ABSTRACT

MORRIS, HILARY LYNN COLE. 2013 Climate Change Attitudes of Southeast Forestry Professionals: Implications for Outreach. (Under the direction of Dr. Mark Megalos).

While climate variability can profoundly impact Southeastern forests, foresters' perspectives on anthropogenic climate change may influence their receptivity to climate science and adaptive management tools. In early 2013, we administered the first regional web survey of Southeast forestry professionals' climate change attitudes and educational needs to identify opportunities and obstacles to outreach on resilient forest management strategies.

Respondents' demographic characteristics were highly associated with climate change acceptance: political ideology, education level, employer, state of residence, gender, and years of forestry experience. Of these variables, political ideology most strongly predicted climate change acceptance.

Our results also demonstrate significant relationships between climate change attitudes, perceptions, and management responses. Foresters who accept climate change are more likely to observe climate change in the environment, feel concerned about the forestry impacts of climate change, and believe climate change will require different management strategies. Our findings also reveal distinct pathways for outreach experts to motivate adaptive management. To communicate effectively with foresters, we recommend educators connect climate change to forestry by illustrating the relevant

impacts of climate change on forestry and demonstrating the appropriate silvicultural management responses. These outreach insights should move the Southeast forestry community toward resilience in the face of climate change.

2013 Climate Change Attitudes of Southeast Forestry Professionals: Implications for Outreach

by
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DEDICATION

I dedicate my thesis to my dad, Brian Cole. His environmental ethic and work as a biologist sparked my interest in conservation, and his advice helped me navigate academic and professional challenges throughout graduate school. I'm so grateful for his patient support.

BIOGRAPHY

Hilary Morris grew up in the mountains of Western North Carolina and attended Charles D. Owen High School, where she was actively involved in soccer, choral music, theater, and journalism. In 2011, she graduated from Duke University with a B.S. in Biology, a B.A. in Environmental Science and Policy, and a certificate in Marine Conservation Science and Leadership. She studied at the Duke Marine Lab in Beaufort, NC for a semester, and pursued various internships in the United States and abroad, working in the public, private, and nonprofit sectors. Hilary remained at Duke to teach molecular biology lab for one year before beginning graduate school at NC State University (NCSU) in the Forestry and Environmental Resources Department. While pursuing her Master's degree, she worked as a graduate research assistant in NCSU Forestry Extension, and as a Pathways intern for the U.S. Fish and Wildlife Service at the South Atlantic Landscape Conservation Cooperative. In the summer of 2013, Hilary married her husband, Jaymeson. She completed her M.S. in Natural Resources with a Policy and Administration technical option in 2014.

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Finally, my family and friends deserve special mention. Thanks to my husband, Jaymeson, for so many things—tireless patience, dependability, healthy perspective, friendship, humor, musical interludes and Excel wizardry. Thanks to my parents and sister, and to Jay and Carolyn, for always believing in me. Thanks to many irreplaceable friends who inspired fun and camaraderie throughout two challenging years.

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CHAPTER 1: INTRODUCTION

Background: Climate Change and Forestry

Climate variability resulting from increasing atmospheric concentrations of CO_2 and other greenhouse gasses will impact Southeast forests. Outcomes include changing temperature and precipitation patterns, altered tree physiology, increasing wildfire frequency and intensity, expanding ranges and populations of pests and diseases, and increasing likelihood of extreme events such as high winds, strong storms, or droughts (Kirilenko & Sedjo, 2007). To address these emerging threats and changes, the U.S. Department of Agriculture funded the Pine Integrated Management: Education, Mitigation, and Adaptation Project (PINEMAP), which focuses on planted loblolly pine *(Pinus taeda)* in the Southeast United States. Two of PINEMAP's overall goals are to improve forests' resilience to climate change and to increase carbon sequestration (PINEMAP).

PINEMAP leverages genetics, ecophysiology, silviculture, and modeling expertise to study how planted Southeast loblolly pine will likely respond to climate change, and identify opportunities for more effective management techniques. Since meeting PINEMAP's resilience and sequestration goals requires foresters to implement the recommended management strategies, PINEMAP also supports economics, Extension, and education research to determine how to motivate the necessary behavioral changes. PINEMAP fully funded this research effort to advance its Extension goals.

The Cooperative Extension Service has been described as "one of the world's most successful change agencies" (Rogers, 2003). Land grant university faculty, called Extension

specialists, rely on Extension agents to link academia to the broader public. Extension specialists and their local advisory groups create and deliver educational programs to meet the needs of the community. "Extension enjoys a unique and particularly powerful relationship with the farming and forestry communities, which could have a very large influence on the success of our societal response to climate changes" (Monroe, Plate, Adams, & Wojcik, 2014).

The objective of this study is to discern the best approach to educate foresters about climate change adaptation. It arose from collaboration with Hubbard and Boby from the Southern Regional Extension Forestry (SREF) office and the University of Georgia (UGA). We designed a needs assessment survey of Southeast professional foresters to ascertain their perceptions of climate change. Foresters' attitudes toward climate change can potentially influence their receptivity to climate change adaptation and mitigation management tools (Lenart & Jones, 2013). As a result, Extension agents must understand how to effectively communicate with foresters and landowners about the best ways to manage their forests in the face of climate change. Our study uses the Cooperative Extension Service as a lens through which to examine universal climate change communication lessons that also apply to many other members of the forestry community—such as researchers, consultants, and industry representatives—who share the goal of forest resilience and need to discuss climate change adaptation with their clients and constituents.

As Smith, Anderson, and Moore (2012) write:

> Climate change cannot be addressed, either scientifically or pragmatically, with an understanding of physical processes alone. A more holistic understanding is needed and can emerge if social science methods and theories are used to develop a clearer understanding of the complex social, cultural, and behavioral realities of the impacts of climate change and individuals' ability to adapt to those impacts. (p.381)

Understanding which factors may influence foresters' attitudes toward climate change, and how those attitudes relate to their perceptions and management decisions, will improve the development of successful outreach materials and ultimately ensure the survival of healthy, resilient, and productive forests in the Southeast United States.

Literature Review: Climate Change Perceptions

The scientific community has reached near consensus that a human-driven increase in heat-trapping gas emissions in the atmosphere is causing global climate change. The Intergovernmental Panel on Climate Change, National Academy of Sciences, American Meteorological Society, American Geophysical Union, and American Association for the Advancement of Science have issued formal statements asserting that natural processes cannot explain the warming trend already observed (Oreskes, 2007). Over 80% of climate scientists worldwide agree that global warming is already occurring (Bast & Taylor, 2007). In addition, scientists convinced by the evidence supporting anthropogenic climate change possess greater credibility within the scientific community. When ranked by expertise, only 2.5% of the top 200 climate researchers doubt the evidence for climate change (Anderegg, Prall, Harold, & Schneider, 2010).

In the face of such overwhelming scientific agreement, why does controversy persist within the American public about the existence and cause of climate change? The scientific literature thoroughly documents the activity of a well-funded, highly organized coalition of climate deniers committed to fomenting climate change doubt within public debate. These deniers typically represent industry, fossil fuel, or free-market lobbies. This manufactured controversy exploits the media's tendency to frame the climate change issue using a point/counterpoint structure, thereby perpetuating uncertainty and lending climate deniers credibility (Antilla, 2010).

Within the United States, public awareness of global warming has grown significantly over the last decade. In a 2007 *New York Times* poll, 89% of respondents had heard or read the term global warming (Institute for European Environmental Policy & Natural Resources Defense Council, 2008). However, climate change awareness does not automatically equate with understanding of the phenomenon or concern about its significance, as evidenced by the growth of conservative anti-environmental movements. A 2008 survey by the Pew Research Center revealed that few Americans reported confidence that they fully understand the complexity of climate change, and the public remained uncertain about whether the majority of scientists agree on the issue (Kim, 2011). A 2007 *Washington Post* poll found that 56% of survey respondents believed scientists still disagree about whether or not global warming is actually happening (Institute for European Environmental Policy & Natural Resources Defense Council, 2008). In a 2007 *New York Times* poll, 51% of people surveyed felt they knew a 'moderate' amount about global

warming, while 37% admitted they knew little or nothing about it. The World Bank determined that in 2009, only 38% of Americans believed scientists agree that global warming is an urgent problem about which enough is known to take action (Brechin & Bhandari, 2011).

Recognition of global warming as a valid problem has waxed and waned as researchers measured American public opinion over the last 25 years. Polling efforts identified growing levels of recognition in the 2000s, followed by a sharp decline in 2009. For example, the Pew Research Center reported that in August 2006 and January 2007, 77% of Americans agreed that there is solid evidence of global warming. Agreement appeared to peak at those levels, and the percentage of Americans believing solid evidence supports rising global temperatures fell to 71% in April 2008 and dropped to only 57% in October 2009. Findings from the National Survey of American Public Opinion on Climate Change (NSAPOCC) reaffirm these data. The NSAPOCC asked nearly the same question as the Pew Center, charting a significant decline in American views on the existence of global warming from the fall of 2008 (72%) through the fall of 2010 (58%) (Lachapelle, Borick, & Rabe, 2012).

Recent data from the Six Americas of Climate Change study reveals that the American public's belief in the reality of global warming has recently increased. In January of 2010, only 57% of Americans stated a belief in global warming, a number which grew to 70% in September 2012. Similarly, the belief that global warming is not happening has

declined from 20% in January of 2010 to 12% in September 2012 (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2012).

However, accepting the reality of climate change does not necessarily elevate the issue to priority status. In 2009, according to the Pew Research Center's 2010 summary report, only 28% of Americans considered climate change a top priority, and only 35% identified climate change as a serious problem. Results of a 2009 Gallup poll indicate only 32% of Americans believe climate change will significantly affect their way of life, while two out of three Americans said climate change will not affect them in their lifetimes (Ratter, Philipp, & Storch, 2012). Research in the United States and other high-income countries illustrates that people frequently view climate change as a distant threat that falls behind more immediate concerns such as health, family, safety, personal comforts, and finances (Reynolds, Bostrom, Read, & Morgan, 2010).

Research Objectives and Chapter Guide

Chapter 2 (survey methodology) describes the survey instrument used in this study and the overall data analysis procedure. Chapters 3 and 4 (research objectives) address unique research questions related to foresters' attitudes toward climate change, where attitude is the degree of acceptance or doubt of the evidence for anthropogenic climate change. Chapter 3 examines which demographic characteristics are associated with Southeast foresters' climate change attitudes. Chapter 4 explores how climate change attitudes predict foresters' perceptions and adaptive management responses, and which factors may ultimately drive foresters' adaptation responses.

Chapter 5 (conclusions) summarizes the results of the previous chapters and concludes with implications for outreach. Ultimately, this research identifies variables linked to foresters' climate change attitudes and adaptive management responses, exploring the communication and education implications of those relationships. We propose outreach strategies to help achieve PINEMAP's resilience and sequestration goals, building on the more complete understanding of foresters' climate change perceptions provided by our 2013 Southeast Foresters Climate Change Survey.

CHAPTER 2: 2013 SOUTHEAST FORESTERS CLIMATE CHANGE SURVEY METHODOLOGY

Survey Design

We designed the 2013 Southeast Foresters Climate Change Survey to address the following research interests for PINEMAP and identify Extension audience needs for SREF: (a) the potential influence of demographic characteristics on Southeast foresters' climate change attitudes, and (b) the relationship between Southeast foresters' climate change attitudes, perceptions, and management responses.

Needs assessment is a critical step in the Cooperative Extension model, and the survey provided an important opportunity to explore the relationships between demographics, climate change attitudes and perceptions, and management actions. The survey included four sections focusing on: (a) attitudes and perceptions of climate change; (b) current knowledge of, and interest in learning more about, climate change science and management tools; (c) continuing education and communication preferences; and (d) demographic characteristics. The survey consisted of thirty-seven questions—three logistical questions about willingness to participate and the use of contact information, eight about climate change attitudes, eleven about familiarity with climate-related management tools, two about preferred communication strategies, and thirteen soliciting demographic information. Appendix A contains a copy of the final survey text.

We developed and administered the survey online using SurveyMonkey. The internet is approaching full coverage for surveys (Weijters, Schillewaert, & Geuens, 2008), and provides a time- and cost-efficient way to reach large numbers of people (Dillman,

2000). To minimize survey fatigue, we restricted the survey to a maximum length of fifteen minutes (Monroe & Adams, 2012). We distributed the survey to 7,500 forestry professionals, compiling contact information from publically available forestry organization membership lists in thirteen states (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, Texas, and Oklahoma). We intended this database to represent, as closely as possible, a census, rather than a random sample, of every forester with an email address working in the Southeast United States.

Eliminating duplicate entries, individuals with multiple distinct email addresses, individuals with invalid email addresses, and individuals who opted out of receiving survey-related emails reduced the total sample size to 6,607. The survey design and implementation process followed Dillman's *The Tailored Design Method* for online surveys, using personalized links, individually tailored emails, and a simple paper-like web interface (Dillman, 2009). We designed questions to maximize options for statistical analysis, ensure clarity and consistency, and provide sufficient scale resolution without overwhelming respondents with options (Weijters, Cabooter, & Schillewaert, 2010; Cox, 1980; Kieruj & Moors, 2010; Matell & Jacoby, 1971).

We used fully labeled five-point Likert scales and universally applied modifiers such as "somewhat", "slightly", and "very"; bi-polar scales included a neutral midpoint. The resulting scales approximate the behavior of interval data, supporting the use of linear models for data analysis (Weijters et al., 2010). All "yes or no" questions provided the

option for an undecided response. We worded questions to promote honesty by casting respondents' management in a flexible light. The survey also used less controversial terminology (such as "weather and climate variability") to avoid politically charged language like global warming and climate change.

The UGA Institutional Review Board approved the survey in December 2012. We administered a pilot survey to a random sample of 100 respondents immediately following survey approval. The full survey launched in February 2013. A pre-survey contact email in Constant Contact alerted recipients to the upcoming survey and explained its importance (Dillman, 2009). The message contained logos for SREF, PINEMAP, and recipients' forestry organizations to build legitimacy. A week later, respondents received their first survey link through SurveyMonkey. Partial and non-respondents received two reminder emails, also containing the survey link, one week apart on day seven and fourteen of the survey implementation schedule (Monroe & Adams, 2012).

Data Analysis

We cleaned, examined, and analyzed all data using the SAS Enterprise Guide 4.3 software program. We tested for non-response bias using the continuum of resistance model, which compares early and late respondents, using late respondents as proxies for non-respondents (Kypri, Stephenson, & Langley, 2004). We lacked data on the general target population of Southeast forestry professionals, which limited our analysis to methods that utilized only the survey respondents. We detected no non-response bias for any climate change attitude, perception, or management response variables. Comparing the

proportion of foresters from each state in the original database and the response population revealed that the respondent proportion differed from the database proportion by no more than 3.5% for each state, and fell within a 95% confidence interval for the majority of states. These findings suggest that non-respondents and respondents are similar, and no confounding unifying factor persuaded a subset of the recipients to refuse to submit the survey.

All data analysis in this study utilized linear models with expectations of normally and independently distributed residuals, NID~(0, σ^2e). We checked the model assumptions by examining the residuals and Q-Q plots, and detected no significant deviations. We pre-established statistical significance at $p<.05$ before beginning data analysis.

Survey Results

We received 1,782 useable responses out of 6,607 survey recipients, generating an overall response rate of 27%, close to the average expected for online surveys (Cook, Heath, & Thompson, 2000; Kaplowitz, Hadlock, & Levine, 2004). We excluded all respondents who did not self-identify as foresters using the second survey question ("How would you best describe yourself?" Check all that apply: forester, wildlife biologist, landowner, logger, industry professional, or other). Capturing only foresters reduced our useable sample to 1,329, but ensured our results portrayed only Southeast forestry professionals. This exceeded the 1,100 responses required to generate a 95% confidence interval with a +/- 2.5% margin of error on each estimate, well-representing the target population of

Southeast forestry professionals (Dillman, 2009). Appendix A summarizes the survey results for each question.

CHAPTER 3: INFLUENCE OF DEMOGRAPHIC VARIABLES ON SOUTHEAST FORESTERS' CLIMATE CHANGE ATTITUDES

Introduction and Literature Review

This chapter examines how different demographic variables may influence Southeast forestry professionals' attitudes toward climate change. Understanding which factors shape Southeast foresters' climate change attitudes will improve the effectiveness of communication about appropriate management responses. Research on the American public suggests that demographic variables are significantly associated with climate change attitudes. Previous studies have found variables such as faith/religion, political affiliation, value/belief system, and preexisting opinions on global warming associated with increased or decreased levels of understanding and concern about climate change (Reynolds et al., 2010). In general, liberal political values increase the probability of concern about climate change, while conservative values decrease the probability (Tjernström & Tietenberg, 2008). According to a 2008 Pew Research Center survey,

> Relatively few Republicans rate dealing with global warming as a top concern, and partisan disagreements over the importance of this issue have increased considerably. Democrats are currently about four times more likely than Republicans to rate global warming as a major priority. (Kim, 2011, p. 691).

Many studies have linked gender to climate change attitudes, with women displaying more concern about the impacts of climate change compared to men (Cobb & Carolan, 2011; Lachapelle et al., 2012; Safi et al., 2012; Semenza et al., 2008). A 2010 study

by McCright, which analyzed ten years of Gallup poll data, discovered that, while women tend to know more about climate change, they lack confidence in their understanding of the issue. Conversely, men typically know less than women do about climate change, but are more confident in their knowledge (Cobb & Carolan, 2011).

Wealth also relates to climate change perceptions, at the national and individual level. In a comparative study of forty-six countries, Sandvik found that a country's gross domestic product (GDP) negatively correlates with the proportion of its population that considers climate change a problem (Cobb & Carolan, 2011). Research indicates that lower-income Americans are more likely to be concerned about climate change (Cobb & Carolan, 2011; Semenza et al., 2008).

Finally, age and education also relate to climate change attitudes (Lachapelle et al., 2012). Tjernström and Tietenberg (2008) found that older people are less likely to be concerned about climate change, and a higher level of education is associated with a higher probability of concern about climate change.

These studies of the American public link demographic variables to climate change attitudes, but offer few insights into the forestry community. Foresters have unique skills and experiences, and may understand climate and other natural processes in distinct ways. Since foresters may not mirror the rest of the country, a survey of Southeastern foresters was critical for targeting outreach efforts and deploying effective management measures. In this study, we tested Southeast foresters' years of experience, education level, gender, political ideology, state of residence, and employer as predictors of climate change attitude.

These variables were important predictors in studies of similar natural resource communities (Labriole & Luzadis, 2011; Adams et al., 2011).

Specific to the forestry community, a survey of the New York Society of American Foresters (NYSAF) identified three key demographic predictors of climate change attitudes: age/experience, employer, and political ideology (Labriole & Luzadis, 2011). The Southeast's distinct political climate and distinct ecological characteristics suggest New York foresters' climate change perceptions may not be transferrable to this region.

The survey of the NYSAF found experience or age to significantly predict climate change attitude. Respondents with ten or fewer years of forestry experience had stronger feelings that climate change is occurring compared to respondents with eleven or more years of experience. Since less experienced foresters were significantly more likely to be younger, the researchers could not determine whether to attribute this trend to age or to experience. The second significant variable was employer. Academic foresters felt most strongly that climate change is occurring while industry foresters had the weakest feeling. The third significant variable was political ideology. Conservative respondents were more likely to feel climate change might not be occurring than liberal or moderate respondents (Labriole & Luzadis, 2011).

A PINEMAP-funded survey of Southeast Extension professionals' climate change perceptions, conducted by Adams, Monroe, and colleagues from the University of Florida, followed the Six Americas of Climate Change format. The Six Americas framework categorizes respondents into six categories ranging from alarmed, concerned, cautious,

disengaged, doubtful, and dismissive. The scale represents a continuum where "alarmed" corresponds to the greatest level of climate change acceptance and "dismissive" corresponds to the greatest degree of doubt. The Southeast Extension Six Americas study audience included Southeast Extension professionals across many disciplines (including family health, agriculture and livestock, and community development). Adams et al. confirmed that natural resource Extensionists matched the climate change attitudes of the American public (Adams et al., 2011), perhaps because universities rely on the similarity between Extension agents and their clients to effectively link academia with the public (Monroe et al., 2014).

The Southeast Extension Six Americas survey found six key predictors of climate change attitudes:

1. Political leaning (conservatives were more likely to be dismissive or doubtful and liberals were more likely to be alarmed or concerned)
2. Education level (those with a Master's degree or above were more likely to be concerned or alarmed and less likely to be disengaged)
3. Coastal influence (Extension agents that serve coastal communities were more likely to be concerned or alarmed)
4. State (respondents from Florida were more likely to be alarmed or concerned)
5. Age (respondents over sixty years old were more likely to be concerned or alarmed)
6. Gender (females were more likely to be concerned or alarmed)

(Adams et al., 2011).

The Southeast Extension Six Americas survey identified the possible influence of geographic location using county data, comparing Extension agents from coastal and inland counties. The 2013 Southeast Foresters Climate Change Survey effort lacks this degree of geographic resolution, restricting geographic distinctions to state-level analysis only. Table 1 summarizes the hypothesized relationships between demographic variables and climate change attitudes based on the research of Labriole and Luzadis (2011) and Adams et al. (2011).

Table 1

Hypothesized Significant Demographic Characteristics Influencing Southeast Foresters' Climate Change Attitudes

Variable	Hypotheses[a]	(Labriole & Luzadis, 2011)[a]	(Adams et al., 2011)[b]
Political ideology	Conservative – Liberal +	Conservative – Liberal +	Conservative – Liberal +
Education level	+	?	+
Years of experience[c]	~	–	+
State	~	?	Florida +
Gender	Male – Female +	?	Male – Female +
Employer	Academia + Industry –	Academia + Industry –	?

[a]Audience: Foresters
[b]Audience: Extension professionals
[c]Directly proportional to age
Note: (+) represents direct and (-) represents inverse association between tested demographic variables and climate change acceptance. (~) represents a statistically significant variable for which directionality is unknown.

Data Analysis

The first research objective addressed by the 2013 Southeast Foresters Climate Change Survey examined the effect of six different demographic variables on climate change attitude. For the demographic variables, the original database provided the state of each forester's residence. A frequency distribution of each state appears in Table 2, including the thirteen states targeted by the foresters database, as well as "other", which captures the few respondents from states outside the Southeast.

Table 2

Frequency Distribution of State of Residence, 2013 Southeast Foresters Climate Change Survey

State	N
AL	155
AR	83
FL	97
GA	148
KY	33
LA	105
MS	151
NC	188
OK	24
Oth.	12
SC	88
TN	63
TX	70
VA	108

We obtained political ideology, employer, education level, gender, and years of experience using survey questions. Table 3 displays the demographic variables and response frequency. The modes for each variable in Tables 2 and 3 provide a profile of the "typical" forester responding to our survey. The typical respondent is male, lives in NC, has between thirty and forty years of forestry experience, has obtained a Bachelor's degree, and identifies as politically conservative.

Table 3

Questions and Responses for Key Demographic Characteristics, 2013 Southeast Foresters Climate Change Survey

Variable	Question	Response Option	N
Highest level of education reached	What was the highest level of education you reached?	• Associate's or technical degree	33
		• Bachelor's degree	747
		• Master's degree	273
		• Doctorate or professional degree	94
		• Other (please specify)	3
Gender	What is your gender?	• Male	1062
		• Female	66
Years of forestry experience[a]	How many years have you worked in the forestry profession?	Open-ended: continuous numerical values	Total: 1091
		Decades of experience:	
		• <10 years	86
		• 10-20 years	224
		• 20-30 years	235
		• 30-40 years	387
		• 40-50 years	130
		• 50-60 years	28

Table 3 Continued

Variable	Question	Response Option	N
Employer	Which of the following best represents your current employer?	• State forestry agency	228
		• Cooperative Extension service	26
		• Private forestry consulting business	301
		• TIMO or REIT	70
		• Private forestry association or organization	23
		• Federal natural resource agency	88
		• Private research firm	7
		• Private forest industrial company	196
		• College, university or other academic institution	75
		• Other (please specify)	130
Political ideology	How do you identify yourself politically?	• Very liberal	11
		• Liberal	70
		• Moderate	277
		• Conservative	500
		• Very conservative	229
		• Other (please specify)	41

[a]Directly proportional to age

Table 4 displays the reported climate change attitude for the demographic analysis and the frequency distribution for each answer choice. The mode for climate change attitude shows that the typical survey respondent believes there is insufficient evidence to determine whether or not climate change is occurring. For statistical analysis, we distilled the original seven-point survey scale displayed in Table 4 into a five-point index for acceptance of anthropogenic climate change (abbreviated CCAI, for Climate Change Acceptance Index), found in Table 5. The CCAI excludes two answer choices from the original scale, which interfered with a linear progression from climate change doubt to

acceptance of anthropogenic climate change. We discarded answer choice three, "climate change is occurring, but we don't know its cause", and answer choice seven, "unsure". The CCAI is consistent with the climate change acceptance scale used in a comparable study of Iowa farmers' climate change attitudes (Arbuckle, Morton, & Hobbs, 2013).

Table 4

Climate Change Attitude, 2013 Southeast Foresters Climate Change Survey

Variable	Question	Response Option	N
Climate change attitude	Please select the statement that best reflects your perspective concerning climate change:	• 1 = Sufficient evidence shows climate change is not occurring	69
		• 2 = Insufficient evidence exists to determine whether or not climate change is occurring	340
		• 3 = Climate change is occurring, but we don't know its cause	173
		• 4 = Climate change is occurring and mostly caused by natural forces	153
		5 = Climate change is occurring and equally caused by human activity and natural forces	257
		• 6 = Climate change is occurring and mostly caused by human activity	172
		• 7 = Unsure	61

Table 5

Climate Change Acceptance Index, 2013 Southeast Foresters Climate Change Survey

Variable	Index
Climate Change Acceptance Index (CCAI)[a]	• 1 = Sufficient evidence shows climate change is not occurring • 2 = Insufficient evidence exists to determine whether or not climate change is occurring • 3 = Climate change is occurring and mostly caused by natural forces • 4 = Climate change is occurring and equally caused by human activity and natural forces • 5 = Climate change is occurring and mostly caused by human activity

[a]Acceptance of anthropogenic climate change

In summary, about 60% of Southeast professional foresters accept climate change, though they attribute it to different causes, while about 40% remain uncertain or doubtful of the evidence for climate change.

Single-variable analysis.

We performed five one-way ANOVAs to determine the potential contribution of each categorical demographic variable (Tables 2 and 3) to climate change acceptance (Table 5). We treated each demographic predictor independently without accounting for the other variables to achieve consistency with the methods used by Labriole and Luzadis (2011) and Adams et al. (2011). The following model tested the effect of political ideology on climate change acceptance:

$$y_{ij} = \mu + A_i + \varepsilon_{ij}$$

Where y_{ij} is climate change acceptance,

μ is the overall mean, or base climate change acceptance,

A_i is the effect of political ideology, and

ε_{ij} is the error term.

We fit the same model to determine the possible influence of the other demographic characteristics on climate change acceptance, changing the predictor variable for education level, gender, employer, and state. After we identified the statistically significant demographic variables, pairwise comparisons determined significant differences between each pair of variable categories (such as liberal and conservative political ideologies), using the Tukey adjustment to correct for the experiment-wise error rate (α=.05).

Since years of forestry experience is continuous, we tested for its correlation with climate change acceptance using simple linear regression according to the following model:

$y_{ij} = \beta_o + \beta_1 A_i + \varepsilon_{ij}$

Where y_{ij} is climate change acceptance,

β_o is the intercept,

β_1 is the slope coefficient for years of forestry experience,

A_i is years of forestry experience, and

ε_{ij} is the error term.

Multiple-variable analysis.

To adjust for potential collinearity among demographic predictor variables, we examined the effect of all demographic variables (political ideology, gender, education level, years of experience, state, and employer) on climate change acceptance. Often,

demographic variables are auto-correlated, repeatedly capturing the effect of one underlying factor (e.g., wealth or political ideology) across multiple measurements. Adjusting for the effect of all demographic variables on climate change acceptance enabled us to identify the most prominent predictors driving the association between the independent and dependent variables, thereby uncovering the dominant relationship obscured by singular analysis. We used a general linear model selection procedure in SAS (GLMSELECT) to identify the best general linear model for predicting climate change acceptance, using any subset of the demographic parameters. The model produced by GLMSELECT can be tested using the appropriate technique from the general linear model family: ANOVA, if all independent variables are categorical; Analysis of Covariance (ANCOVA) if the independent variables consist of mixed categorical and continuous factors; or linear regression, if all independent variables are continuous.

General linear models accommodate continuous as well as categorical variables and therefore permitted the inclusion years of experience as a covariate alongside the categorical political ideology, employer, state, education, and gender variables. Model selection eliminated those variables that were no longer significant after adjusting for the other demographic factors. Stepwise, forward, and backward model selection converged on the same reduced model with the lowest Schwarz Bayesian Criterion (SBC), also called the Bayesian Information Criterion, score. The reduced model included only one variable—political ideology—significantly associated with climate change acceptance after adjusting for state, gender, education level, years of experience, and employer. After determining

political ideology was the most important demographic predictor variable, we also included as potential parameters all interaction terms between political ideology and other demographic factors. However, political ideology alone remained in the best model. The final model was identical to the identical to the one-way ANOVA model presented in the single-variable analysis section, testing the relationship between political ideology and climate change acceptance:

$y_{ijk} = \mu + A_i + \varepsilon_{ij}$

Where y_{ijk} is climate change acceptance,

μ is the overall mean, or base climate change acceptance, and

A_i is the effect of political ideology, and

ε_{ijk} is the error term.

Results

Single-variable analysis.

The five one-way ANOVAs and simple linear regression described earlier analyzed the independent association between various demographic characteristics and foresters' climate change acceptance. Consistent with our hypothesis, we found that all six demographic characteristics were significantly related to climate change acceptance:

1. Political ideology (liberals and moderates were more accepting than conservatives)
2. Highest education level (PhD foresters were more accepting than those with a Master's degree or below)

3. Employer (academics were more accepting than employees of private industry, consulting companies, and TIMOs and REITs)
4. State (Oklahoma and Kentucky foresters were most accepting while Mississippi foresters were least accepting)
5. Gender (women were more accepting than men)
6. Years of forestry experience (acceptance was inversely related to experience, with less experienced, younger foresters more likely to accept climate change compared to more experienced, older foresters)

Table 6 summarizes the results of the one-way ANOVAs and Table 7 summarizes the results of the simple linear regression.

Table 6

Analyses of Variance for Influence of Demographic Characteristics on Southeast Foresters' Climate Change Acceptance

Variable	DF	Mean Square	F Value	Pr > F
Political ideology	5	66.51	56.14	<.0001
Education level	4	10.71	7.09	<.0001
Employer	9	16.30	6.84	<.0001
State	13	7.50	5.08	<.0001
Gender	1	7.20	4.64	.032

Table 7

Simple Linear Regression for Influence of Years of Forestry Experience on Southeast Foresters' Climate Change Acceptance

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Years of forestry experience	-.008	.004	-2.31	.021

Note: R^2 = .006, Pr > F = .021

Table 8 shows how the significant demographic variable findings correspond with the original hypotheses and results of other research.

Table 8

Significant Demographic Characteristics Influencing Southeast Foresters' Climate Change Attitudes

Variable	Study Findings[a]	Hypotheses[a]	(Labriole & Luzadis, 2011)[a]	(Adams et al., 2011)[b]
Political ideology	Conservative – Liberal +	Conservative – Liberal +	Conservative – Liberal +	Conservative – Liberal +
Education level	+	+	?	+
Years of experience[c]	–	~	–	+
State	OK, KY + MS –	~	?	Florida +
Gender	Male – Female +	Male – Female +	?	Male – Female +
Employer	Academia + TIMO/REIT, private consulting or industry –	Academia + Industry –	Academia + Industry -	?

[a]Audience: Foresters
[b]Audience: Extension professionals
[c]Directly proportional to age
Note: (+) represents direct and (-) represents inverse association between tested demographic variables and climate change acceptance. (~) represents a statistically significant variable for which directionality is unknown.

Figures 1-6 capture the relationships between each demographic variable and climate change acceptance.

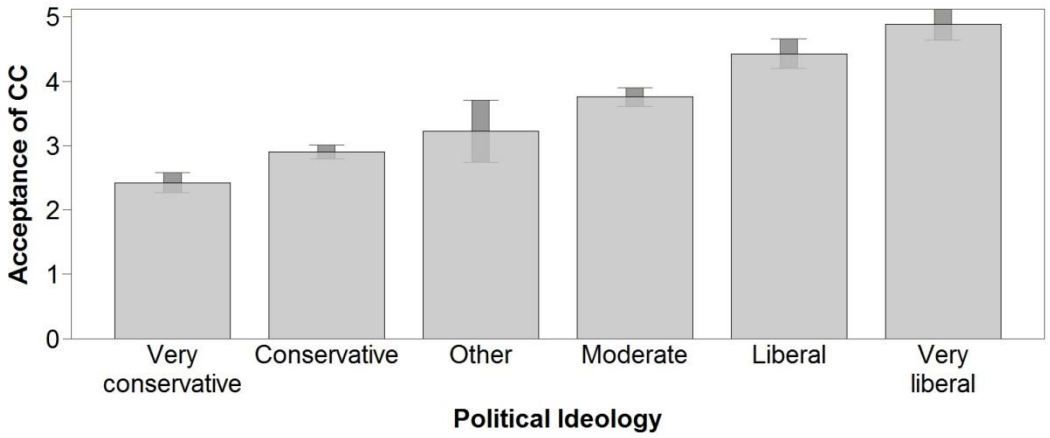

Figure 1. Southeast foresters' climate change acceptance by political ideology, showing a 95% confidence interval surrounding the mean.

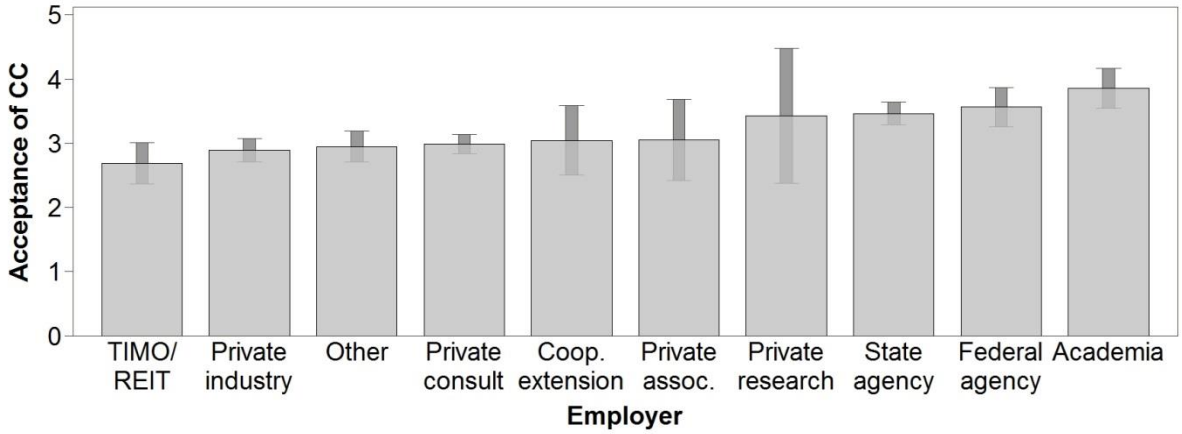

Figure 2. Southeast foresters' climate change acceptance by employer, showing a 95% confidence interval surrounding the mean.

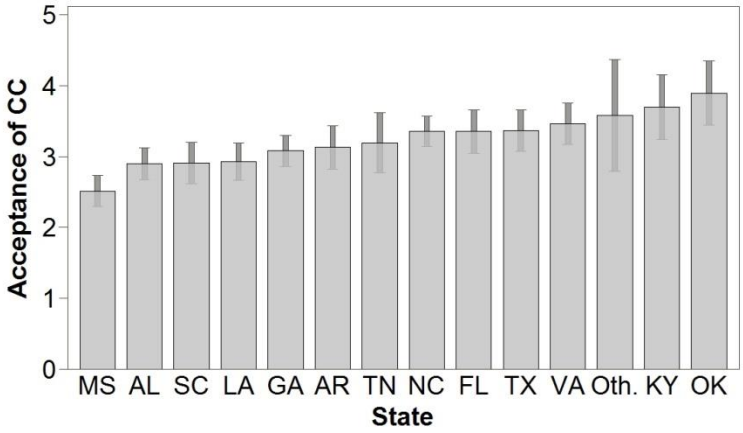

Figure 3. Southeast foresters' climate change acceptance by state, showing a 95% confidence interval surrounding the mean.

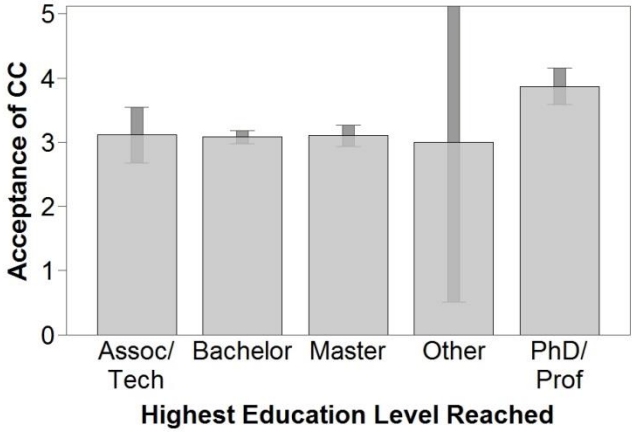

Figure 4. Southeast foresters' climate change acceptance by highest education level, showing a 95% confidence interval surrounding the mean.

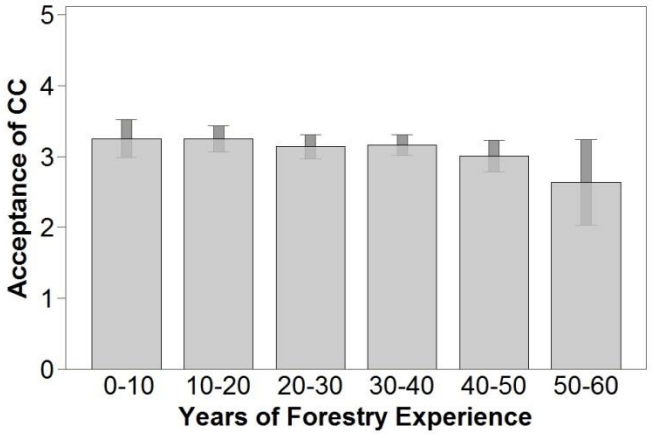

Figure 5. Southeast foresters' climate change acceptance by years of forestry experience, showing a 95% confidence interval surrounding the mean.

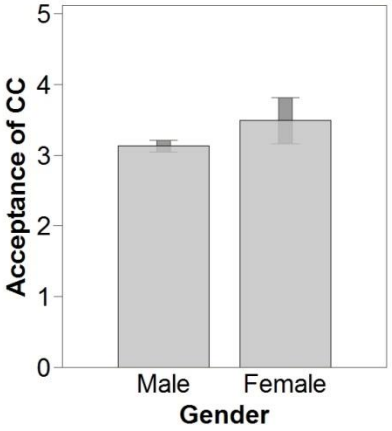

Figure 6. Southeast foresters' climate change acceptance by gender, showing a 95% confidence interval surrounding the mean.

Multiple-variable analysis.

The general linear model selection procedure, SAS GLMSELECT, demonstrated that only political ideology significantly predicted climate change acceptance after adjusting for

the effect of years of experience, state, employer, gender, and education level, and the effect of all possible interaction terms between political ideology and other demographic factors.

Table 9 summarizes the results of the final one-way ANOVA (identical to the political ideology row of Table 6).

Table 9

Analysis of Variance for Influence of Political Ideology on Southeast Foresters' Climate Change Acceptance

Variable	DF	Mean Square	F Value	Pr > F
Political ideology	5	66.51	56.14	<.0001

Discussion

These findings—that political ideology, education level, employer, state, years of forestry experience, and gender are significantly associated with climate change acceptance—suggest that the demographic relationships found in the general public and similar natural resource communities hold true for Southeast foresters. The connections identified between demographic characteristics and climate change attitudes are consistent with our hypotheses and existing data. Despite foresters' unique relationships with the natural world, their opinions appear to be similarly influenced by their demographic

characteristics. As a result, foresters are likely to present the same challenges for climate change outreach as members of the general public.

Of the demographic variables collected in the 2013 Southeast Foresters Climate Change Survey, political ideology is the most influential demographic characteristic on climate change acceptance. The association with other demographic factors identified in the single-variable analysis resulted from collinearity with either political ideology or other unmeasured variables. Other research has shown that variables not included in this study, such as religious beliefs (Reynolds et al., 2010), income (Cobb & Carolan, 2011; Semenza et al., 2008), and recent weather conditions (Donner & McDaniels, 2013; Hamilton & Stampone, 2013), all influence climate change attitudes. As an example of collinearity, rather than education level uniquely and independently contributing to climate change acceptance, perhaps PhD foresters are more likely to be liberal. Rather than state directly affecting climate change acceptance, perhaps foresters who work in Mississippi are more likely to be conservative. These hypothetical auto-correlations may generate the apparent relationships in the one-way ANOVAs between other demographic variables and climate change acceptance, although political ideology (or another untested variable) is actually responsible for the trend.

CHAPTER 4: RELATIONSHIPS BETWEEN SOUTHEAST FORESTERS' CLIMATE CHANGE ATTITUDES, PERCEPTIONS, AND MANAGEMENT RESPONSES

Introduction and Literature Review

This chapter examines the relationships between Southeast foresters' climate change attitudes, perceptions of climate change impacts, and adaptive management actions. In a 2010 environmental law article on climate change adaptation, Craig argued that climate change should be treated as a long-term natural disaster, rather than a human-caused phenomenon, to redirect focus from mitigation to adaptation. The author asserted that, since some impacts from climate change are now unavoidable, society should move past debating the cause of climate change and commit to adapting to the inevitable changes (Craig, 2010). This article prompted reflection on the wisdom of expecting people to abandon the politically charged debate surrounding anthropogenic climate change and adopt substantive adaptation measures (regardless of their attitudes).

Social psychology literature supports that "people hold onto their beliefs strongly. Changing beliefs take time and effort, and it is often easier to disregard alternative perspectives than to adapt existing beliefs" (Hernandez & Preston, 2013, p.178). Confirmation bias, the inclination to seek out information consistent with preexisting beliefs, is one example of this tendency (Hernandez & Preston, 2013). Given the human predisposition to hold on to existing beliefs, do climate change doubters observe climate change impacts, ignore them, or attribute them to another cause? Do they consider climate change relevant to their lives and therefore worthy of adaptive lifestyle changes? Do they

consider adaptation necessary, or discount that possibility entirely because their worldview excludes climate change from consideration?

These questions especially apply to natural resource professionals, since current and future climate change threats will require managers to undertake adaptive management to ensure the viability of forests, farms, and ecologically important conservation lands. Like Craig (2010) suggests, should Extension agents expect foresters across the climate change attitude spectrum to accept the necessary management adjustments? Or, do preconceived attitudes toward climate change strongly influence how managers perceive climate impacts and receive adaptive management guidance?

More specifically, this research examined how climate change acceptance may affect forestry professionals' willingness or ability to:

1. Observe weather or climate changes in the environment
2. Feel concerned about the forestry impacts of climate change
3. Believe climate change will require different forest management strategies.

To simplify, we abbreviated those concepts as see (evidence for climate change), connect (climate change to forestry), and adapt (management to new realities). In summary, this research question asks: does climate change acceptance influence foresters' ability to see, connect, and adapt? Phrased another way, are foresters who accept climate change more likely to make those conceptual leaps and recognize the need to actively prescribe adaptive management?

There was little data available to describe the relationship between accepting and seeing, and between accepting and connecting. However, data supports the hypothesis that climate change accepters would be more likely than doubters to adapt to climate change (Blennow, Persson, Tomé, & Hanewinkel, 2012; Lenart & Jones, 2013). Figure 7 graphically represents these hypotheses.

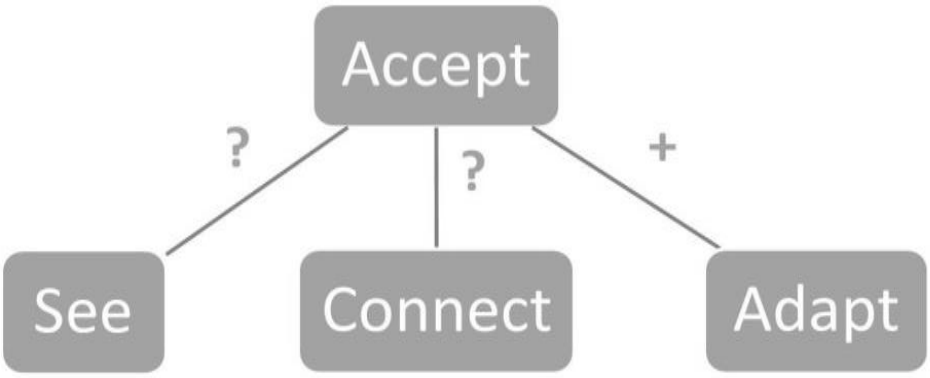

Figure 7. Hypotheses for influence of Southeast foresters' climate change acceptance on willingness to see, connect, and adapt to climate change.

We also examined which characteristics correlate most closely with climate change adaptation, since management responses represent the behavioral change Extension seeks to motivate in its clients. PINEMAP cannot accomplish its mitigation and resilience goals without successful outreach and education to prompt foresters to adopt adaptive management measures. We rearranged our attitudes, perceptions, and management

variables to explore which factors shape foresters' willingness to implement adaptation actions.

Figure 8 graphically represents our hypotheses for our secondary question—how do climate change attitudes and perceptions predict Southeast foresters' willingness to undertake adaptive management? No data was available to suggest a relationship between connecting and adapting. However, literature supports the hypothesis that foresters who accept climate change and see climate change would be more likely to adapt to climate change (Blennow et al., 2012; Lenart & Jones, 2013). Are foresters who accept, see, and connect to climate change more likely to undertake adaptive management measures?

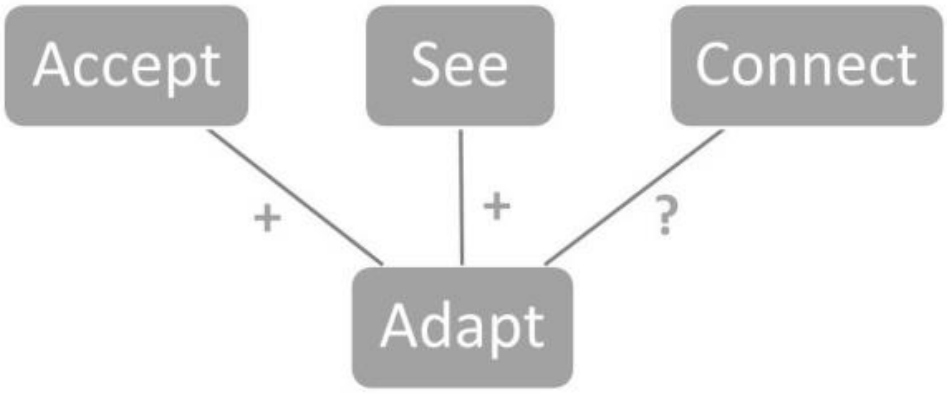

Figure 8. Hypotheses for influence of Southeast foresters' willingness to accept, see, and connect to climate change on adaptive management response.

Finally, we incorporated the demographic factors as potential predictors of adaptation. We analyzed the demographic, perception, and attitude variables to ascertain

which factors directly influence foresters' willingness to implement adaptive management strategies, and which have only indirect effects. This analysis was purely exploratory, conducted outside the context of previous research.

Two studies, one involving foresters and one involving landowners, support a link between accepting and adapting. Lenart and Jones from the University of Arizona surveyed foresters to determine their willingness to adopt management actions based on their perceptions of climate change (Lenart & Jones, 2013). Their research (still under review) shows that climate change perceptions are significantly associated with foresters' willingness to undertake certain management actions. While willingness to utilize thinning and prescribed burning remained relatively consistent across climate change doubters and accepters, willingness to foster connected landscapes, minimize habitat fragmentation, and adopt species adaptation measures closely correlated with degree of climate change acceptance. The divide between climate accepters and climate doubters apparently widens as foresters are asked to adopt management measures that diverge from traditional management practices linked to forest productivity and economic benefits (Lenart & Jones, 2013).

A study of private forest landowners in Sweden, Germany, and Portugal tested "the hypothesis that the variables personal strength of belief and perception of local effects of climate change, explain human responses to climate change" (Blennow et al., 2012, p. 1). The authors concluded that strength of belief in the local impacts of climate change and

reported personal experience with climate change both predict and explain adaptation actions—a link between accepting and adapting, as well as seeing and adapting.

Data Analysis

This research objective examined the relationship between climate change attitudes, perceptions, and management responses. Using survey questions, we measured agreement with observed climate change, frequency of observed climate change, concern about the forestry impacts of climate change, and belief climate change would require different management strategies.

Table 10 displays Southeast foresters' reported climate change attitudes and the frequency distribution for each answer choice. The mode for climate change attitude shows that the typical survey respondent believes there is insufficient evidence to determine whether or not climate change is occurring. As explained in Chapter 3, for statistical analysis, we distilled the original seven-point survey scale displayed in Table 10 into a five-point index for acceptance of anthropogenic climate change (abbreviated CCAI, for Climate Change Acceptance Index), found in Table 11. The CCAI excludes two answer choices from the original scale, which interfered with a linear progression from climate change doubt to acceptance of anthropogenic climate change. We discarded answer choice three, "climate change is occurring, but we don't know its cause", and answer choice seven, "unsure". The CCAI is consistent with the climate change attitude scale used by Arbuckle et al. in a 2013 study.

Table 10

Climate Change Attitude, 2013 Southeast Foresters Climate Change Survey

Variable	Question	Response Option	N
Climate change attitude	Please select the statement that best reflects your perspective concerning climate change:	• 1 = Sufficient evidence shows climate change is not occurring	69
		• 2 = Insufficient evidence exists to determine whether or not climate change is occurring	340
		• 3 = Climate change is occurring, but we don't know its cause	173
		• 4 = Climate change is occurring and mostly caused by natural forces	153
		• 5 = Climate change is occurring and equally caused by human activity and natural forces	257
		• 6 = Climate change is occurring and mostly caused by human activity	172
		• 7 = Unsure	61

Table 11

Climate Change Acceptance Index, 2013 Southeast Foresters Climate Change Survey

Variable	Index
Climate Change Acceptance Index (CCAI)[a]	• 1 = Sufficient evidence shows climate change is not occurring • 2 = Insufficient evidence exists to determine whether or not climate change is occurring • 3 = Climate change is occurring and mostly caused by natural forces • 4 = Climate change is occurring and equally caused by human activity and natural forces • 5 = Climate change is occurring and mostly caused by human activity

[a]Acceptance of anthropogenic climate change

In summary, about 60% of Southeast professional foresters accept climate change, though they attribute it to different causes, while about 40% remain uncertain or doubtful of the evidence for climate change.

For the dependent variables, questions targeting frequency of observed climate change and concern about the forestry impacts of climate change asked each respondent to score how frequently he/she had observed, or how concerned he/she felt, about sixteen different climate change phenomena, on a scale from one to five. These phenomena included:

1. Greater frequency and/or severity of flooding
2. Longer dry periods and/or drought conditions
3. Greater frequency of, or more severe occurrences of, insect damage
4. Greater frequency of, or more severe occurrences of, disease damage
5. Greater frequency of, or more severe occurrences of, invasive plant infestations
6. More frequent and/or extreme rainfall events
7. Increased soil erosion
8. Increased frequency of, or more severe, fire events
9. Warmer winters
10. Cooler winters
11. Hotter summers
12. Cooler summers
13. Drier planting seasons

14. Wetter planting seasons
15. Change in length of growing season
16. Increase in frequency of extreme weather events (tornadoes, hurricanes, ice storms, etc.).

Calculating the respondent's mean score for each phenomenon generated an average frequency of observed climate change and average concern about forestry impacts from climate change, ranging from one to five. Table 12 displays the dependent variables for the perceptions and management analysis and the frequency distribution for each answer choice. The modes for each question in Table 12 provide a profile of the "typical" forester responding to our survey. The typical respondent agrees that he has noticed a change in the climate in his lifetime, has rarely to occasionally witnessed specific climate change phenomena, feels unconcerned to slightly concerned about the impacts of climate change on forestry, and believes climate change will require some change to forest management strategies.

Table 12

Questions and Responses for Willingness to See, Connect, and Adapt to Climate Change, 2013 Southeast Foresters Climate Change Survey

Variable	Question	Response Option	N
Agreement with observed climate change	Please indicate your level of agreement with the following statement: "In my lifetime, I have noticed a change in the climate (longer, hotter summers; warmer, drier winters; cooler, moister summers; earlier, drier springs, etc.)."	• 1 = Strongly disagree • 2 = Disagree • 3 = Neither agree or disagree • 4 = Agree • 5 = Strongly agree	96 255 387 541 116
Frequency of observed climate change[a]	The following are some conditions that U.S. farmers and forest owners/managers have experienced over the past few years. To what extent have you or your clients witnessed any of these in the past several years?	• 1 = Never • 2 = Rarely • 3 = Occasionally • 4 = Frequently • 5 = Very frequently Average frequency: 1-2 2-3 3-4 4-5	Total: 1412 143 692 373 16
Concern about forestry impacts of climate change[a]	To what extent do you feel concerned about the long term impacts on our forests from the following weather and climate related factors?	• 1 = Not concerned • 2 = Slightly concerned • 3 = Somewhat concerned • 4 = Moderately concerned • 5 = Very concerned Average concern: 1-2 2-3 3-4 4-5	Total: 1222 462 418 287 55

Table 12 Continued

Variable	Question	Response Option	N
Belief that climate change will require different management strategies	To what extent do you think that forest management strategies will need to change to better respond to future weather and climate uncertainties?	• 1 = No change needed • 2 = Slight change needed • 3 = Some change needed • 4 = Moderate change needed • 5 = Significant change needed	302 333 338 231 90

[a]Average concern and average frequency across all sixteen phenomena

Single-variable analysis.

We tested the possible contribution of climate change acceptance (Table 11) to seeing, connecting, and adapting (Table 12) using simple linear regression. To examine the relationship between climate change acceptance and agreement with observed change, we fit the following model:

$y_{ij} = \beta_o + \beta_1 A_i + \varepsilon_{ij}$

Where y_{ij} is agreement with observed climate change,

β_o is the intercept,

β_1 is the slope coefficient for climate change acceptance,

A_i is climate change acceptance, and

ε_{ij} is the error term.

We fit the same model to determine the possible influence of climate change acceptance on average frequency of observed climate change, average concern about forestry impacts of climate change, and belief that climate change will require different

management strategies, changing the dependent variables to reflect seeing, connecting, and adapting.

Multiple-variable analysis.

Influence of attitudes and perceptions on adaptation.

We examined this question by identifying the best multiple linear regression model, using any subset of the attitude and perception variables. Model selection with the SAS GLMSELECT procedure eliminated those independent variables that were no longer significant after adjusting for other factors. Stepwise, forward, and backward model selection converged on the same reduced model with the lowest SBC score. The best model included three predictors (or four parameters, including the intercept). The following reduced multiple linear regression model tested the possible influence of accepting, seeing, and connecting on adapting to climate change:

$y_{ijkl} = \beta_o + \beta_1 A_i + \beta_2 B_j + \beta_3 C_k + \varepsilon_{ijkl}$

Where y_{ijkl} is belief climate change will require different management strategies,

β_o is the intercept,

β_1 is the slope coefficient for climate change acceptance,

A_i is acceptance of climate change,

β_2 is the slope coefficient for average frequency of observed climate change,

B_j is average frequency of observed climate change,

β_3 is the slope coefficient for average concern about forestry impacts of climate change,

C_k is concern about forestry impacts of climate change, and

ε_{ijkl} is the error term.

Influence of attitudes, perceptions, and demographic variables on adaptation.

Building on the previous exploration of the effect of attitudes and perceptions on climate change adaptation response, this step adds demographic characteristics to the analysis—how do the combination of demographic characteristics, accepting, seeing, and connecting correlate with adapting? We wanted to determine which variables may ultimately drive foresters' management actions. Do demographic characteristics directly influence adaptation response, or only indirectly contribute by affecting climate change attitudes and perceptions? For example, are liberals more likely than conservatives to adapt their management strategies (a direct relationship between political ideology and adaptation)? Or, are liberals more likely to accept the evidence for climate change, and foresters who accept the evidence for climate change are more likely to adapt their management strategies (an indirect relationship)?

We addressed this question by identifying the best general linear model for predicting foresters' belief climate change would require different management strategies, using any subset of the independent variable parameters. The initial set of independent variables included all demographic variables from Chapter 3, the "see" and "connect" variables from Chapter 4, and climate change acceptance. We performed the SAS GLMSELECT procedure because general linear models accommodate continuous as well as categorical variables, and the independent variables included a mix of categorical and

continuous data. The model of best fit produced by GLMSELECT can be tested using the appropriate technique from the general linear model family: ANOVA, if all independent variables are categorical; ANCOVA if the independent variables consist of mixed categorical and continuous factors; or linear regression, if all independent variables are continuous. Model selection eliminated those independent variables that were no longer significant after adjusting for other factors. Stepwise, forward, and backward model selection converged on the same reduced model with the lowest SBC score. Since the included independent variables were all continuous, the following reduced multiple linear regression model tested the possible influence of accepting and connecting on adapting:

$y_{ijk} = \beta_o + \beta_1 A_i + \beta_2 B_j + \varepsilon_{ijk}$

Where y_{ijk} is the adaptation response to climate change,

β_o is the intercept,

β_1 is the slope coefficient for acceptance of climate change,

A_i is acceptance of climate change,

β_2 is the slope coefficient for concern about forestry impacts of climate change,

B_j is concern about forestry impacts of climate change, and

ε_{ijk} is the error term.

Results

Single-variable analysis.

The simple linear regression described earlier analyzed the association between climate change acceptance and seeing, connecting, and adapting. Climate change

acceptance significantly predicted personal climate change observations (seeing), concern about forestry impacts from climate change (connecting), and belief climate change will require different management strategies (adapting). Reported levels of seeing, connecting, and adapting increased directly with climate change acceptance. Tables 13-16 summarize the results of each regression.

Table 13

Simple Linear Regression for Influence of Southeast Foresters' Climate Change Acceptance on Agreement with Observed Climate Change (Seeing)

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Acceptance of climate change	.40	.02	16.02	<.0001

Note: R^2 = .21, Pr > F = <.0001

Table 14

Simple Linear Regression for Influence of Southeast Foresters' Climate Change Acceptance on Average Frequency of Observed Climate Change (Seeing)

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Acceptance of climate change	.21	.01	14.90	<.0001

Note: R^2 = .18, Pr > F = <.0001

Table 15

Simple Linear Regression for Influence of Southeast Foresters' Climate Change Acceptance on Average Concern about Forestry Impacts of Climate Change (Connecting)

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Acceptance of climate change	.39	.02	19.29	<.0001

Note: R^2 = .27, Pr > F = <.0001

Table 16

Simple Linear Regression for Influence of Southeast Foresters' Climate Change Acceptance on Belief that Climate Change Will Require Different Management Strategies (Adapting)

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Acceptance of climate change	.54	.03	16.26	<.0001

Note: R^2 = .21, Pr > F = <.0001

Figures 9-12 display the relationship between accepting and seeing, connecting, and adapting in graph form.

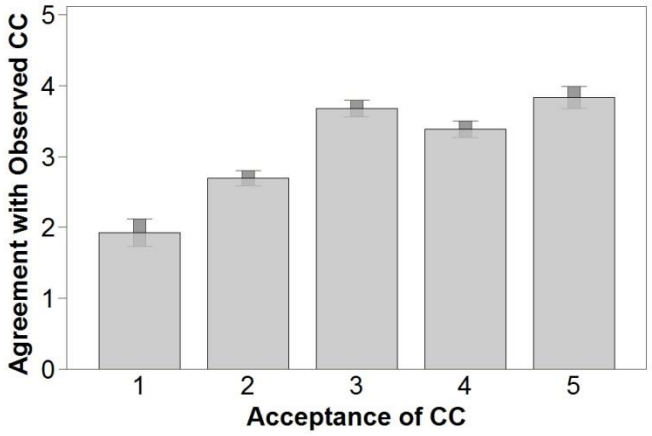

Figure 9. Agreement with observed climate change (seeing) by Southeast foresters' climate change acceptance, showing a 95% confidence interval surrounding the mean.

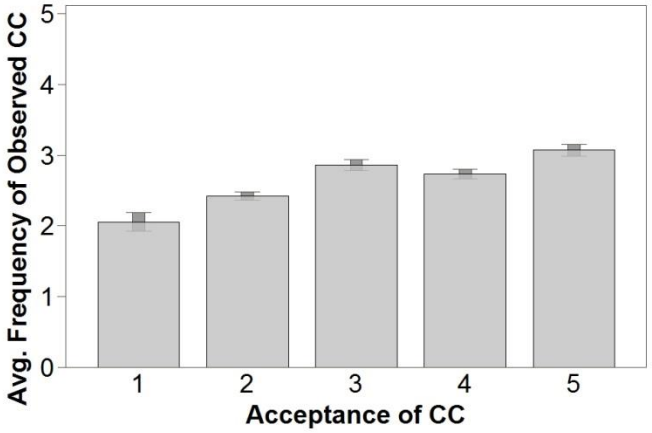

Figure 10. Average frequency of observed climate change (seeing) by Southeast foresters' climate change acceptance, showing a 95% confidence interval surrounding the mean.

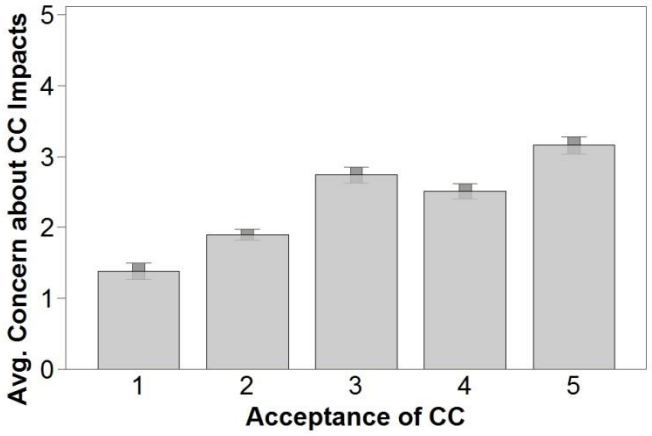

Figure 11. Average concern about the forestry impacts of climate change (connecting) by Southeast foresters' climate change acceptance, showing a 95% confidence interval surrounding the mean.

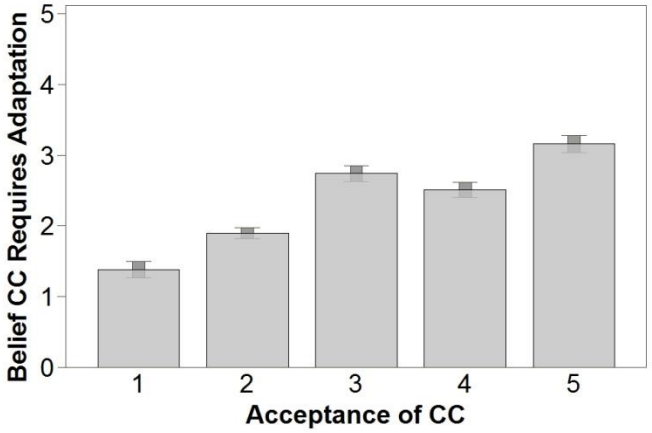

Figure 12. Belief that climate change will require different management techniques (adapting) by Southeast foresters' climate change acceptance, showing a 95% confidence interval surrounding the mean.

Figure 13 shows how the study findings relate to the original hypotheses.

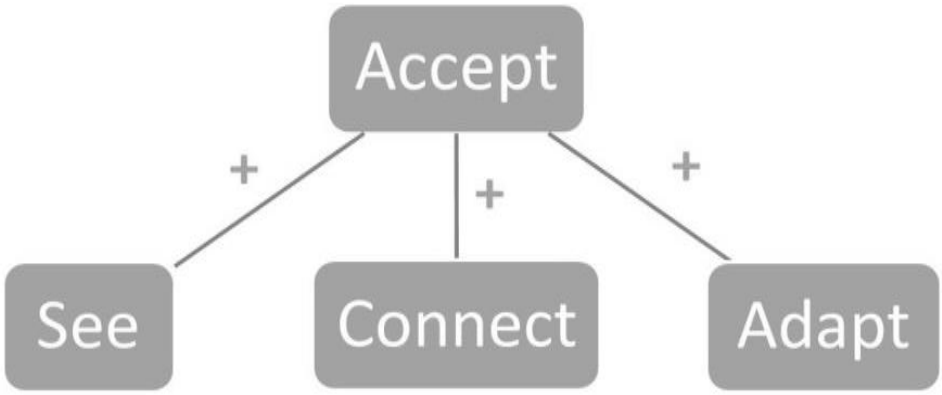

Figure 13. Influence of Southeast foresters' climate change acceptance on willingness to see, connect, and adapt to climate change.

Multiple-variable analysis.

Influence of attitudes and perceptions on adaptation.

The multiple linear regression analyzed the potential combined influence of accepting, seeing, and connecting on foresters' climate change adaptation responses (controlling for collinearity among variables). This analysis revealed that climate change acceptance, average frequency of observed climate change (seeing), and average concern about forestry impacts (connecting) all uniquely and independently associate with belief climate change will require different management strategies (adapting). Since agreement with observed climate change and average frequency of observed climate change both measure the "see" construct, we were unsurprised to find that they were collinear with one another, and that model selection found only one of the two variables significant. Table 17 summarizes the results of the multiple linear regression.

Table 17

Multiple Linear Regression for Influence of Southeast Foresters' Willingness to Accept, See, and Connect to Climate Change on Adaptive Management Responses

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Average frequency of observed change	.27	.09	3.03	.0025
Average concern about forestry impacts	.61	.06	9.90	<.0001
Acceptance of climate change	.24	.03	7.00	<.0001

Note: R^2 = .38, Pr > F = <.0001

Figure 14 shows how the study findings relate to the original hypotheses.

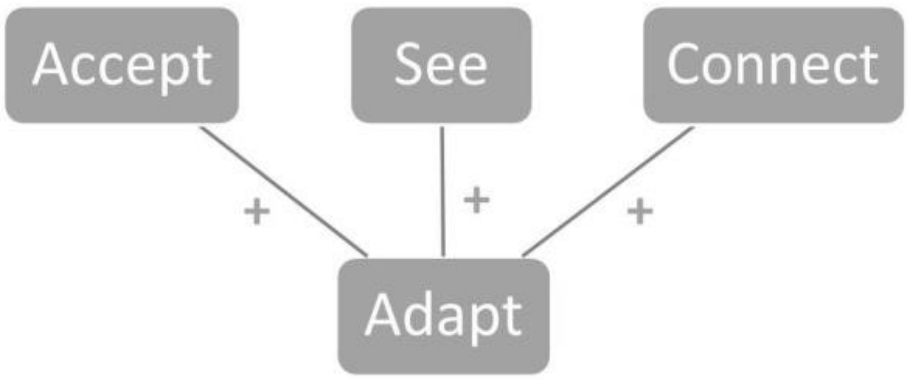

Figure 14. Influence of Southeast foresters' willingness to accept, see, and connect to climate change on adaptive management responses.

This multivariate analysis confirms that accepting, seeing, and adapting are closely linked to foresters' adaptive management responses to climate change. Accepting, seeing, and connecting each independently affect adaptation.

Influence of attitudes, perceptions, and demographic variables on adaptation.

The general linear model selection process analyzed the possible influence of climate change acceptance, demographic characteristics, and climate change perceptions on belief that climate change will require different management responses to determine which factors primarily drive Southeast foresters' adaptive management actions. The best model included only accepting and connecting as predictors of adapting. No demographic characteristics appeared in the final model, signifying that those variables were collinear with accepting and connecting, or with another untested variable.

Notably, when demographic factors were included as potential model parameters to predict climate change adaptation response, the GLMSELECT procedure determined the two "see" variables were not significant. Since the multiple linear regression analyzing the possible influence of accepting, seeing, and connecting and adapting found all three to be significant predictors of adaptive management, this marks the difference between the two multiple-variable analyses for Chapter 4. Table 18 summarizes the multiple linear regression results.

Table 18

Multiple Linear Regression for Influence of Southeast Foresters' Willingness to Accept and Connect to Climate Change on Adaptive Management Responses

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Acceptance of climate change	.25	.03	7.28	<.0001
Concern about forestry impacts	.73	.05	15.71	<.0001

Note: R^2 = .37, Pr > F = <.0001

Discussion

The first findings of this chapter—that climate change acceptance predicts seeing, connecting, and adapting to climate change—demonstrate the potential effect of climate change attitude on personal perceptions and management responses. Foresters who do not accept climate change are less likely to see, connect, and adapt. The link identified between accepting and adapting is consistent with our hypothesis and existing data in the forestry field. The connections between accepting and seeing, and accepting and connecting, provide new insights into how foresters' attitudes toward climate change may influence their perceptions of change in the natural world.

These relationships mirror those found in studies of Midwest farmers by Arbuckle et al. The authors reported that "farmers who believed that climate change is occurring and attributable to human activity were significantly more likely to express concern about impacts and support adaptive and mitigative action" (Arbuckle et al., 2013, p. 943) and that "farmers who were concerned about the impacts of climate change on agriculture and

attributed it to human activities had more positive attitudes toward both adaptive and mitigative management strategies" (Arbuckle, Morton, & Hobbs, 2013, p. 551). This suggests that the connections between attitudes, perceptions, and management responses may transcend regional and disciplinary differences.

In response to the original inspiration for this research question, Craig's 2010 call for climate change adaptation law, we conclude that it is not realistic to expect Southeast forestry professionals to universally see, connect, and adapt to the reality of climate change. Rather, Southeast foresters across the climate change attitude spectrum perceive climate change impacts and appropriate management responses very differently. This finding is not necessarily fatalistic, implying that climate change doubters will never be willing to adapt; rather, our data allude to the importance of considering clients' attitudes when designing a climate change adaptation outreach strategy.

What causes these relationships? One possibility is confirmation bias, the tendency to seek out information or interpret new information in a way that conforms to a person's preconceptions (Hernandez & Preston, 2013). This phenomenon conflicts with the information-deficit model, which proposes that if educators effectively teach the public about the validity and importance of an issue, people will learn and change their attitudes and behaviors accordingly. Despite the appealing logic of the information-deficit model, it has persistently failed for decades. In such a technologically advanced age, information is widely available. As a result, people exhibit selective exposure, paying attention to information congruent with what they already believe. Another relevant process is called

motivated reasoning. This describes the tendency to uncritically accept information consistent with our preconceptions, but to counter-argue or distort inconsistent information. In the words of Roser-Renouf of the Six Americas project, "we will go to great lengths cognitively to be able to reject what we don't want to believe" (Roser-Renouf, September, 2013). For example, perhaps climate change accepters see more climate variability in the environment because they are predisposed to look for it, while climate change doubters do not see climate variability in the environment because they are predisposed to discount climate change.

Alternatively, the relationship between accepting and observing climate change might reflect not that foresters must "believe" in order to see, but instead that they must see in order to "believe". Data from the 2010 NSAPOCC found that 40% of American respondents who believe climate change is occurring cite personal observations of warming temperatures and changing weather patterns as the primary reason why they believe global temperatures are increasing. This is consistent with other work highlighting the importance of experiential knowledge, instead of abstract knowledge, in influencing behavior (Lachapelle et al., 2012). If learning through experience is truly key to accepting climate change, residents of the Southeast may lag behind those of other regions. Compared to other areas of the country, the Southeast has so far seen milder climate change impacts, such as percent change in precipitation, increase in mean temperature, and decrease in frost-free days (National Climate Assessment and Development Advisory Committee, 2013). Perhaps, as the Southeast experiences a higher frequency and intensity of events

attributable to climate change in the future, an increasing percentage of foresters will accept the evidence for climate change—and report seeing, connecting, and adapting to change.

This chapter also demonstrated that accepting, seeing, and connecting influence foresters' willingness to adapt to climate change. Foresters who accept, see, and connect to climate change are more likely to adapt. The linkages identified between accepting and adapting, and seeing and adapting, are consistent with our hypothesis and existing data in the forestry field. The relationship between connecting and adapting provides new insights into the factors which predict adaptive management response. Again, these correlations mirror those found by Arbuckle et al. in studies of Midwest farmers and indicate the trends founds in this study may surpass regional and disciplinary boundaries (Arbuckle, Morton, & Hobbs, 2013; Arbuckle et al., 2013). Our results suggest that, since Extension is ultimately concerned with implementing adaptive forest management actions, successful outreach and education efforts must accommodate clients' attitudes and perceptions. These results also identify three unique pathways to influence clients' willingness to adapt. Organizations like the Cooperative Extension Service can convince foresters to adopt adaptive management actions by increasing their willingness to accept climate change (β=.24), see climate change (β=.27), and/or connect to climate change (β=.61).

We can imagine alternative outreach strategies to target each of those pathways. To increase foresters' acceptance of climate change, Extension could attempt to convince clients that climate change is real and anthropogenic. To increase foresters' observations of

climate change, educators might share human-interest stories about local extreme weather events, wildfires, or pest outbreaks. To increase foresters' connections to climate change, Extension could emphasize the best management practices available to increase forests' resilience to the impacts of climate change. The relative slope values for these independent variables in the multiple linear regression predicting adaptation suggest that connecting has the greatest impact on adapting. Therefore, demonstrating the relevance of climate change to forestry has the greatest potential to motivate adaptive management responses.

The quantitative evidence for focusing on the connect pathway to increase adaptation converges with logical reasoning. At .21, the coefficient for acceptance was the smallest of the three predictors. Given the strong link between climate change attitudes and demographic factors beyond the control of climate change educators, attempting to convince foresters that climate change is happening and is caused by humans likely represents an unwise investment of resources. Furthermore, given the politically charged nature of the climate change debate, clients might perceive an acceptance-focused outreach strategy as advocacy rather than objective scientific information, violating clients' trust in Extension and alienating traditional constituents.

The effect size for seeing was only slightly higher than for accepting at .24. Sharing examples of local climate change impacts might increase some foresters' climate change observations, particularly if the right spokesperson—such as a prominent landowner or forester—delivered the right message for a particular audience. Illustrating the real consequences of climate change could help other foresters recognize the effects when

encountered. However, as mentioned earlier in the discussion, seeing is likely driven by local climate conditions and confirmation bias tendencies related to climate change attitude. It is difficult to imagine how Extension could consistently open clients' minds to overcome confirmation bias, or cause foresters to personally experience climate change impacts (e.g., by instigating or predicting a drought or wildfire event).

Connecting, which had the largest effect size at .61, is an intuitive choice for an outreach and education strategy. Extension could demonstrate how climate change threatens forests through droughts, wildfires, pests, diseases, and extreme storms. Educators might teach foresters how to deploy familiar silvicultural tools—such as species and site selection, site preparation, thinning, burning, and applying fertilizer—to minimize vulnerability to climate change, protecting their economic investments.

Finally, this chapter showed that demographic factors do not directly influence climate change adaptation. This suggests that demographics may only indirectly affect foresters' management decisions by shaping their climate change attitudes. We interpret this as a positive indicator for successful climate change outreach and education, because it implies that many opportunities exist for organizations like Extension to mediate the impact on behavior of variables such as political ideology and empower foresters to undertake active, adaptive management.

CHAPTER 5: CONCLUSIONS

Results Summary

This study demonstrates that demographic characteristics significantly predict the climate change attitudes of Southeast professional foresters. Respondents' political ideology, education level, employer, state, years of forestry experience, and gender were significantly associated with climate change acceptance. Liberals and moderates were more accepting than conservatives; PhD foresters were more accepting than those with a Master's degree or below; academics were more accepting than employees of private industry, consulting companies, and TIMOs and REITs; Oklahoma and Kentucky foresters were most accepting while Mississippi foresters were least accepting; women were more accepting than men; and less experienced, younger foresters were more accepting than more experienced, older foresters. Of these variables, political ideology is most closely linked to foresters' climate change attitudes. These findings mirror demonstrated relationships in the general public, suggesting that foresters' opinions are similarly associated with their demographic characteristics, and that foresters are likely to present similar challenges for climate change outreach and education.

We also found a close relationship between foresters' climate change attitudes, perceptions, and management responses. Climate change acceptance may significantly influence foresters' willingness to see, connect, and adapt to climate change. Foresters who accept climate change are significantly more likely than doubters to observe climate change

in the environment, feel concerned about the forestry impacts of climate change, and believe climate change will require different management strategies. These trends may result from confirmation bias, as climate change accepters and doubters alike filter their experiences to conform to their preconceptions. Alternatively, foresters in the Southeast United States may lack the firsthand experience with climate change necessary to convince them of its local relevance, since the Southeast has so far witnessed milder climate change impacts relative to other regions of the country (National Climate Assessment and Development Advisory Committee, 2013). Regardless of the cause, these findings reinforce: (a) the need for outreach to convince foresters to adopt adaptive management measures, and (b) the importance of tailoring communication strategies to varied audience needs.

Accepting, seeing, and connecting to climate change are all correlated with foresters' willingness to undertake adaptive management. Therefore, Extension's concern with motivating adaptive management responses remains inextricably linked with foresters' climate change attitudes and perceptions. These relationships match trends found in Midwest farmers, suggesting these relationships could transcend regional and disciplinary boundaries (Arbuckle, Morton, & Hobbs, 2013; Arbuckle et al., 2013). These predictors of adaptation highlight three potential pathways for organizations like the Cooperative Extension Service to motivate adaptive management in response to climate change—by persuading foresters that climate change is real and anthropogenic, by helping foresters observe climate change impacts in the environment, and/or by demonstrating the impacts of climate change on forestry and the appropriate management responses. The relative

effect sizes of these predictors suggests that focusing on the connect pathway will have the largest impact on adaptation.

Finally, our data show that demographic characteristics do not directly influence adaptation; instead, they relate indirectly to adaptation through climate change acceptance. This reflects positively on the potential success of climate change outreach and education efforts, indicating that climate change communicators have opportunities to mediate the influence of demographic factors on management decisions by influencing Southeast foresters' climate change attitudes and perceptions.

Figure 15 summarizes the results from the research questions in Chapters 3 and 4. Bold arrows indicate relationships that remain significant after accounting for the other variables; standard arrows indicate relationships that are only significant in single-variable analysis.

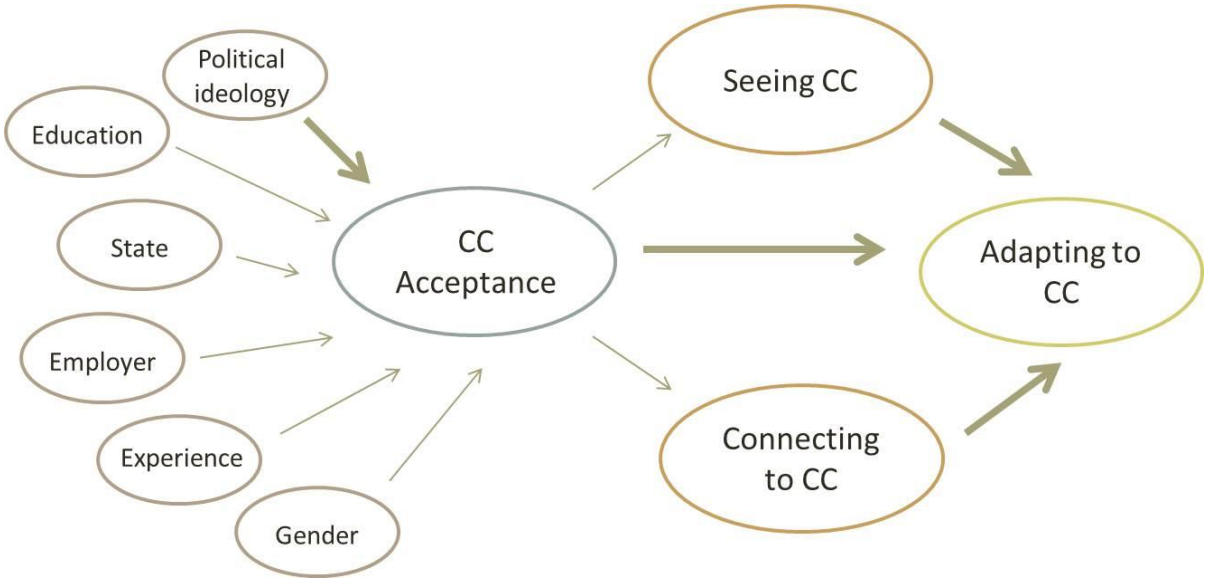

Figure 15. Summarized relationships between demographic characteristics, climate change attitudes, personal perceptions, and adaptive management responses for Southeast forestry professionals. *Note:* bold arrows indicate relationships that remain significant after accounting for the other variables; standard arrows indicate relationships that are only significant in single-variable analysis. Please see the results sections for statistics quantifying the effect sizes of each predictor.

Next Steps

Structural equation modeling (SEM) and path analysis are statistical techniques that model multiple relationships simultaneously. SEM would require the development of a theoretical model and an appropriate survey instrument that constructed latent variables using multiple measures and minimized the number of nominal categorical variables. SEM could test how many of the variables explored in this study moderate the influence of climate change attitudes on behavior, taking a systems view of foresters' climate change attitudes, perceptions, and adaptive management responses.

Additional research is needed on foresters who remain unsure about the validity of climate change. Those uncertain individuals were beyond the scope of our study and excluded from this research. It is possible foresters' strong convictions about climate change reflect adherence to politically dictated opinions, while unsure opinions reflect foresters' considered analysis of climate science and its inherent uncertainties. If so, the trends identified in this research for convinced foresters may not apply to uncertain foresters. After Extension reaches accepting foresters with climate change outreach, uncertain foresters represent the next most accessible audience segment (Roser-Renouf, September, 2013). Better understanding the attitudes and behaviors of these uncertain foresters would improve the success of targeted outreach efforts.

Finally, the effectiveness of the suggested outreach strategy outlined in the following section requires testing. Rigorously measuring the success or failure of Extension efforts to convince foresters to adapt their management to climate change will entail more than simple pre-workshop and post-workshop participant knowledge and attitude surveys. Research should determine whether outreach efforts ultimately result in desired behavioral changes. Ideally, different climate change messaging strategies should be assigned experimentally to various groups to determine the most effective way to communicate with the Southeast forestry professional audience.

Outreach Implications

This research indicates that climate change doubters are unlikely to believe climate change will require different management strategies. Thus, framing adaptive management

solutions in terms of climate change will probably not reach the 40% of Southeast foresters who remain doubtful or uncertain of climate change. In recognition of this trend, Cooperative Extension could approach climate change education with several different tactics. One option is to create a tiered outreach strategy, targeting different segments of the climate change attitude spectrum with different educational approaches. Extension could share explicit climate science information with accepting foresters while avoiding overt mention of climate change with doubting foresters. Alternatively, Extension could craft a more universal outreach strategy to reach accepting, doubting, and uncertain foresters alike with adaptive management techniques. Extension can demonstrate the necessary adaptive management tools without focusing on anthropogenic climate change by emphasizing forest health and resilience to the symptoms of climate change (such as drought, wildfire, disease impacts, and extreme storms) rather than the ultimate cause.

Our research also demonstrates that foresters who accept climate change, observe climate change in the environment, and feel concerned about the forestry impacts of climate change are more likely to believe climate change will require different management strategies. This reveals three key mechanisms for Extension to motivate adaptive management in its clients—by increasing foresters' willingness to accept, see, and connect to climate change. Because connecting had the largest impact on adapting, we conclude that focusing outreach on this pathway will prove most effective and efficient. Extension could help foresters connect to climate change by emphasizing the relevance of climate

change impacts to forest health and sharing the best management practice to minimize forests' vulnerability to climate change threats.

Other studies on climate change communication provide valuable lessons that likely apply to the Southeast forester audience. Research from the Six Americas of Climate Change suggests first targeting outreach on cautious and disengaged individuals, who lack strong convictions about climate change and may remain more receptive to adaptation information than their doubtful and dismissive counterparts (Roser-Renouf, September, 2013). These cautious and disengaged foresters likely reported uncertain climate change attitudes in the 2013 Southeast Foresters Climate Change Survey. Thus, while we did not incorporate their responses into the CCAI because the original scale poorly fit our statistical models, uncertain foresters still represent a critical audience segment for successful climate change communication. Highly accepting foresters may already be early adopters of the desired management techniques and rely less heavily on Extension's guidance, while highly doubtful foresters may be too resistant to the topic of climate change for outreach to prove effective. Extension should first focus its educational efforts on these uncertain foresters with the greatest capacity for behavioral change.

A needs assessment of family forest landowners in the Pacific Northwest (Oregon, Washington, Idaho, and Alaska) suggests ways to improve Extension climate change programming (Grotta, Creighton, Schnepf, & Kantor, 2013). The authors advise emphasizing research transparency, new forest policies, and economic impacts, as well as simplifying and condensing complex research and improving modeling literacy. The needs

assessment suggests incorporating climate change into existing programs on forest management, addressing forest resilience to insects, disease, wildfire, and other threats, rather than developing new programs exclusively about climate change. It also recommends that Extension tailor programs to the local impacts of climate change within the context of regional climate history, rather than focusing on broader global climate projections that clients may not consider relevant (Grotta et al., 2013).

Extension must find a way to educate all clients about the best forestry management tools for a changing climate, providing the best available scientific information while remaining sensitive to foresters' varied perspectives. Our research shows that foresters' adaptive management actions are intertwined with their climate change attitudes and perspectives, and successful climate change outreach and education efforts will accommodate those diverse belief systems. To successfully motivate clients across the climate change attitude spectrum to undertake adaptive management, Extension agents may require additional training on climate science and adaptive management solutions, and need to rise above personal and institutional barriers to accommodate clients' different opinions. Equipping foresters with the silvicultural tools to maintain healthy, productive forests is an important goal for the Cooperative Extension Service and PINEMAP.

We conclude that climate change communicators should design outreach strategies that avoid forcing the topic of climate change on doubting foresters and capitalize on the strong relationship between connecting and adapting. To help foresters connect climate change to forestry, Extension should illustrate the relevant impacts of climate change on

forestry (e.g., drought) and demonstrate the appropriate management solutions (e.g., thinning). Extension can still promote climate change adaptation without focusing on anthropogenic climate change by emphasizing minimizing risk, planning for uncertainty, and managing for resilience to local climate change impacts. More research is needed to refine this climate change outreach approach, but these insights will move the Southeast forestry community toward resilience in the face of climate change.

REFERENCES

Adams, D. C., Monroe, M. C., Plate, R., & Wojcik, D. (2011). *The six Americas of climate change: Perceptions of Southeast Extension professionals.* PINEMAP. Retrieved from http://www.pinemap.org/publications/research-summaries/extension/Six_Americas.pdf

Anderegg, W. R. L., Prall, J. W., Harold, J., & Schneider, S. H. (2010). Expert credibility in climate change. *Proceedings of the National Academy of Sciences of the United States of America, 107*(27), 12107-12109. doi:10.1073/pnas.1003187107

Antilla, L. (2010). Self-censorship and science: A geographical review of media coverage of climate tipping points. *Public Understanding of Science, 19*(2), 240-256. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=lah&AN=20103089485&site=ehost-live&scope=site; http://pus.sagepub.com/archive/

Arbuckle Jr., J. G., Morton, L. W., Tyndall, J., Widhalm, M., Prokopy, L. S., Haigh, T., . . . McGuire, J. (2013). Climate change beliefs, concerns, and attitudes toward adaptation and mitigation among farmers in the midwestern United States. *Climatic Change, 117*(4), 943-950. doi:10.1007/s10584-013-0707-6

Arbuckle Jr., J. G., Morton, L. W., & Hobbs, J. (2013). Farmer beliefs and concerns about climate change and attitudes toward adaptation and mitigation: Evidence from Iowa. *Climatic Change, 118*(3), 551-563. doi:10.1007/s10584-013-0700-0

Bast, J., & Taylor, J. M. (2007). *Scientific consensus on global warming - results of an international survey of climate scientists*. Chicago, IL: The Heartland Institute. Retrieved from http://heartland.org/sites/all/modules/custom/heartland_migration/files/pdfs/20861.pdf

Blennow, K., Persson, J., Tomé, M., & Hanewinkel, M. (2012). Climate change: Believing and seeing implies adapting. *PloS One, 7*(11), e50182. Retrieved from http://proxying.lib.ncsu.edu.prox.lib.ncsu.edu/index.php?url=http://search.ebscohost.com.prox.lib.ncsu.edu/login.aspx?direct=true&db=a9h&AN=84716782&site=ehost-live&scope=site

Brechin, S. R., & Bhandari, M. (2011). Perceptions of climate change worldwide. *Interdisciplinary Reviews: Climate Change (WIRE's), 2*(6), 871-885. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=lah&AN=20113406297&site=

ehost-live&scope=site; http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1757-7799

Cobb, A., & Carolan, M. S. (2011). Public attitudes to climate change: Their origins and significance in mitigation and adaptation. *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources, 6*(007), 1-12. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=lah&AN=20113091779&site=ehost-live&scope=site; http://www.cabi.org/cabreviews

Cook, C., Heath, F., & Thompson, R. L. (2000). A meta-analysis of response rates in web- or internet-based surveys. *Educational and Psychological Measurement, 60*(6), 821-836. doi:10.1177/00131640021970934

Cox, E. P. (1980). The optimal number of response alternatives for a scale: A review. *Journal of Marketing Research, 17*(4), 407-422. Retrieved from http://www.jstor.org.prox.lib.ncsu.edu/stable/3150495

Craig, R. K. (2010). 'Stationarity is dead' - long live transformation: Five principles for climate change adaptation law. *Harvard Environmental Law Review, 34*(1), 9.

Donner, S. D., & McDaniels, J. (2013). The influence of national temperature fluctuations on opinions about climate change in the U.S. since 1990. *Climatic Change, 118*(3), 537-550. doi:10.1007/s10584-012-0690-3

Dillman, D. A. (2000). *Mail and internet surveys: The tailored design method*. New York: J. Wiley. Retrieved from http://www2.lib.ncsu.edu/catalog/record/DUKE002689728

Dillman, D. A. (2009). In Christian L. M., Smyth J. D. (Eds.), *Internet, mail, and mixed-mode surveys: The tailored design method*. Hoboken, N.J.: Wiley & Sons.

Grotta, A. T., Creighton, J. H., Schnepf, C., & Kantor, S. (2013). Family forest owners and climate change: Understanding, attitudes, and educational needs. *Journal of Forestry, 111*(2), 87-93. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=lah&AN=20133155138&site=ehost-live&scope=site; http://www.ingentaconnect.com/content/saf/jof/2013/00000111/00000002/art00005

Hamilton, L. C., & Stampone, M. D. (2013). Blowin' in the wind: Short-term weather and belief in anthropogenic climate change. *Weather, Climate, and Society,* 130123150419007. doi:10.1175/WCAS-D-12-00048.1

Hernandez, I., & Preston, J. L. (2013). Disfluency disrupts the confirmation bias. *Journal of Experimental Social Psychology, 49*(1), 178. doi: 10.1016/j.jesp.2012.08.010

Institute for European Environmental Policy, & Natural Resources Defense Council. (2008). Climate change and sustainable energy policies in Europe and the United States. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=lah&AN=20083310506&site=ehost-live&scope=site; http://www.ieep.eu/publications/pdfs/tpage/tpageccfinalreport.pdf

Kaplowitz, M. D., Hadlock, T. D., & Levine, R. (2004). A comparison of web and mail survey response rates. *The Public Opinion Quarterly, 68*(1), 94-101. doi:10.1093/poq/nfh006

Kieruj, N. D., & Moors, G. (2010). Variations in response style behavior by response scale format in attitude research. *International Journal of Public Opinion Research, 22*(3), 320-342. doi:10.1093/ijpor/edq001

Kim, K. (2011). Public understanding of the politics of global warming in the news media: The hostile media approach. *Public Understanding of Science, 20*(5), 690-705. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=lah&AN=20113329463&site=ehost-live&scope=site; http://pus.sagepub.com/content/20/5/690.abstract

Kirilenko, A. P., & Sedjo, R. A. (2007). Climate change impacts on forestry. *Proceedings of the National Academy of Sciences of the United States of America, 104*(50), 19697-19702. doi:10.1073/pnas.0701424104

Kypri, K., Stephenson, S., & Langley, J. (2004). Assessment of nonresponse bias in an internet survey of alcohol use. *Alcoholism, Clinical and Experimental Research, 28*(4), 630-634. doi:10.1097/01.ALC.0000121654.99277.26

Labriole, M. M., & Luzadis, V. A. (2011). New York Society of American Foresters' perceptions of climate change. *Journal of Forestry, 109*(2), 89-94. Retrieved from http://docserver.ingentaconnect.com.prox.lib.ncsu.edu/deliver/connect/saf/00221201/v109n2/s9.pdf?expires=1392944870&id=77271188&titleid=3830&accname=North+Carolina+State+University+-+Raleigh&checksum=CD8F5BFEB2FE81C0657BED6E446CA82E

Lachapelle, E., Borick, C. P., & Rabe, B. (2012). Public attitudes toward climate science and climate policy in federal systems: Canada and the United States compared. *Review of Policy Research, 29*(3), 334-357. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=lah&AN=20123241969&site=

ehost-live&scope=site; http://onlinelibrary.wiley.com/doi/10.1111/j.1541-1338.2012.00563.x/full

Leiserowitz, A., Maibach, E., Roser-Renouf, C., Feinberg, G., & Howe, P. (2012). *Climate change in the American mind: Americans' global warming beliefs and attitudes in September 2012.* Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication. Retrieved from http://environment.yale.edu/climate-communication/files/Climate-Beliefs-September-2012.pdf

Lenart, M., & Jones, C. (2013). Perceptions of climate change influence willingness to undertake some forestry adaptation and mitigation practices. Manuscript submitted for publication.

Matell, M. S., & Jacoby, J. (1971). Is there an optimal number of alternatives for Likert scale items? Study I: Reliability and validity. *Educational and Psychological Measurement, 31*(3), 657-674. doi:10.1177/001316447103100307

Monroe, M. C., & Adams, D. C. (2012). Increasing response rates to web-based surveys. *Journal of Extension, 50*(6). Retrieved from http://www.joe.org/joe/2012december/tt7.php

Monroe, M. C., Plate, R. R., Adams, D. C., & Wojcik, D. J. 2014. Harnessing homophily to improve climate change education. Manuscript submitted for publication.

National Climate Assessment and Development Advisory Committee. (2013). *National climate assessment report: Draft for public comment.* U.S. Global Change Research Program. Retrieved from http://ncadac.globalchange.gov/download/NCAJan11-2013-publicreviewdraft-chap2-climate.pdf

Oreskes, N. (2007). The scientific consensus on climate change: How do we know we're not wrong? In J. F. C. DiMento, & P. Doughman (Eds.), *Climate change: What it means for us, our children, and our grandchildren* (pp. 65-99) MIT Press. Retrieved from http://med.ucsd.edu/documents/Oreskes_2007_MIT_Press.pdf

PINEMAP. Pine Integrated Network: Education, Mitigation, and Adaptation Project. Retrieved from http://www.pinemap.org/who-we-are

Ratter, B. M. W., Philipp, K. H. I., & Storch, H. (2012). Between hype and decline: Recent trends in public perception of climate change. *Environmental Science & Policy, 18*, 3-8. Retrieved from

http://search.ebscohost.com/login.aspx?direct=true&db=lah&AN=20123117262&site=ehost-live&scope=site; http://www.sciencedirect.com/science/article/pii/S1462901111001973

Reynolds, T. W., Bostrom, A., Read, D., & Morgan, M. G. (2010). Now what do people know about global climate change? Survey studies of educated laypeople. *Risk Analysis, 30*(10), 1520-1538. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=lah&AN=20103369533&site=ehost-live&scope=site; http://onlinelibrary.wiley.com/doi/10.1111/j.1539-6924.2010.01448.x/pdf

Rogers, E. M. (2003). *Diffusions of innovations.* (5th ed.). New York, NY: The Free Press.

Roser-Renouf, C. (September, 2013). Communicating with global warming's six Americas: Strategies for building public understanding and issue engagement. *2013 Pacific Northwest Climate Science Conference,* Portland, Oregon. Retrieved from https://www.youtube.com/watch?v=IIgqCeSrcv4

Safi, A. S., Smith, W. J., J., & Liu, Z. W. (2012). Rural Nevada and climate change: Vulnerability, beliefs, and risk perception. *Risk Analysis, 32*(6), 1041-1059. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=lah&AN=20123254148&site=ehost-live&scope=site; http://onlinelibrary.wiley.com/doi/10.1111/j.1539-6924.2012.01836.x/full

Semenza, J. C., Hall, D. E., Wilson, D. J., Bontempo, B. D., Sailor, D. J., & George, L. A. (2008). Public perception of climate change: Voluntary mitigation and barriers to behavior change. *American Journal of Preventive Medicine, 35*(5), 479-487. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=lah&AN=20083276828&site=ehost-live&scope=site; http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VHT-4TMSJS2-F&_user=6686535&_coverDate=11%2F30%2F2008&_rdoc=13&_fmt=high&_orig=browse&_srch=doc-info(%23toc%236075%232008%23999649994%23699246%23FLA%23display%23Volume)&_cdi=6075&_sort=d&_docanchor=&_ct=18&_version=1&_urlVersion=0&_userid=6686535&md5=2e7bcd42654276522f271674247f01cc

Smith, J. W., Anderson, D. H., & Moore, R. L. (2012). Social capital, place meanings, and perceived resilience to climate change. *Rural Sociology, 77*(3), 380-407. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=lah&AN=20123312469&site=

ehost-live&scope=site; http://onlinelibrary.wiley.com/doi/10.1111/j.1549-0831.2012.00082.x/full

Tjernström, E., & Tietenberg, T. (2008). Do differences in attitudes explain differences in national climate change policies? *Ecological Economics, 65*(2), 315-324. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=lah&AN=20083104239&site=ehost-live&scope=site; http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6VDY-4P53RP8-4-1&_cdi=5995&_user=6686535&_orig=browse&_coverDate=04%2F01%2F2008&_sk=999349997&view=c&wchp=dGLbVzW-zSkzV&md5=4ff112d6aecdc43870622ac68f84ec2b&ie=/sdarticle.pdf

Weijters, B., Cabooter, E., & Schillewaert, N. (2010). The effect of rating scale format on response styles: The number of response categories and response category labels. *International Journal of Research in Marketing, 27*(3), 236-247. doi:10.1016/j.ijresmar.2010.02.004

Weijters, B., Schillewaert, N., & Geuens, M. (2008). Assessing response styles across modes of data collection. *Journal of the Academy of Marketing Science, 36*(3), 409-422. doi:10.1007/s11747-007-0077-6

APPENDIX

Appendix A: 2013 Southeast Foresters Climate Change Survey Results

Resilient Forest Management Strategies for Today's Professionals: A Continuing Education Survey

SurveyMonkey

1. Participation in this survey is voluntary.

		Response Percent	Response Count
I'm ready to proceed.		**92.5%**	**1,634**
I'd prefer not to participate; please take my email off reminder lists.		7.5%	132
	Other (please specify)		15
		answered question	**1,766**
		skipped question	**16**

2. How would you best describe yourself? (This survey is designed for forestry and natural resource professionals. However, others are welcome to submit answers as well.)

		Response Percent	Response Count
Forester		**84.8%**	**1,398**
Wildlife Biologist		3.2%	52
Landowner		9.2%	151
Logger		0.8%	13
Industry Professional (non-forester)		3.5%	58
Other (please specify)		12.7%	209
		answered question	**1,649**
		skipped question	**133**

3. Please indicate your level of agreement with the following statement: "In my lifetime, I have noticed a change in the climate (longer, hotter summers; warmer, drier winters; cooler, moister summers; earlier, drier springs, etc.)."

	Response Percent	Response Count
Strongly disagree	6.8%	101
Disagree	18.5%	274
Neither disagree or agree	28.3%	419
Agree	**38.4%**	**568**
Strongly agree	8.0%	118
	answered question	**1,480**
	skipped question	**302**

4. The following are some conditions that U.S. farmers and forest owners/managers have experienced over the past few years. To what extent have you or your clients witnessed any of these in the past several years?

	Never	Rarely	Occasionally	Frequently	Very frequently	Rating Count
Greater frequency and/or severity of flooding	12.8% (188)	33.7% (496)	**44.5% (655)**	7.9% (117)	1.2% (17)	1,473
Longer dry periods and/or drought conditions	4.3% (63)	12.0% (177)	**41.9% (621)**	35.6% (527)	6.3% (93)	1,481
Greater frequency of or more severe occurrences of insect damage	11.9% (174)	**38.3% (562)**	35.2% (517)	12.7% (187)	1.9% (28)	1,468
Greater frequency of or more severe occurrences of disease damage	13.7% (201)	**41.4% (609)**	32.2% (474)	10.7% (157)	2.1% (31)	1,472
Greater frequency of or more severe occurrences of invasive plant infestations	5.3% (78)	16.5% (244)	30.0% (443)	**34.8% (514)**	13.5% (199)	1,478
More frequent and/or extreme rainfall events	8.5% (125)	36.0% (531)	**41.1% (607)**	11.9% (176)	2.5% (37)	1,476
Increased soil erosion	17.5% (256)	**50.5% (737)**	25.0% (365)	6.2% (91)	0.8% (11)	1,460
Increased frequency of or more severe fire events	14.5% (213)	**34.3% (505)**	29.2% (430)	17.5% (258)	4.5% (66)	1,472
Warmer winters	4.1% (61)	13.6% (201)	**44.9% (663)**	31.2% (461)	6.1% (90)	1,476
Cooler winters	11.4% (165)	**52.7% (766)**	34.5% (502)	1.2% (17)	0.2% (3)	1,453
Hotter summers	6.5% (95)	19.4% (285)	**41.6% (610)**	26.8% (394)	5.7% (84)	1,468
Cooler summers	18.7% (272)	**54.7% (798)**	25.6% (373)	1.0% (14)	0.1% (1)	1,458
Drier planting seasons	6.0% (87)	22.8% (331)	**49.3% (716)**	19.5% (283)	2.4% (35)	1,452
Wetter planting seasons	9.5% (137)	**43.7% (629)**	42.7% (616)	3.9% (56)	0.2% (3)	1,441
Change in length of growing season	12.4% (181)	30.5% (445)	**38.4% (560)**	16.7% (243)	2.0% (29)	1,458
Increase in frequency of extreme weather events (tornadoes,	10.0% (144)	28.9% (416)	**36.4% (524)**	20.4% (294)	4.4% (63)	1,441

hurricanes, ice storms, etc.)	
Other (please specify and provide how frequently you see this)	57

answered question	**1,492**
skipped question	**290**

5. To what extent do you feel concerned about the long term impacts on our forests from the following weather and climate related factors:

	Not concerned	Slightly concerned	Somewhat concerned	Moderately concerned	Very concerned	Rating Count
Greater frequency and/or severity of flooding	**46.5% (690)**	27.8% (412)	16.3% (241)	6.9% (102)	2.6% (38)	1,483
Longer dry periods and/or drought conditions	16.0% (237)	**23.2% (343)**	22.9% (338)	22.6% (334)	15.2% (225)	1,477
Greater frequency of or more severe occurrences of insect damage	18.6% (275)	**29.1% (429)**	23.5% (346)	18.5% (273)	10.3% (152)	1,475
Greater frequency of or more severe occurrences of disease damage	22.2% (328)	**28.1% (415)**	23.6% (349)	17.3% (256)	8.7% (128)	1,476
Greater frequency of or more severe occurrences of invasive plant infestations	12.8% (190)	16.2% (240)	21.7% (321)	**26.3% (390)**	23.0% (340)	1,481
More frequent and/or extreme rainfall events	**33.4% (493)**	31.0% (457)	22.5% (332)	9.6% (141)	3.5% (52)	1,475
Increased soil erosion	**34.1% (501)**	31.6% (464)	19.7% (289)	11.2% (164)	3.5% (52)	1,470
Increased frequency of or more severe fire events	22.1% (326)	**25.8% (381)**	21.4% (316)	19.3% (285)	11.5% (170)	1,478
Warmer winters	**30.0% (443)**	23.4% (346)	21.6% (319)	17.3% (255)	7.8% (115)	1,478
Cooler winters	**55.3% (817)**	27.7% (410)	13.2% (195)	2.8% (41)	1.0% (15)	1,478
Hotter summers	**29.3% (432)**	22.1% (325)	20.0% (294)	19.1% (281)	9.5% (140)	1,472
Cooler summers	**57.1% (841)**	26.6% (391)	12.0% (176)	3.5% (51)	0.9% (13)	1,472

Drier planting seasons	21.2% (311)	**23.8% (348)**	**23.8% (348)**	21.4% (314)	9.8% (143)	1,464
Wetter planting seasons	**44.6% (655)**	31.8% (466)	17.5% (256)	4.7% (69)	1.4% (21)	1,467
Change in length of growing season	**37.3% (545)**	25.4% (371)	21.0% (307)	11.5% (168)	4.9% (71)	1,462
Increase in frequency of extreme weather events (tornadoes, hurricanes, ice storms, etc.)	**26.6% (381)**	22.9% (328)	22.2% (319)	18.3% (262)	10.0% (144)	1,434
					Other (please specify)	31
					answered question	**1,487**
					skipped question	**295**

6. To what extent do you think that forest management strategies will need to change to better respond to future weather and climate uncertainties?

		Response Percent	**Response Count**
No change needed		21.4%	318
Slight change needed		**23.8%**	**354**
Some change needed		**23.8%**	**354**
Moderate change needed		16.4%	243
Significant change needed		6.4%	95
Uncertain		8.1%	121
		answered question	**1,485**
		skipped question	**297**

7. Please select the statement that best reflects your perspective concerning climate change:

		Response Percent	Response Count
Sufficient evidence exists that shows that climate change is not occurring		5.3%	79
Sufficient evidence does not exist to know with certainty whether climate change is occurring or not		**26.5%**	**395**
Climate change is occurring, but we don't know its cause		13.8%	206
Climate change is occurring, and it is caused equally by natural changes in the environment and human activities		12.2%	182
Climate change is occurring, and it is mostly caused by natural changes in the environment in addition to contributions from human activities		20.6%	307
Climate change is occurring, and it is mostly caused by human activities in addition to contributions from natural factors		16.0%	239
Unsure		5.5%	82
		answered question	**1,490**
		skipped question	**292**

8. Do your clients ever ask you about changes in climate or extreme weather and how it might affect their forest?

	Response Percent	Response Count
Yes	24.9%	367
No	**75.1%**	**1,109**
	If yes, what kinds of questions have they asked?	256
	answered question	**1,476**
	skipped question	**306**

9. If you answered yes to the previous question, did you feel confident in answering their question?

	Response Percent	Response Count
Yes	**56.6%**	**300**
No	20.0%	106
Unsure	23.4%	124
	Comments?	89
	answered question	**530**
	skipped question	**1,252**

10. Do you think climate change might provide any benefits to forest management?

	Response Percent	Response Count
Yes	33.4%	489
No	16.3%	239
Unsure	**50.3%**	**737**
	Comments?	267
	answered question	**1,465**
	skipped question	**317**

11. How knowledgeable do you feel you are about the science behind climate and the climate change discussion?

	Response Percent	Response Count
Not knowledgeable	7.5%	108
Slightly knowledgeable	32.0%	464
Somewhat knowledgeable	**33.9%**	**491**
Moderately knowledgeable	20.3%	294
Very knowledgeable	6.3%	91
	answered question	**1,448**
	skipped question	**334**

12. How interested are you in learning more about the science behind climate and the climate change discussion?

	Response Percent	Response Count
Not interested	9.6%	140
Slightly interested	25.7%	373
Somewhat interested	**29.7%**	**431**
Moderately interested	20.2%	293
Very interested	14.8%	215
	answered question	**1,452**
	skipped question	**330**

13. Do you use any tools to assist with "climate smart" forest management (such as long-term climate models, recent updates to the plant hardiness zone maps, the U.S. Drought Monitor, the Keech-Byram Drought Index, etc.)?

	Response Percent	Response Count
Yes	35.4%	510
No	**61.7%**	**890**
Unsure	2.9%	42
	Comments?	122
	answered question	**1,442**
	skipped question	**340**

14. If yes, how confident are you in accessing and using these tools to make management decisions?

	Response Percent	Response Count
Not confident	21.5%	154
Slightly confident	21.4%	153
Somewhat confident	**26.3%**	**188**
Moderately confident	22.9%	164
Very confident	8.0%	57
	Comments?	43
	answered question	**716**
	skipped question	**1,066**

15. If yes, how confident do you feel about the information that these tools provide?

	Response Percent	Response Count
Not confident	14.2%	96
Slightly confident	26.9%	182
Somewhat confident	**29.4%**	**199**
Moderately confident	25.0%	169
Very confident	4.4%	30
	Comments?	39
	answered question	**676**
	skipped question	**1,106**

16. In general, how knowledgeable are you about weather (including forecasts, tools, technologies and the science behind it)?

	Response Percent	Response Count
Not knowledgeable	3.6%	52
Slightly knowledgeable	21.7%	312
Somewhat knowledgeable	**33.4%**	**481**
Moderately knowledgeable	32.8%	472
Very knowledgeable	8.5%	123
	Comments?	25
	answered question	**1,440**
	skipped question	**342**

17. How interested are you in learning more about weather (science, forecasts, and tools and technologies)?

	Response Percent	Response Count
Not interested	5.9%	85
Slightly interested	22.0%	318
Somewhat interested	**30.7%**	**444**
Moderately interested	26.4%	381
Very interested	15.0%	216
	Comments?	13
	answered question	**1,444**
	skipped question	**338**

18. Do you use any weather tools to assist with forest management (such as short term and 1-3 month weather forecasts, soil moisture predictions, or other measurements)?

	Response Percent	Response Count
Yes	**59.1%**	**847**
No	39.1%	561
Unsure	1.8%	26
	Comments?	55
	answered question	**1,434**
	skipped question	**348**

19. If yes, how confident are you in using these tools?

	Response Percent	Response Count
Not confident	7.3%	70
Slightly confident	19.7%	190
Somewhat confident	**33.7%**	**325**
Moderately confident	28.6%	275
Very confident	10.7%	103
	Comments?	26
	answered question	**963**
	skipped question	**819**

20. In general, how knowledgeable are you about forest resiliency strategies, options and concepts (including risk assessment, "climate-smart" best management practices, economic sensitivity analyses, etc.) that help promote forest health and productivity under increasingly uncertain future scenarios?

	Response Percent	Response Count
Not knowledgeable	**35.0%**	**502**
Slightly knowledgeable	31.5%	452
Somewhat knowledgeable	20.1%	288
Moderately knowledgeable	10.6%	152
Very knowledgeable	2.8%	40
	Comments?	31
	answered question	**1,434**
	skipped question	**348**

21. How interested are you in learning more about forest management strategies that promote forest health and resiliency?

	Response Percent	Response Count
Not interested	5.6%	81
Slightly interested	21.5%	309
Somewhat interested	**29.6%**	**425**
Moderately interested	24.6%	353
Very interested	18.7%	268
	Comments?	30
	answered question	**1,436**
	skipped question	**346**

22. Please rate your level of interest in the following topics.

	Not interested	Slightly interested	Somewhat interested	Moderately interested	Very interested	Rating Count
General climate and weather science education	7.2% (102)	25.8% (366)	**32.1% (454)**	24.6% (349)	10.2% (145)	1,416
Communication skills regarding the importance of climate, weather and forest resilience to my clients	17.6% (249)	28.1% (396)	**29.4% (415)**	18.6% (263)	6.2% (88)	1,411
Climate and weather models	10.3% (145)	**31.5% (444)**	30.5% (430)	20.5% (289)	7.1% (100)	1,408
Silvicultural recommendations based on weather and climate guidance	6.4% (90)	17.9% (252)	25.8% (364)	**30.9% (436)**	18.9% (267)	1,409
Growth and yield models reflective of climate and weather variables	9.1% (129)	19.8% (280)	26.7% (378)	**29.8% (422)**	14.7% (208)	1,417
Planting guidelines, seedling selection and genetics	5.5% (77)	14.4% (203)	26.6% (376)	**30.9% (437)**	22.6% (319)	1,412
Assessing stand vulnerability	5.9% (83)	13.4% (189)	**31.0% (437)**	30.4% (428)	19.3% (272)	1,409
Economic impact of weather, climate and climate change	7.7% (109)	18.5% (261)	29.2% (412)	**29.5% (416)**	15.0% (211)	1,409
Other (please specify below)	**45.8% (55)**	5.0% (6)	13.3% (16)	10.0% (12)	25.8% (31)	120
Other (please specify below)	**68.4% (52)**	3.9% (3)	11.8% (9)	2.6% (2)	13.2% (10)	76
					Other (please specify)	67
					answered question	**1,419**
					skipped question	**363**

23. Would you be willing to participate in following types of learning activities?

	Yes	No	Rating Count
Individual webinars or webinar series	**71.9% (1,006)**	28.1% (394)	1,400
Online courses that are self-led (i.e., you can do them at any time)	**73.1% (1,025)**	26.9% (377)	1,402
Online courses that are led by an instructor	**55.8% (775)**	44.2% (615)	1,390
Online courses that include both an instructor-led portion and a self-led portion	**56.6% (784)**	43.4% (600)	1,384
Videos/DVDs	**68.1% (946)**	31.9% (444)	1,390
Correspondence courses	32.2% (440)	**67.8% (927)**	1,367
In-person workshops or short courses	**79.8% (1,123)**	20.2% (285)	1,408
An online community for sharing information and interacting	**54.7% (716)**	45.3% (592)	1,308
If you answered "no" to any of the above educational methods, could you please elaborate?			433
		answered question	**1,414**
		skipped question	**368**

24. In which states do you perform forest management services? Please check all that apply.

	Response Percent	Response Count
Alabama	**24.1%**	**325**
Arkansas	13.3%	179
Georgia	22.0%	297
Florida	14.0%	189
Kentucky	6.0%	81
Louisiana	16.5%	223
Mississippi	20.4%	275
North Carolina	22.0%	297
Oklahoma	5.6%	75
South Carolina	14.0%	189
Texas	11.5%	155
Tennessee	10.5%	141
Virginia	14.5%	196
	Other states (please specify)	87
	answered question	**1,349**
	skipped question	**433**

25. In what general natural resources field is your highest degree?

	Response Percent	Response Count
Forestry	**95.3%**	**1,252**
Wildlife	2.4%	31
Natural Resource Conservation	2.4%	31
Other (please specify)		100
answered question		**1,314**
skipped question		**468**

26. What was the highest level of education you reached?

	Response Percent	Response Count
Associates or Technical Degree	3.9%	54
Bachelors Degree	**60.5%**	**843**
Masters Degree	23.6%	329
Doctorate or Professional Degree	12.1%	168
Other (please specify)		35
answered question		**1,394**
skipped question		**388**

27. In what year did you finish your final education?

Select a range

	1960-1965	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990	1991-
Range of years	2.8% (38)	4.5% (62)	10.6% (144)	**15.5% (211)**	13.9% (189)	11.7% (159)	11.3 (15

28. What is your gender?

	Response Percent	Response Count
Male	**92.4%**	**1,269**
Female	7.6%	105
	answered question	**1,374**
	skipped question	**408**

29. How many years have you worked in the forestry profession?

	Response Count
	1,320
answered question	**1,320**
skipped question	**462**

30. Which of the following best represents your current employer?

	Response Percent	Response Count
A state forestry agency (for example, Georgia Forestry Commission, Florida Forest Service, etc.)	21.8%	264
The Cooperative Extension Service	3.5%	42
A private forestry consulting business	**27.5%**	**334**
A Timber Management Investment Organization (TIMO) or Real Estate Investment Trust (REIT)	6.9%	84
A private forestry association or organization	2.6%	31
A federal natural resource agency	10.0%	121
A private research firm	0.6%	7
A private forest industrial company	18.9%	229
A university, college, or other academic institution	10.8%	131
	Other (please specify)	221
	answered question	**1,213**
	skipped question	**569**

31. If you work with clients directly, which categories best describe your clients? Please check all that apply.

	Response Percent	Response Count
Forest products companies	27.2%	367
Forest contractors (tree planting, harvesting, or other clients)	31.5%	424
Private landowners	**68.2%**	**919**
Industrial landowners	22.7%	306
Natural resource professionals	33.7%	454
Extension agents	19.6%	264
TIMO or REIT clients	20.3%	273
Fellow researchers	11.3%	152
Granting agencies	8.6%	116
I don't work with clients directly	14.4%	194
	Other (please specify)	78
	answered question	**1,348**
	skipped question	**434**

32. If you don't work with clients directly, who is your target audience?

	Response Count
	167
answered question	**167**
skipped question	**1,615**

33. Does your work involve pine plantation management either directly, or through advising others?

	Response Percent	Response Count
Yes	**71.5%**	**993**
No	28.5%	395
	answered question	**1,388**
	skipped question	**394**

34. If yes, approximately how many acres do you manage or advise others on managing?

	Response Count
	761
answered question	**761**
skipped question	**1,021**

35. How do you identify yourself politically?

	Response Percent	Response Count
Very liberal	1.4%	18
Liberal	8.7%	115
Moderate	26.5%	349
Conservative	**44.5%**	**586**
Very conservative	18.9%	249
	Other (please specify)	67
	answered question	**1,317**
	skipped question	**465**

36. Please select YES if you would like to include your answers in our research survey. Please select NO if you want your responses discarded.

	Response Percent	Response Count
Yes	94.5%	1,333
No	5.5%	78
answered question		1,411
skipped question		371

37. Please provide your email if you are interested in receiving continuing education and other information regarding pine plantation management in the face of uncertain weather and climate conditions. *Note: your answers will not be linked to your email address.

	Response Count
	586
answered question	586
skipped question	1,196