RESEARCH ARTICLE

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Climate Change Attitudes of Southern Forestry Professionals: Outreach Implications

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Greater climate variability may profoundly impact southern forests, requiring climate-resilient management strategies to sustain them into the future. Foresters design and implement these strategies, and their perspectives on climate change may influence their receptivity to outreach on climate science and adaptation. To effectively engage this audience, communicators such as Extension agents must understand their views. We surveyed southern forestry professionals to address that need, identifying opportunities and obstacles for education about climate-resilient forestry. Demographic characteristics, particularly political ideology, correlated highly with acceptance of climate change. We also found significant relationships between climate change attitudes, experiences, perceptions, and management responses. Foresters who accept climate change are more likely to observe it in the environment, feel concerned about its impacts on forestry, and agree that it will require different management strategies. We explored multiple outreach options and ultimately recommend connecting climate change to forestry by emphasizing forest health and productivity concerns.

Keywords: climate change, outreach, education, resilience, adaptive management

Climate variability resulting from increasing atmospheric concentrations of CO_2 and other greenhouse gasses will impact forests in the southern United States (Kirilenko and Sedjo 2007). Outcomes include shifting temperature and precipitation patterns, changing tree physiology, increasing wildfire frequency and intensity, expanding ranges and populations of pests and diseases, and the growing likelihood of extreme weather events such as high winds, strong storms, or droughts. However, public debate about the validity of climate change persists despite scientific consensus (Bast and Taylor 2007, Oreskes 2007). Surveys of the American public reveal that awareness of the issue, knowledge of climate science, perceptions of expert agreement, and concern about climate change vary greatly among individuals and has changed over time (Institute for European Environmental Policy and Natural Resources Defense Council 2008, Reynolds et al. 2010, Kim 2011).

A 2007 Washington Post poll found that 56% of survey respondents believed scientists still disagree about whether global warming is actually happening (Institute for European Environmental Policy and Natural Resources Defense Council 2008). Few respondents in a 2008 Pew Research Center survey reported being confident that they fully understand the complexity of climate change (Kim 2011). The same survey found that the American public overall remained uncertain about whether the majority of scientists agree on the issue. However, opinions have shifted since 2008. The Six Americas of Climate Change project found that the public's belief in global warming recently increased. In January 2010, only 57% of the respondents stated a belief in global warming; by September 2012, that number grew to 70% (Leiserowitz et al. 2012).

Although there is a wealth of research on the general public's climate change attitudes, the perspectives of foresters and other natural resource professionals have received less attention, particularly in the southern region. Labriole and Luzadis (2011), Blennow et al. (2012), Lenart and Jones (2014), and Wojcik et al. (2014) provide valuable insights into the views of US foresters, international forest landowners, northeastern foresters, and southeastern Extension professionals, respectively. Assessing the climate change attitudes of southern foresters will extend this growing body of knowledge to guide effective outreach on climate-resilient forestry.

Maintaining forest viability in a chang-

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ing climate will require adaptive forest management, including silvicultural methods that reduce risk and increase resiliency to climate change impacts such as drought and pests. Foresters often rely on continuing education and organizations such as Cooperative Extension to learn about the latest science-based management solutions to emerging threats. In the case of climate change, research shows foresters' personal perspectives may influence their receptivity to professional climate science information and management tools (Lenart and Jones 2014). However, foresters must at least be willing to anticipate climate change risks and consider practical adaptation alternatives. Therefore, education and outreach specialists must understand how to successfully engage foresters. How should these educators communicate the issue of climate-resilient forestry to maximize the likelihood that foresters include adaptation strategies in their portfolio of management tools? This study applies not only to traditional communications professionals but also to other members of the southern forestry community such as researchers, consultants, and industry representatives who share the goal of forest resilience and also need to discuss climate change adaptation with their clients and constituents.

Understanding the breadth of southern foresters' attitudes lays a strong foundation for effective outreach by helping communicators frame their message to resonate with the target audience (Krantz and Monroe 2016). We conducted the survey to characterize southern foresters' views on climate change and identify barriers and opportunities for outreach on climate-resilient forest management. We sought to determine which factors may influence foresters' attitudes toward climate change and how those attitudes relate to their personal perceptions and management decisions. Our survey functioned as a needs assessment, an important initial phase of program development in the Cooperative Extension model for disseminating best management practices (BMP) to natural resource professionals (Seevers et al. 2007). Needs assessments help educators tailor programs to the needs of learners in a community.

Specifically, our study addressed two research questions: Do demographic variables relate to southern foresters' climate change attitudes? and Are foresters' climate change attitudes, personal perceptions of climate change, and adaptive management responses interrelated? Our objective is to help inform development of tailored outreach programs and materials to ensure the survival of healthy, resilient, and productive southern forests.

Demographic Characteristics and Climate Change Attitude

Research on the American public suggests that demographic variables such as religious faith, political affiliation, age, education level, wealth, and gender correlate with understanding and concern about climate change (Tjernström and Tietenberg 2008, Reynolds et al. 2010, Cobb and Carolan 2011, Lachapelle et al. 2012). In general, liberal political values increase the probability of concern about climate change, whereas conservative values decrease the probability (Tjernström and Tietenberg 2008). Women typically display more concern about climate change impacts than men, and lower-income Americans are more likely to be concerned about climate change (Cobb and Carolan 2011). Finally, older individuals are less likely to be concerned about climate change, and higher education levels are associated with increased concern about climate change (Tjernström and Tietenberg 2008).

These studies of the general public link demographic variables to climate change attitudes but offer few insights into the forestry community. Our study investigates this relationship in an unexplored segment of the forestry audience, southern foresters. Given that foresters have unique skills, educational backgrounds, and experiences and the South has a distinct cultural and political climate, do trends established in the American public overall hold true for southern forestry professionals?

We studied the relationship between six demographic variables and southern foresters' climate change attitudes: years of forestry experience, education, gender, political ideology, state of residence, and employer (e.g., state agency or private industrial company). The climate change attitude metric assessed in this study is acceptance that climate change is occurring. We refer to foresters who accept climate change as "accepters" and foresters who doubt climate change as "doubters."

In a survey of members of the New York Society of American Foresters, Labriole and Luzadis (2011) found that forestry experience, employer, and political ideology predicted climate change attitudes. Respondents with 10 or fewer years of forestry experience felt more strongly that climate change is occurring than respondents with 11 or more years of experience. Academic foresters felt most strongly that climate change is occurring, whereas industry foresters were least convinced. Conservative respondents were more likely than liberal and moderate respondents to doubt climate change (Labriole and Luzadis 2011).

In a survey of southeastern Extension professionals' climate change perceptions, Wojcik et al. (2014) used the Six Americas of Climate Change format to group respondents into six categories: alarmed, concerned, cautious, disengaged, doubtful, and dismissive. On this continuum, "alarmed" reflected the greatest level of climate change

Management and Policy Implications

The scientific literature generally recommends that foresters facilitate climate change adaptation by managing for (1) resistance to the forces of climate change, (2) resilience to climate change to absorb impacts without losing function, (3) responding to climatic transitions to minimize negative impacts, and (4) realigning altered forests to current climatic conditions through restoration (Vose et al. 2012). Specific management actions recommended to help southern forests adapt to climate change, such as thinning to reduce water stress, vary, depending on each site's unique management objectives, stand characteristics, and climate change impacts. This study is not designed to refine the climate-resilient management toolkit, but rather to enhance educators' understanding of foresters' climate change attitudes. The results indicate that demographic characteristics shape climate change attitudes in ways comparable to those for the general public. Further, foresters' climate change attitudes, personal observations, concerns about impacts to forestry, and management actions are closely intertwined. This observation suggests that outreach aimed to implement climate-resilient adaptive management strategies will require a nuanced approach to effectively reach all foresters. We conclude that communicators should avoid emphasizing climate change to doubting foresters and instead lead with potential impacts to forest health and productivity (such as drought and pests), continuing to outline and encourage appropriate management solutions.

acceptance and "dismissive" reflected the greatest level of doubt. Findings were consistent with those of the New York Society of American Foresters for political ideology and education level. Conservative Extension professionals were more likely to be dismissive or doubtful, and liberals were more likely to be alarmed or concerned. Respondents with a master's degree or above were more likely to be concerned or alarmed and less likely to be disengaged. They also found proximity to coastline, state, gender, and age significant. Extension professionals serving coastal communities and the state of Florida were more likely to be concerned or alarmed. Women and respondents older than 60 years old were similarly more likely to be concerned or alarmed. In this study, we tested comparable demographic variables to determine whether southern foresters exhibit similar trends.

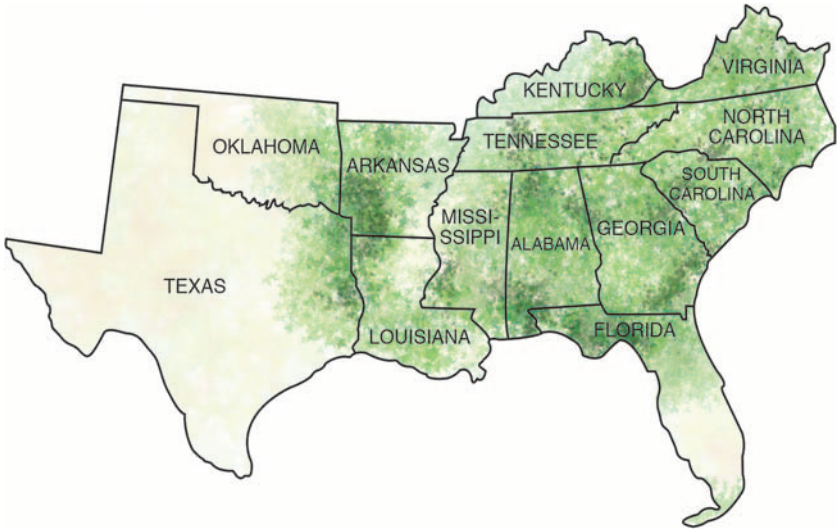

Figure 1. Map of the study area including all Southern Regional Extension Forestry states. Green shading is based on the amount of forested land in nonfederal ownership (Wear and Greis 2013).

Climate Change Attitudes, Perceptions, and Management Responses

Research on foresters and forest owners suggests that climate change accepters are more likely than doubters to implement adaptive climate change management strategies (Blennow et al. 2012, Lenart and Jones 2014). Foresters who experience local climate change impacts and consider them relevant to forestry are also more likely to adapt to climate change. A study of private forest landowners in Sweden, Germany, and Portugal tested the influence of climate change beliefs and experiences on behavior (Blennow et al. 2012). The authors concluded that strength of belief in the local impacts of climate change and reported personal climate change experiences both predict and explain adaptation actions.

Lenart and Jones (2014) surveyed US foresters to determine willingness to adopt management actions based on their climate change perceptions. Results showed that climate change attitudes are significantly associated with foresters' willingness to undertake some management actions but not others. Willingness to thin and perform prescribed burns remained relatively consistent across the range of climate change attitudes. However, 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 change accepters and doubters widened as foresters considered management measures that diverged from traditional practices linked to forest productivity and economic benefits (Lenart and Jones 2014).

We examined similar relationships between climate change attitudes, experiences, perceptions, and management responses, comparing southern foresters with these related communities. We measured climate change attitude by gauging their acceptance that climate change is occurring and evaluated three other specific metrics. The first variable (abbreviated "see") assessed how frequently foresters have observed climate change in the environment. The second variable (abbreviated "connect") assessed how concerned foresters feel about forestry impacts from climate change. The third variable (abbreviated "adapt") assessed foresters' belief that climate change will require different management strategies. Our research tested the relationships between climate change acceptance and forestry professionals' tendencies to see, connect, and adapt.

Methods

Survey Design and Implementation

We administered the survey online using SurveyMonkey, following Dillman's tailored design method (Dillman et al. 2009). We distributed the survey to 6,600 individuals, compiling contact information from publically available and requested forestry organization membership lists in 13 southern states (Figure 1). Sources included university forestry programs, state consulting forester registries, and state Cooperative Extension programs. Twenty-seven percent of survey recipients responded. We limited our study to respondents who self-identified as foresters, excluding about 400 nonforesters from data analysis. Our final sample of 1,330 respondents supported a 95% confidence interval with a $\pm 2.5\%$ margin of error on each estimate, likely to accurately represent the target population of southern forestry professionals (Dillman et al. 2009).

We designed questions to maximize options for statistical analysis, ensure clarity and consistency, and provide sufficient scale resolution without overwhelming respondents, based on recommendations from the literature. We used fully labeled, unidirectional, 5-point Likert-type ordinal scales (Matell and Jacoby 1971, Cox 1980, Kieruj and Moors 2010, Weijters et al. 2010). The resulting scales approximate the behavior of interval data, supporting the use of linear models for data analysis (Weijters et al. 2010). Although an ideal survey instrument would have allowed us to average multiple questions to generate each variable, other studies use linear models to analyze individual questions (Leiserowitz 2006, Peterson et al. 2011). Information loss for individual 5-point scales relative to multiscale averages and continuous data is minimal (Bollen and Barb 1981, Srinivasan and Basu 1989).

We administered a pilot survey to a random sample of 100 individuals from the database of southern foresters. The pilot results informed changes to the content and frequency of introductory and reminder

Table 1. Survey question for climate change acceptance (accept).

Question	Answer choices
Please select the statement that best reflects your perspective concerning climate change	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, but we don't know its cause* 4 = Climate change is occurring and mostly caused by natural forces 5 = Climate change is occurring and equally caused by human activity and natural forces 6 = Climate change is occurring and mostly caused by human activity 7 = Unsure*

* Answer choices 3 and 7 were not analyzed, distilling the original 7-point scale into a 5-point scale consistent with Arbuckle et al. (2013). These choices reflected uncertain climate change attitudes that did not fit an ordered progression from climate change doubt to climate change acceptance. The remaining answer choices were renumbered 1 to 5, where 1 represents the lowest climate change acceptance and 5 represents the highest climate change acceptance.

e-mails accompanying the survey, designed to increase response rate. The full survey launched in February 2013. A presurvey contact e-mail in Constant Contact alerted recipients to the upcoming survey and explained its importance (Dillman 2009). One week later, respondents received their first survey link through SurveyMonkey. Partial respondents and nonrespondents received two reminder e-mails resending the survey link 1 week apart (Monroe and Adams 2012).

We tested for nonresponse bias using the continuum of resistance model, which compares early and late respondents, using late respondents as proxies for nonrespondents (Kypri et al. 2004). We divided the response population into three waves based on early, middle, or late survey submission and performed a one-way analysis of variance (ANOVA) on all climate change attitude, perception, and management response variables. We detected no nonresponse bias.

We measured climate change attitude using seven answer choices (Table 1), but for data analysis distilled the original response categories into a 5-point climate change acceptance scale. This variable omits two choices that did not fit a linear progression from climate change doubt to acceptance: options three ("climate change is occurring, but we don't know its cause") and seven ("unsure"). We included those categories to depict uncertain climate change attitudes and probably captured foresters across the climate change acceptance spectrum who simply lacked confidence in their responses. Foresters who ultimately believe that climate change is not occurring, that it is occurring and naturally caused, or that it is occurring and anthropogenic might all select one of those choices, making it impossible to place them on an ordered acceptance scale. Although not analyzed in this study, these categories characterize a subset of the forestry community that remains uncertain about climate change, which may have other useful applications. The final variable is consistent with the acceptance scale used in a comparable study of Iowa farmers' climate change attitudes (Arbuckle et al. 2013).

Demographic survey questions collected data on employer, gender, education level, years of forestry experience, and political ideology (categorized as degrees of liberal, moderate, or conservative). We determined state of residence from the original database of forester contact information. For climate change perceptions and management actions, we measured seeing (observed climate change), connecting (concern about forestry impacts), and adapting (agreement climate change requires different management strategies) using 5-point scales. We measured how frequently respondents reported witnessing 16 different climate change phenomena (Table 2). Averaging those scores across all phenomena generated a mean frequency of observed climate change. Similarly, we measured how concerned respondents felt about forestry impacts from those same phenomena (Table 2). Averaging those scores generated a mean concern about climate change. Finally, we measured respondents' agreement that climate change would require different management strategies (Table 3).

Data Analysis

Demographic Characteristics and Climate Change Attitude. We performed five one-way ANOVAs to determine the potential contribution of each categorical demographic variable to explaining the variance in climate change acceptance. We treated each demographic predictor independently to test its individual relationship with climate change acceptance. This is consistent with methods used by Labriole and Luzadis (2011) and Wojcik et al. (2014), allowing us to compare results with those studies. For years of experience, the only continuous predictor variable, we used simple linear regression to test its association with climate change acceptance.

We used a general linear model selection procedure in SAS Enterprise Guide 4.3 (GLMSELECT) to adjust for potential collinearity among demographic predictor variables and identify the most prominent predictors of climate change acceptance. GLMSELECT characterized the best general linear model for predicting climate change acceptance, using any subset of the demographic parameters. Model selection eliminated insignificant variables after adjustment for other demographic factors. Stepwise, forward, and backward model selection converged on the same reduced model with the lowest Schwarz Bayesian criterion score.

Climate Change Attitudes, Perceptions, and Management Responses. We tested the possible contribution of climate change acceptance to seeing, connecting, and adapting using four separate simple linear regressions. We also examined which characteristics correlate most closely with adapting using a multiple linear regression. We again used the GLMSELECT procedure, this time to identify the best model for predicting adapting using any subset of the accept, see, and connect variables. All model selection algorithms converged on the same reduced model with the lowest Schwarz Bayesian criterion score.

Results

This survey showed that 14% of southern foresters believed climate change is occurring but were uncertain of its cause, 12% thought climate change is mostly naturally caused, 21% thought natural and human causes contribute equally to climate change, 14% thought climate change is mostly human caused, 6% believed evidence suggests climate change is not occurring, 28%

Table 2. Survey questions for frequency of observed climate change (see) and concern about forestry impacts from climate change (connect).

See question and answer choices	Connect question and answer choices	Climate phenomena
The following are some conditions that US 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?	To what extent do you feel concerned about the long term impacts on our forests from the following weather and climate related factors?	More frequent/severe flooding
		Longer dry periods/drought conditions
		More frequent/severe insect damage
		More frequent/severe disease damage
		More frequent/severe invasive plant infestations
1 = Never	1 = Not concerned	More frequent/extreme rainfall events
2 = Rarely	2 = Slightly concerned	Increased soil erosion
3 = Occasionally	3 = Somewhat concerned	More frequent/severe fire events
4 = Frequently	4 = Moderately concerned	Warmer winters
5 = Very frequently	5 = Very concerned	Cooler winters
		Hotter summers
		Cooler summers
		Drier planting seasons
		Wetter planting seasons
		Change in length of growing season
		More frequent extreme weather events (tornadoes, hurricanes, ice storms, etc.)

Table 3. Survey question for agreement climate change will require different management strategies (adapt).

Question	Answer choices
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

Table 4. Summarized ANOVA for influence of demographic characteristics on southern foresters' climate change acceptance.

Variable*	*df*	Mean square	*F* value	Pr > *F*
Political ideology†	5	66.51	56.14	<0.0001
Education level	4	10.71	7.09	<0.0001
Employer	9	16.30	6.84	<0.0001
State	13	7.50	5.08	<0.0001
Gender	1	7.20	4.64	0.032

* Years of forestry experience was also significant, but as a continuous variable, was analyzed using simple linear regression. The results of that analysis are reported in the text.
† The results of the one-way ANOVA after model selection are identical to this row.

thought insufficient evidence exists to determine whether or not climate change is occurring, and 5% remained unsure of their opinion (Morris 2014). Combining related categories suggests that 60% of southern foresters believed climate change is occurring (but attributed it to a range of causes), whereas 40% remained uncertain or doubtful.

Demographic Characteristics and Climate Change Attitude

All demographic characteristics tested predicted the climate change attitudes of southern forestry professionals. Respondents' political ideology ($P < 0.001$), education level ($P < 0.001$), employer ($P < 0.001$), state of residence ($P < 0.001$), and gender ($P = 0.032$) were significantly associated with climate change acceptance (Table 4). Years of forestry experience was also statistically significant ($P = 0.021$; $R^2 = 0.006$; parameter estimate $= -0.008$; SE $= 0.004$; t value $= -2.31$). Liberal and moderate foresters were more accepting than conservative foresters. Foresters with PhDs were more accepting than those with a master's degree or below. Foresters in academic appointments were more accepting than employees of private industry, consulting companies, and timber investment management organizations and real estate investment trusts. Oklahoma and Kentucky foresters were most accepting, whereas Mississippi foresters were least accepting. Women were more accepting than men. Finally, less experienced foresters were more accepting than more experienced foresters.

After we performed model selection to adjust for potential collinearity between demographic characteristics, the reduced model included only political ideology (Figure 2). This suggests that political ideology most strongly predicts climate change acceptance among the factors analyzed. Whereas other demographic variables individually relate to climate change acceptance, adding them to the regression did not add sufficient predictive power to offset statistical penalties for increasing model complexity.

Climate Change Attitudes, Perceptions, and Management Responses

The relationship between foresters' climate change attitudes, perceptions, and management responses was statistically significant. Climate change acceptance predicts foresters' tendencies to see ($P < 0.001$), connect ($P < 0.001$), and adapt ($P < 0.001$) to climate change (Table 5). Foresters who accept climate change are more likely than doubters to observe climate change in the environment, feel concerned about forestry impacts from climate change, and agree climate change will require different management strategies.

After we performed model selection, the final multiple linear regression model included accept, see, and connect as predictors of adapting. Accepting, seeing, and connecting ($P < 0.001$) to climate change are all

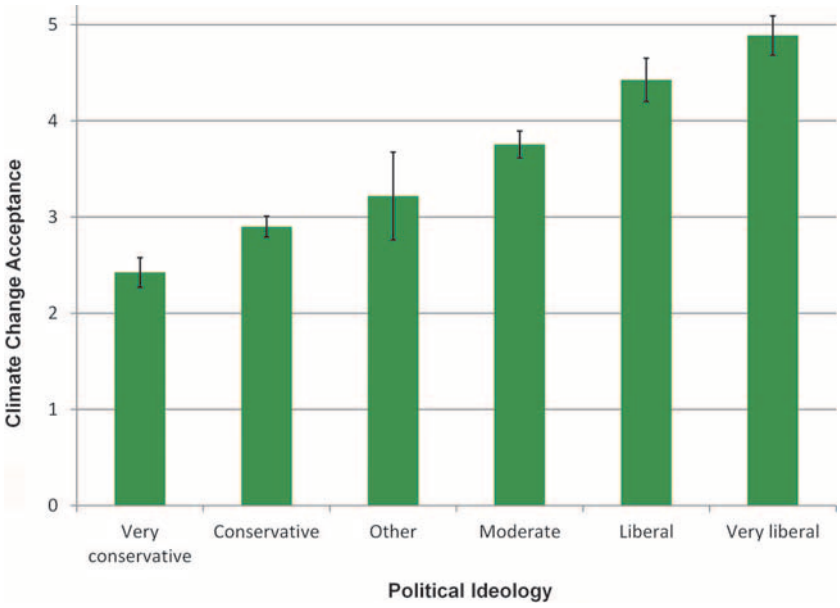

Figure 2. Southern foresters' climate change acceptance by political ideology, showing a 95% confidence interval surrounding the mean. On the *y*-axis, 1 = lowest climate change acceptance and 5 = highest climate change acceptance.

Table 5. Summarized simple linear regressions for influence of southern foresters' climate change acceptance on seeing, connecting, and adapting to climate change.

Independent variable	Dependent variable	Parameter estimate	SE	*t* value	Pr > |*t*|	R^2
Climate change acceptance	Average frequency of observed climate change (see)	0.21	0.01	14.90	<0.0001	0.18
Climate change acceptance	Average concern about forestry impacts from climate change (connect)	0.39	0.02	19.29	<0.0001	0.27
Climate change acceptance	Agreement climate change will require different management strategies (adapt)	0.54	0.03	16.26	<0.0001	0.21

Table 6. Summarized multiple linear regression for influence of southern foresters' willingness to accept, see, and connect to climate change on agreement climate change will require different management strategies (adapt).

Independent variable	Parameter estimate	SE	*t* value	Pr > |*t*|
Average frequency of observed climate change (see)	0.27	0.09	3.03	0.0025
Average concern about forestry impacts from climate change (connect)	0.61	0.06	9.90	<0.0001
Climate change acceptance (accept)	0.24	0.03	7.00	<0.0001

R^2 = 0.38; *F* value = 196.95; Pr > |*F*| = <0.0001.

correlated with foresters' perceived need to undertake adaptive management (Table 6). Foresters who accept, see, and connect to climate change are more likely to agree that climate change will require different management strategies. The relative effect sizes (β coefficients) for each of these predictor variables reflect the strength of the relationship with adapting. Connecting had the largest coefficient, followed by seeing and accepting (Table 6). This finding indicates that outreach efforts focusing on foresters' concerns about the relevant impacts of climate change on forestry should prove most effective for encouraging implementation of adaptive management strategies (Figure 3). Figure 4 summarizes the study results.

Discussion

Our findings suggest that the relationships between demographics and views on climate change among southern foresters are comparable to those of the general public and other natural resource practitioners. Our study also indicates that climate change acceptance among southern foresters relates to seeing, connecting, and adapting to climate change, demonstrating 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. Because southern foresters' opinions about climate change vary widely, with about 60% of the population accepting and 40% doubting or uncertain, it is probably unrealistic to expect southern forestry professionals to universally see, connect, and adapt to climate change. Rather, southern foresters across the climate change attitude spectrum perceive climate change impacts and appropriate management responses differently. This finding does not necessarily imply that climate change doubters will never willingly manage for climate variability; instead, it alludes to the importance of considering foresters' attitudes when designing a climate change adaptation outreach strategy.

Confirmation bias is one possible cause of the relationships observed in this study. Confirmation bias is the tendency to seek out information or interpret new information in a way that conforms to one's preconceptions (Hernandez and Preston 2013). This conflicts with the information-deficit model, which proposes that people will change their attitudes and behaviors if educators simply teach them about an issue's validity and importance (Connie Roser-Renouf, George Mason University, pers. comm., Sept. 5, 2013). However, the information deficit model rarely reflects reality in today's information-rich world, and individuals tend to exhibit selective exposure by paying attention only to information congruent with their existing beliefs. They also employ motivated reasoning, uncritically accepting information consistent with their preconceptions while counterarguing or distorting inconsistent information. For example, perhaps climate change accepters observe climate variability in the environment because they are predisposed to find it. In contrast, climate change doubters may fail to observe climate variability in the environment because they are predisposed to discount it. In addition, our survey results suggest that many foresters agree the climate is changing but do not believe it is caused by human activity (Morris 2014) and therefore

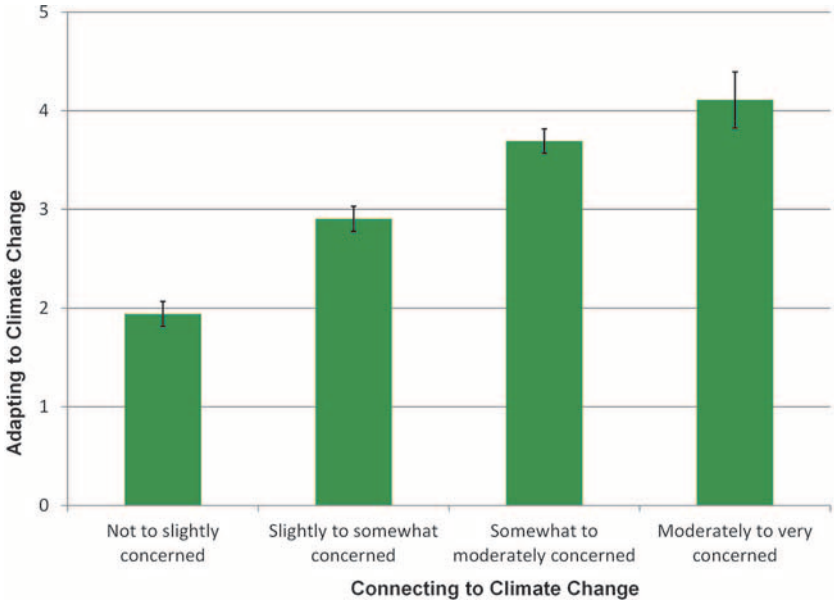

Figure 3. Southern foresters' agreement that climate change will require different management strategies (adapt) by average concern about forestry impacts from climate change (connect), showing a 95% confidence interval surrounding the mean. 1 = lowest adapt score and 5 = highest adapt score.

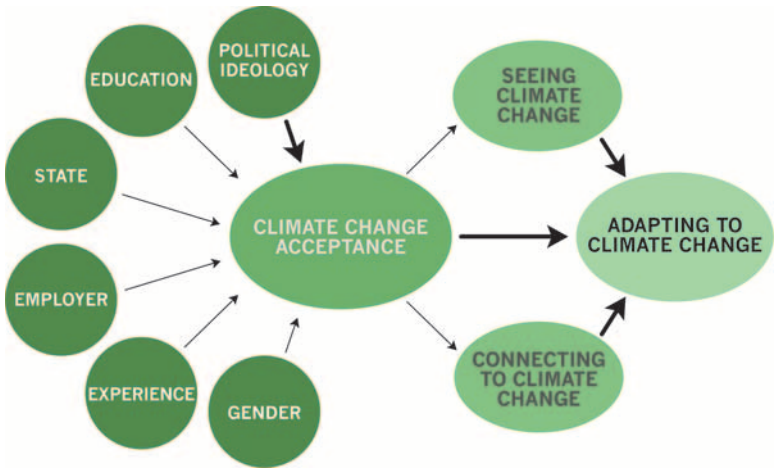

Figure 4. Summarized relationships among demographic characteristics, climate change attitudes, personal perceptions, and adaptive management responses for southern forestry professionals. Bold arrows indicate relationships that remain significant after accounting for other variables; standard arrows indicate relationships only significant in single-variable analysis.

may attribute their perceptions to natural climate variability or other climate phenomena, such as El Niño southern oscillation cycles.

Alternatively, the relationship between accepting and observing climate change could suggest that foresters may not need to "believe" to "see," but instead must "see" to "believe." The 2010 National Survey of American Public Opinion on Climate Change reported that 40% of Americans 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 (Lachapelle et al. 2012). This finding is consistent with other work highlighting the importance of experiential knowledge, instead of abstract knowledge, in influencing behavior.

State-by-state observations of particular climate change impacts such as drought and pest occurrence suggest that this also exists among southern foresters. For example, Oklahoma experienced severe droughts in both 2011 and 2012. Foresters working in Oklahoma reported more frequent observations of increased drought intensity and duration than their counterparts in other states (Rachel Greene, North Carolina State University, pers. comm., Nov. 24, 2014). In our study, foresters residing in Oklahoma also led the region in climate change acceptance (Morris 2014), perhaps due to their recent memory of these extreme drought conditions attributable to climate change.

If experience is truly key to accepting climate change, residents of the southern United States may lag behind those of other regions. Compared with other areas of the country, the South has so far seen milder climate change impacts, such as percent change in precipitation, increase in mean temperature, and decrease in frost-free days (Walsh et al. 2014). If and when the South experiences a higher frequency and intensity of events attributable to climate change, foresters may accept the evidence for climate change at greater rates and adapt accordingly.

We also demonstrated that the extent to which foresters accept, see, and connect to climate change influences their perceived need to adapt. Foresters who accept, see, and connect to climate change are more likely to think adapting is necessary. These results identify three unique pathways to influence clients' adaptive behavior, suggesting that communicators could encourage foresters to adopt climate-resilient practices by increasing their likelihood of accepting, seeing, or connecting to climate change.

Alternative outreach strategies could target each of those three pathways to support adoption of climate-resilient forest management strategies, but the effect and nature of each differ. The accept measurement was the smallest of the three predictors. To increase foresters' acceptance of climate change, communicators could attempt to demonstrate to foresters that climate change exists. Given the strong link between climate change attitudes and demographic factors beyond the control of educators, this probably represents a poor investment of resources. Because the climate change debate remains politically charged (Kim 2011), foresters might perceive an acceptance-focused outreach strategy as advocacy rather than objective guidance, violating trust in the communicator and alienating constituents of programs such as Cooperative Extension.

The effect of seeing was only slightly larger than the effect of accepting. To increase foresters' observations of climate change, educators might share human-interest stories about local extreme weather

Figure 5. The National Workshop on Climate and Forests was co-sponsored by the Society of American Foresters and held at Northern Arizona State University from May 16–18, 2011. The workshop was attended by more than 200 participants representing private, public, and nonprofit forest practitioners, Federal and university researchers, and Extension educators. They heard from research scientists and modelers, national association and lobby leaders, and Extension administrators to learn the current state of climate and forest research, management options, and policy. Photo credit: Dr. Mark Megalos, North Carolina State University Extension Forestry Specialist.

events, wildfires, or pest outbreaks. This might increase some foresters' climate change observations, particularly if the right spokesperson, such as a prominent landowner or forester perceived as similar to the audience (Krantz and Monroe 2016), delivered the right message. Illustrating the consequences of climate change could help other foresters recognize the effects when encountered. However, seeing is probably driven by local climate conditions and confirmation bias tendencies related to climate change attitude. It is difficult to imagine how communicators could overcome confirmation bias or arrange personal experience with the impacts of climate change (e.g., by instigating or predicting a drought or wildfire).

Our results show that connecting has the greatest impact on adapting. Therefore, demonstrating the effect of climate change on forestry has the greatest potential to influence adaptive management responses. Of all the options, this is an intuitive choice for an outreach and education strategy. To strengthen connections between climate change and forestry, educators could emphasize available BMP to increase forests' resilience to the observable impacts of climate change, such as planting drought-resistant seedlings. Outreach could demonstrate how climate change threatens forests through droughts, wildfires, pests, diseases, and extreme storms. Communicators might reframe conversations about the familiar silvicultural tools foresters already use, such as species and site selection, site preparation and planting strategies, thinning, burning, and applying fertilizer, around minimizing vulnerability to climate change to reduce risk and thereby protect their economic investments (Figure 5). Climate change aside, the forest threats listed above are already known quantities to most foresters. The large coefficient for connecting suggests that focusing outreach on those risks, rather than on climate change itself, may better resonate with foresters and encourage adoption of adaptive techniques even if one does not consider them an issue exacerbated by climate change.

Other climate change communication studies provide valuable lessons that probably apply to the southern forester audience. The Six Americas project suggests first targeting outreach to 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 (Connie Roser-Renouf, George Mason University, pers. comm., Sept. 5, 2013). Highly accepting foresters may be early adopters of climate-resilient forest management techniques, whereas highly doubtful foresters may prove too resistant to the topic of climate change to consider taking adaptation action. This suggests that education should initially focus on uncertain foresters.

A 2013 needs assessment of Pacific Northwest family forest landowners by Grotta et al. (2013) recommends incorporating climate change into existing forest management programs addressing resilience to insects, disease, wildfire, and other threats, rather than developing separate climate change initiatives. The authors also advise tailoring outreach to local climate change impacts within a historical regional context, instead of describing broader global climate projections that clients may consider irrelevant. Our study is consistent with the program components outlined by Grotta et al. (2013), which emphasize climate change threats and management solutions.

Conclusions

Educators must provide foresters the best available management tools for a changing climate regardless of opinions about the validity or source of climate change. Successful climate change education will accommodate varied belief systems. Because many foresters do not agree that climate change will require different management strategies, we conclude that communicators should avoid forcing climate change on doubting foresters. Instead, they should capitalize on the strong relationship between connecting and adapting by illustrating the relevant impacts of climate change on forestry (e.g., drought) and continuing to demonstrate the appropriate management solutions (e.g., thinning). Educators can still discuss potential climate change adaptations without overemphasizing the cause or existence of climate change by focusing on minimizing risk, planning for uncertainty, and managing for resilience to local impacts. Additional work is needed to refine this approach, but these insights will help move the southern forestry community toward resilience in the face of climate change.

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