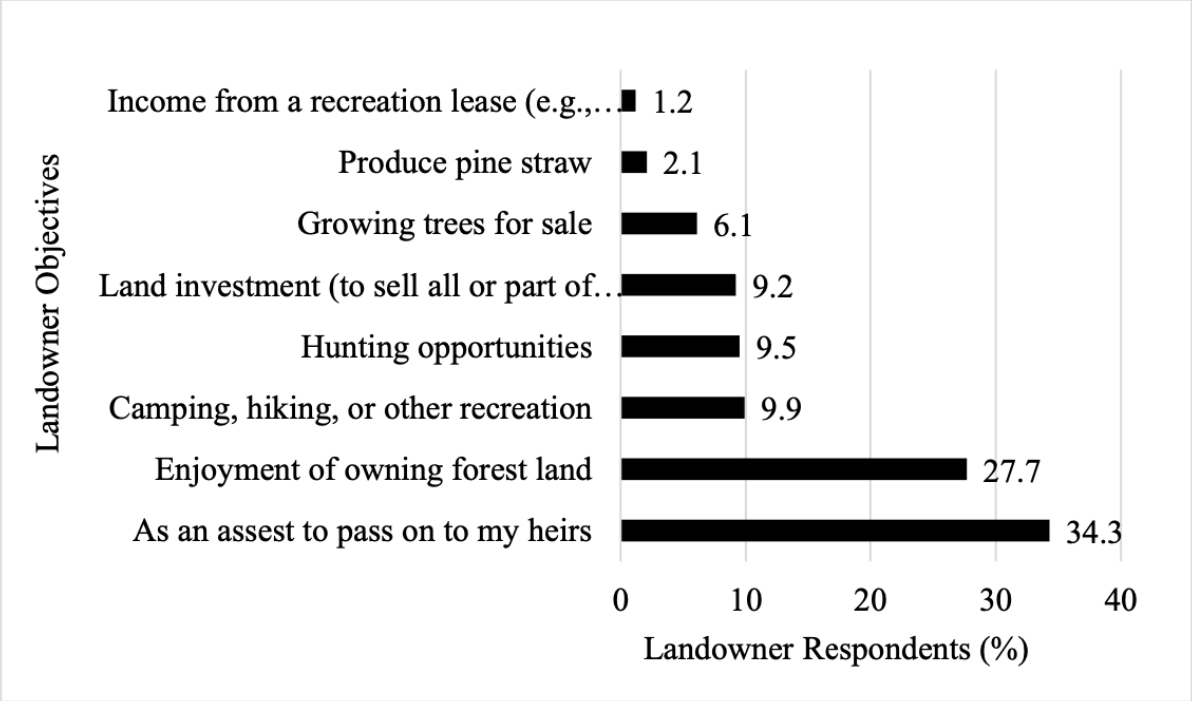

Figure 2.3 Nonindustrial private forest landowner ownership objectives

4.3. Interest in longleaf pine and prescribed fire (Hypothesis 1, landowners and non-landowners)

Forty-one percent of respondents, landowners and non-landowners alike, were aware of differences between longleaf pine and other pine species, while 59 percent reported little to no knowledge about longleaf pine (Figure 2.4.). Fifty-five percent of all respondents knew that longleaf pine was once the dominant forest ecosystem in the Southern United States. Eighty-two percent reported that, when restored to full ecological function, longleaf pine ecosystems provide habitat for numerous plant and animal species. Respondents were relatively evenly distributed (47.4 percent) regarding knowledge about the need of fire for longleaf pine restoration, while 32 percent reported there had been extensive efforts to increase longleaf pine acreage. Eighty-one percent of the net sample reported had an interest in reestablishing longleaf pine ecosystems (Figure 2.5.).

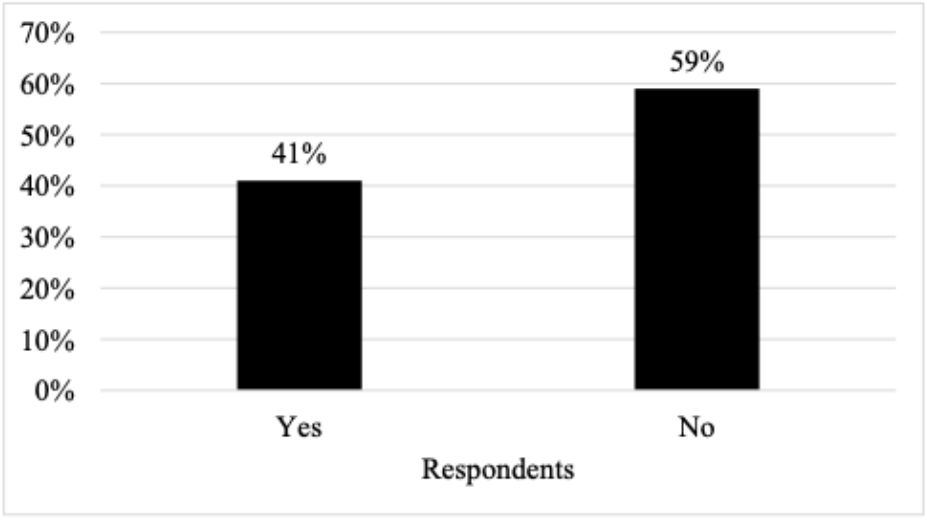

Figure 2.4 Respondent knowledge regarding longleaf pine

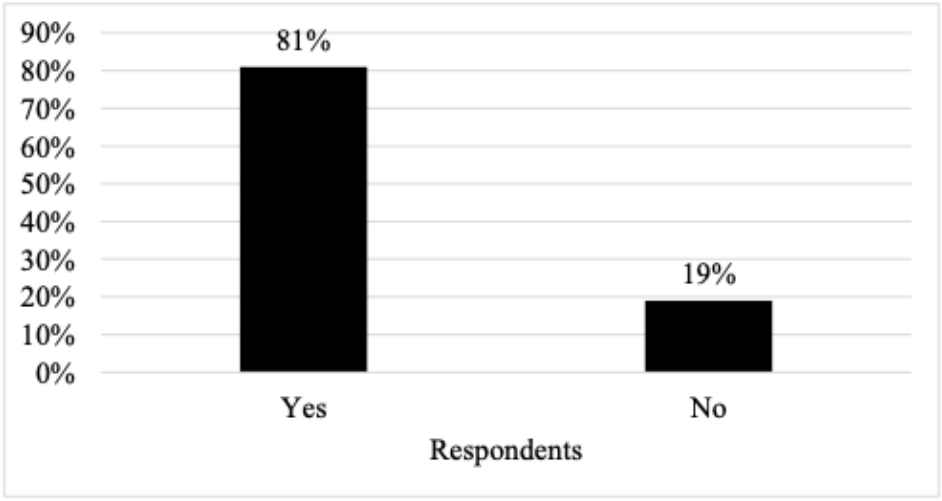

Figure 2.5 Respondent interest in reestablishing longleaf pine ecosystem

In short, 81 percent of the respondents had an interest in reestablishing the longleaf pine ecosystem and three different variables were significantly associated with interest in longleaf reestablishment. Landowners and non-landowners were interested in longleaf pine restoration. A Chi-square test revealed associations between GENDER, OWNER, and LLP KNOWLEDGE variables with an interest in longleaf pine reestablishment (Table 2.5.). These variables were GENDER (χ^2= 7.948, p = 0.005), RACE (χ^2 = 11.099, p = 0.000), OWNER (χ^2 = 6.356, p = 0.012), and LLP KNOWLEDGE (χ^2 = 18.537, p = 0.000) which were significantly associated with interest in longleaf pine reestablishment.

Table 2.5 Variables associated with interest in longleaf pine reestablishment ($p < 0.05$)

Variables	Interest in longleaf pine reestablishment	
	Chi-square (χ^2) value	P-value
GENDER	7.948	0.005*
EDUCATION	1.673	0.196
OWNER	6.356	0.012*
LLP KNOWLEDGE	18.537	0.000*

More than half (58%) of the 2,700 respondents were familiar with the term prescribed fire, while 72 percent of participants were aware of the benefits of prescribed fire. Ninety-two percent agreed prescribed fire removes accumulated material on the ground to prevent wildfire. Similarly, 93 percent of respondents agreed prescribed fire improves conditions for longleaf pine establishment, and 89 percent agreed that prescribed fire maintains a natural balance in the ecosystem. Fifty-four percent of landowners reported they would be concerned about a prescribed fire in or near their property. Most of the respondents (42%) would trust state-certified prescribed burn managers to implement a prescribed fire, followed by uncertified public foresters (35%) and then wildlife biologists (31%) who would conduct the burn as part of the government sponsored wildfire fuel reduction. Only 22 percent of the respondents knew about prescribed fire regulations. Nine percent of 821 landowners reported they had ever conducted a prescribed fire on their property, while nine percent of landowners said they had purchased insurance to conduct a prescribed fire. Nearly half (49%) of the landowners would consider conducting a prescribed fire on their property in future.

Landowners rated seven factors which they regarded as reasons for not implementing prescribed fire (Figure 2.6). Sixty-seven percent of participating landowners reported potential liability as the primary reason. Sixty-two percent reported capacity as the other important reason followed by limited parcel size (54%) and cost related issues (52%). Concern about smoke was recognized as another reason by 51 percent of landowners.

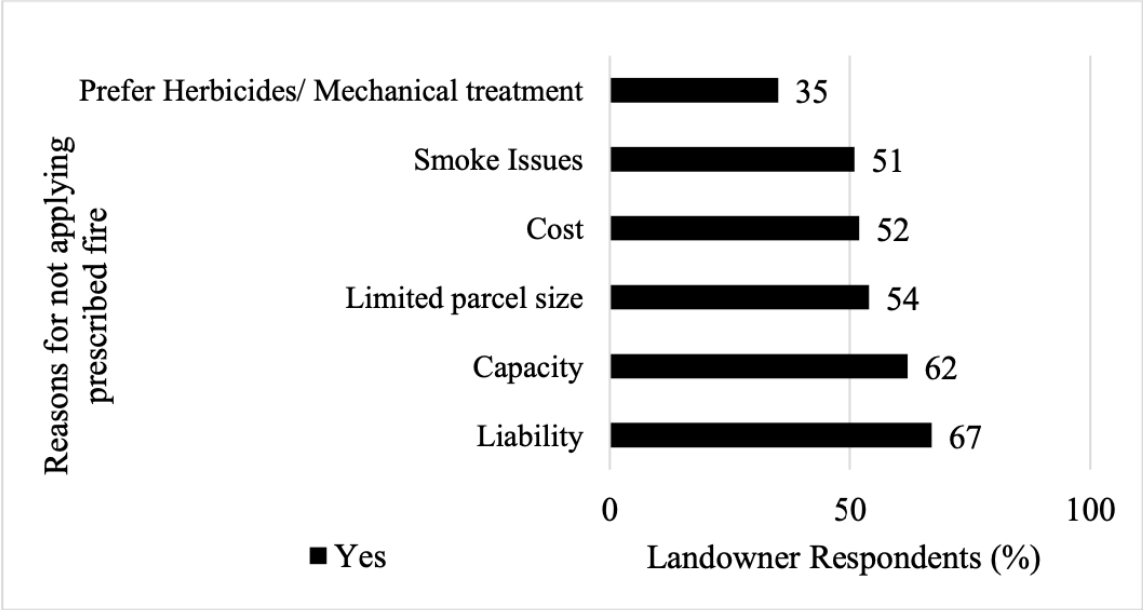

Figure 2.6 Reasons for not implementing prescribed fire

4.4. Effect of place attachment on interest in longleaf pine (Hypothesis 2, landowners and non-landowners)

I expected place attachment to have a significant effect on landowners' and non- landowners' interest in longleaf pine restoration. A logistic regression model explained 10 percent of the variation in responses (Table 2.6.). As age of the respondent increased, interest in longleaf pine diminished by two percent (p=0.005). Respondents with higher levels of knowledge regarding longleaf pine and its benefits were more than six times more interested in longleaf pine restoration than their counterparts (p=0.000). Similarly, respondents with higher levels of knowledge regarding prescribed fire and its benefits were more than three times more interested in longleaf pine reestablishment than those with lower levels of knowledge (p=0.011). Landowners owning land to pass on to their heirs were more than twice as interested in restoration programs compared with landowners with other management objectives (p=0.022). Similarly, landowners owning land for enjoyment were more than three times interested in restoring longleaf pine than other management objectives (p=0.001). Finally, as the place attachment score decreased, interest in longleaf pine restoration decreased by 20 percent (p=0.026). In other words, as the level of attachment increased, interest in longleaf pine reestablishment increased as well. Variables such as "GENDER", "EDUCATION", "ANNUAL INCOME", "PINE STRAW", and "RECREATION" were not found to be statistically significant in the analysis.

Table 2.6 Logistic regression showing the extent to which socio-demographics, knowledge, objectives, and place attachment explain variation in interest in longleaf pine restoration.

Variables	Interest in longleaf pine restoration		
	B	Odds Ratio	P-value
Socio-demographic			
AGE	-0.017	0.983	0.005*
GENDER	-0.254	0.776	0.218
EDUCATION	0.292	1.339	0.186
ANNUAL INCOME	0.058	1.059	0.690
Knowledge Status			
LLP KNOWLEDGE	1.863	6.442	0.000*
PF KNOWLEDGE	1.161	3.192	0.011*
Management Objectives			
PINE STRAW	0.103	3.168	0.678
RECREATION	0.829	0.989	0.160
INHERITANCE	0.401	2.291	0.022*
ENJOYMENT	1.153	3.168	0.001*
PLACE ATTACHMENT	-0.218	0.804	0.026*
Nagelkerke R^2	0.100		

* Factors were considered significant at $\alpha < 0.05$

4.5. Effect of place attachment and interest in longleaf pine on intent to apply prescribed fire (Hypothesis 3, landowners)

A logistic regression model added the variables above, including interest in restoration, to predict intent to apply prescribed fire. REASONS for not applying prescribed fire and COLLABORATION were also added to the model which explained 46.1 percent of variation ion responses (Table 2.7.). As age increased, younger landowners were nearly two times more interested in applying prescribed fire than older landowners (p=0.025). Landowners with increasing knowledge regarding longleaf pine were nearly four times more interested in applying prescribed fire on their land than their counterparts (p=0.007). Similarly, landowners with knowledge regarding prescribed fire and its benefits were more than three times more interested in applying prescribed fire than those without knowledge about prescribed fire (p=0.018).

In addition, as the REASONS score increased, landowners were less likely to apply prescribed fire. Landowners were 36 percent less likely than those landowners who think various limiting factors were not the reason to apply prescribed fire on their property (p=0.028). Landowners who were interested in restoration of longleaf pine were nearly twice as likely as landowners who were not interested in restoration of longleaf pine to use prescribed fire on their property (p=0.033). Landowners who were interested in participating (COLLABORATION) with other landowners for appropriate use of fire were nearly three times interested in applying prescribed fire (p=0.000) in comparison to the landowners who were not interested in COLLABORATION. Variables such as “PLACE ATTACHMENT”, “GENDER”, “EDUCATION”, and “ANNUAL INCOME” were not found statistically significant in the analysis.

Table 2.7 Logistic regression showing the extent to which place attachment, and interest in longleaf pine restoration explain variation in landowners' intent to apply prescribed fire.

Variables	Intent to apply prescribed fire		
	B	Odds Ratio	P-value
Socio-demographic			
AGE	-0.013	1.875	0.025*
GENDER	-0.093	0.912	0.801
EDUCATION	-0.105	0.900	0.602
ANNUAL INCOME	0.294	1.342	0.440
Knowledge Status			
LLP KNOWLEDGE	0.815	3.859	0.007*
PF KNOWLEDGE	0.864	3.471	0.018*
PLACE ATTACHMENT	0.070	1.072	0.532
REASONS	0.493	0.638	0.028*
LLP INTEREST	0.606	1.833	0.033*
COLLABORATION	0.973	2.646	0.000*
Nagelkerke R^2	0.461		

* Significant at level of significance 0.05

5. Discussion

This study explored how place attachment and the Theory of Planned Behavior influenced the general public's and landowners' interest in longleaf pine restoration and landowners' intent to apply prescribed fire on their property. Similar explanatory approaches have been employed to understand other forestry behaviors with family forest owners (e.g., Brough et al. 2013; Karppinen 2005; Thompson and Hansen 2013).

Among Gulf Coast residents, the 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. As well, Johnson and Franklin (2000) suggested much of the interest in longleaf restoration has been the result of an increasing interest in ecological values of longleaf forests. In addition, this growing interest may be explained by the perception that some of the unique characteristics of longleaf are superior to other southern pines. While this would be related to subjective attitudes, a stand of longleaf pine does produce a greater percentage of high-valued poles than other southern pine species (Williston and Screptis 1975). These high valued poles have a potential financial advantage for landowners and industry because poles may be twice as valuable as sawtimber.

In terms of demographic characteristics, age was negatively significant in both regression models. Younger respondents were more interested in longleaf pine restorationwere more likely to apply prescribed fire than older respondents. This finding is similar to other studies that have found a negative association between age and acceptance of forest management practices (Joshi and Arano 2009; Loyland et al. 1995; Kuuluvainen et al. 1996; Zhang and Flick 2001). One

explanation for this is that older landowners are interested in leaving the forest land for future generation resulting in minimal or no restoration efforts during the lifetime of the older landowner. Another possible reason for lack of interest might be that they want to use forest land for recreation and enjoyment rather than for restoration, which require active management and investment.

Results from this research are consistent with studies which have documented that knowledge regarding longleaf pine and prescribed fire is important for ecological restoration (Kreuter et al. 2008; Morton et al. 2010; Piatek et al. 2010). These studies suggest that educational efforts increasing knowledge significantly raise interest and support for restoration programs. Increased levels of knowledge contribute to understanding of the benefits of the species and the practices, including risks and benefits, required in restoration efforts.

Findings illustrate how the relationships people have with a particular place influence environmental attitudes and interest in restoring native habitats. Similar to other studies applying place attachment to natural resource management, this study supports the notion that place attachment is an important indicator of intention and support for restoration (Alam 2011; Stedman 2003; Williams and Vaske 2003). This study indicated that individuals who were strongly attached to the Gulf Coast exhibit high interest in conservation and restoration of longleaf pine. This might be because individuals holding a high level of place attachment wish to maintain the original settings of the place as they prefer those settings, which may be historical, actual or imaginary. Although this analysis did not specify the most important place attachment measure, in general, the attachments that individuals have to a place is important for public acceptance of restoration efforts (Stedman 2003).

Ownership objectives also influenced interest in longleaf pine restoration. Landowners who owned their land for enjoyment were interested in restoring longleaf pine forest. As shown in Butler et al. (2004), enjoyment is one of the most important landownership objectives among private landowners. If landowners place high importance in this objective, they seem more interested in environmental conservation, preservation, and restoration. Similarly, landowners who were planning to pass their forest lands to their heirs were more interested in longleaf pine restoration. This result is similar to Butler (2008), who illustrated forest owners wish to pass their land to family heirs illustrating a tremendous opportunity for management horizons that span generations. Although goals of forest industry are designed primarily for long-term profit, this does not suggest that such NIPF landowners do not manage forests for secondary, non-timber benefits, in addition to timber. As a matter of both good business sense and environmental concerns, NIPF landowners could support the management practices that ensure sustainability of multiple resource values. These findings were consistent with my initial expectations; however, education level, gender, and annual household income were not significant predictors of interest in the prescribed fire despite these variables being significant in other studies (Amacher et al. 2003; Butler 2008; Joshi and Arano 2009).

While the TPB model guided prediction of intentions of implementing prescribed fire, the inclusion of additional factors enriches the TPB framework of beliefs, attitudes, and intentions. Intent towards applying prescribed fire was influenced by interest in collaboration with various organizations, a result that is consistent with previous studies (Kobziar et al. 2015; Kreuter et al.

2008). This research suggests collaboration with peers will influence perceptions regarding prescribed fire use. Collaboration works toward educating the public, local communities, and decision-makers about the benefits of prescribed fire use, and enhances communication between local officials, fire-managers, and landowners (McCaffrey and Olsen 2012). Collaborative programs can provide informational materials and non-monetary (or monetary in some instances) incentives for landowners. Such programs would also promote peer-to-peer sharing of experiences. Although uncommon, prescribed fire groups found in some states and county forestry associations are examples of such local collaborative activities.

Implementation of prescribed fire is challenging. This research identified "liability", "capacity", "cost-related issues" and "smoke issues" as the major reasons for not using prescribed fire in the study region. Previous literature has documented liability as the major reason (Kreuter et al. 2008; Kobziar et al. 2015; and Morton et al. 2010). This previous research has shown high levels of concern among NIPF landowners and agencies regarding lawsuits from an escaped fire or smoke issue. Although there is some degree of prescribed fire liability protection, these protections are not comprehensive. As well, most NIPF landowners probably are not aware of the legal considerations of prescribed fire. Results highlighting capacity as an important reason were similar to a lack of technical knowledge as reported by Harr et al. (2014) and "need for assistance" as reported by Jarret et al. (2009) and Kreuter et al. (2008). Demand for prescribed fire is increasing while the capacity to use prescribed fire is not (Melvin 2012). This is because the supply of technical service providers and burn practitioners is insufficient across the region. In some cases, capacity may be the most important issue to address in promoting prescribed fire. In addition to liability and capacity, NIPF landowners also considered the cost of prescribed fire treatment to be a critical reason for not burning. This finding, was consistent with results from Fischer (2011) and Kobziar et al. (2015) which found management costs related to applying prescribed fire at a regular interval were higher that what landowners preferred, which was exacerbated by long investment horizons needed to recover costs. Cost is a major reason because prescribed fire implementation varies widely due to terrain and weather, with application not always feasible. A lack of agency and nonprofit funding for prescribed fire programs also presents challenge to incentivize landowners. In short, NIPF landowners' cost-benefit analysis often does not lead to motivations to apply prescribed fire.

The survey also reported concerns about smoke, similar to one results by Blanchard and Ryan (2007) and Morton et al. (2010). Smoke concerns are linked to the regulations regarding air-quality (Achtemeier et al. 1998). Smoke issues and management have been considered the major reason in other studies (Blanchard and Ryan 2007; Morton et al. 2010); yet, this study revealed smoke issues as only the fourth most important reason. This might be because when respondents have a better understanding about the benefits of prescribed fire, people are more acceptable of smoke as a risk. Smoke and its effects on air quality can lead to public health concerns, limitations of acceptable to burn days, and negative press. Properly trained personnel and proper assistance are required for maintaining and implementing prescribed fire and for balancing out the benefits and potential costs of prescribed fire.

6. Conclusions and Recommendations

This study verified the applicability of using the TPB to analyze landowners' intentions and behaviors towards ecological restoration using prescribed fire. The chi-square and binomial logistic regression results showed that TPB was theoretically appropriate. Results support the hypothesis of a causal chain between the variables of the TPB model. Results are consistent with my initial expectations regarding the growing interest in longleaf pine restoration among landowners and also general public (as stated in hypothesis 1); hence, the null hypothesis is rejected. According to the results, interest towards longleaf pine reestablishment would be positively influenced by demographic characteristics, knowledge regarding longleaf pine and prescribed fire, place attachment, and ownership objectives (as stated in hypothesis 2); hence, the null hypothesis can be rejected. Findings from this study also suggest intent towards prescribed fire would be positively influenced by socio-demographic characteristics, along with knowledge regarding longleaf pine and prescribed fire, landowners' level of attachment to place, some perceived reasons for not implementing prescribed fire, interest in longleaf pine restoration, and collaboration with other landowners for using prescribed fire (as stated in hypothesis 3). These findings were partially consistent with my initial expectations. Therefore, the null hypothesis was not rejected because using landowners' intention to reflect their forthcoming behavior was acceptable.

Future research should consider additional factors such as past experience, trust in prescribed burners, and environmental concerns, which could influence interest in implementing prescribed fire. Previous experience with prescribed fire may be associated with less concern about smoke. Trust is those implementing a prescribed fire practice reflects landowners' views on professional knowledge and experience. Environmental concerns may affect willingness to implement prescribed fire if landowners are concerned about air pollution, landscape damage, or promoting "natural" landscapes.

This study suggests educational efforts to enhance literacy about longleaf and prescribed fire should be customized for various demographic target groups. Based on the idea that people have emotional attachments to special places, demonstration sites should be promoted, e.g., state parks, wildlife management areas, natural areas, and other public lands to showcase habitat restoration efforts. This research helps to identify key messages, such as longleaf pine restoration is an important part of Gulf Coast identity, to develop and distribute to the public to expand understanding of the historical role of fire in Gulf Coast landscapes and the role that prescribed fire can play today. Collaboration and peer-to-peer learning (or landowners helping other landowners) and partnering with land management agencies may provide additional motivations for extending the longleaf range. While not ideal due to its unsustainable nature, cost-share assistance may incentivize some landowners by offsetting the costs of implementing prescribed fire. Similarly, increasing the amount of funding available through state, federal, and nongovernmental grant programs may resonate with some landowners, especially if their primary objectives are not economic-based. To decrease the risk of liability, prescribed burn association can ensure members have proper training and equipment, or provide contracting of professionals within economies of scale. Capacity issues can be addressed through increasing training/certification of private landowners, many of whom could eventually implement prescribed fire in their own. Results from this study are indicative of the need for more efforts to

enhance general awareness and knowledge of longleaf pine and prescribed fire among public and landowners for expansion of the use of prescribed fire for longleaf pine restoration.

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