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Climate Change Attitudes of United States Family Forest Owners and their Influence on Forest Management Practices

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**CLIMATE CHANGE ATTITUDES OF UNITED STATES FAMILY FOREST
OWNERS AND THEIR INFLUENCE ON FOREST MANAGEMENT
PRACTICES**

A Thesis Presented

by

LOGAN M. MILLER

Submitted to the Graduate School of the
University of Massachusetts Amherst in partial fulfillment
of the requirements for the degree of

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Environmental Conservation
Environmental Policy and Human Dimensions

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Approved as to style and content by:

Brett Butler, Chair

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Environmental Conservation

DEDICATION

To my teachers, professors, and advisors throughout my life who have pushed and encouraged me to explore, learn more, and to protect this world. To Andrea Knudsen for instilling me with a passion for the environment, to Shari Rodriguez for introducing me to human dimension research and for helping get into graduate school, and to Kyle Barret for his encouragement throughout my undergraduate career. Thank you, I am the researcher I am today because of each of your investments in me.

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I first want to thank God for perseverance and unending peace throughout my research and graduate school experience.

Thank you, Brett Butler, for your copious amounts of patience and insight into the field of human dimension research. You pushed me to challenge myself as a researcher and academic, to think about the why's behind each statistic and survey response. I am beyond grateful for your encouragement and knowledge.

I would also like to thank, Meg Graham-MacLean, your kindness and data analysis support was beyond anything I could imagine from a committee member. You encouraged me to critically think about my data analysis and results while also demonstrating ways to create an inclusive and equitable academic space.

Thank you to my lab members and the undergraduate workers at the Family Forest Research Center, for helping me understand the in- and outs of survey research, for trouble shooting Teleform with me, and for cold calling so many family forest owners with me. And thank you to all the family forest owners and foresters who took the time to sit down for an interview or to fill out my survey, your passion and love for your forests encouraged me to keep moving forward.

And a major thanks to my family and friends. To those who helped me stuff more than 5,000 survey packets at my kitchen table, for encouraging me to rest and take time to have fun, and for intentionally supporting me throughout these past two years – I could not have done this without y'all.

LAND ACKNOWLEDGEMENT¹

The forestland that is owned by the family forest owners studied in this thesis as well as the land on which the University of Massachusetts resides on stolen Native and Indigenous land. The University of Massachusetts Amherst resides on the stolen land of the Norrwutuck community within the Pocumtuc Nation. The University of Massachusetts Amherst received this land through the Morrill Land Grant Act of 1862, in which the Tribal lands of 82 Native Nations west of the Mississippi river were often forced to sign the treaties ceding the land to the U.S. government because of the poor living conditions and violence.

Today, Indigenous Nations in southern New England continue to employ diverse strategies to resist ongoing colonization, genocide, and erasure begun by the English, French, Dutch, Portuguese and other European Nations, and that continued when Tribal homelands became part of the United States. Native Americans from Tribal Nations across the U.S. and Indigenous peoples from around the world also travel into these Pocumtuc homelands to live and work. This land has always been and always will be, Native Land.

I also am grateful for the waters and lands on which I was raised, those which were home to the Cheraw, the Catawba, the Occaneechi, the Tutelo, and the Keyauwee peoples. I recognize these lands and waters as important Relations with which, I am, as we are all, interconnected and depend on to sustain life and wellbeing.

Addressing the land and its history is only a precursor to the work that needs to be done to appropriately address the atrocities committed and that are still being committed against indigenous people in the United States. The best ways to fight for indigenous rights is to learn from and work alongside local indigenous people and communities and seek out resources and literature by indigenous people.

ABSTRACT

CLIMATE CHANGE ATTITUDES OF UNITED STATES FAMILY FOREST OWNERS AND THEIR INFLUENCE ON FOREST MANAGEMENT PRACTICES

SEPTEMBER 2023

LOGAN M. MILLER,

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Understanding family forest owners' (FFOs') attitudes and behaviors towards climate change will allow for more sustainable forest management practices to be implemented, helping to combat climate change and its impacts. The goals for this research are (1) to begin measuring U.S. FFO attitudes towards climate change, (2) to determine what factors impact these attitudes, and (3) to determine how they influence the FFO's management practices using the Responsible Environmental Behavior (REB) framework (Hines et al. 1987). Chapter 1 explores the different facets of my thesis project focusing on forests and forests' ecosystem services, forest ownership in the United States, and exploration of the REB model and serves as a more in-depth introduction section of Chapter 2. I explored past research of climate change attitude and beliefs and found age, political affiliation, education level and income of U.S. forest owners and foresters were significant factors in comparison to their climate change belief or attitude. Chapter 2 follows my research project, in which I measure the climate change attitudes of FFOs in Alabama, Oregon, and Wisconsin and their employment of climate centered forest management practices as well as the factors that influence these practices

using mailed surveys. Based on the categories developed by Maibaeh et al. (Maibach et al. 2009) to describe the general public's attitudes towards climate change, I found about 16% of the FFOs in the study area were in the *Alarmed* segment, 16% in the *Concerned*, 37% in the *Cautious*, 2% in the *Disengaged*, 10% in the *Doubtful*, and 20% in the *Dismissive*. FFOs in Oregon and Wisconsin were more likely to be in a higher climate change attitude segment than those in Alabama. FFOs who had a college degree were more likely to be in a higher climate change attitude segment than those and a college degree. Climate change attitude was not a significant factor in determining if the FFO would carry out a climate centered management practice within the REB framework but rather the FFOs who indicated financial objectives were an important reason for owning their forest\land were more likely to carry out the listed management practices. These results indicate climate change belief is not necessary for an FFO to manage their land to mitigate or adapt to future climate impacts, but rather the individual objectives and values determine which management practices are utilized.

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CHAPTER 1

**BACKGROUND FOR THE RESEARCH OF CLIMATE CHANGE ATTITUDES
AND CLIMATE CENTERED MANAGEMENT PRACTICES OF UNITED
STATES FAMILY FOREST OWNERS**

1.1 Introduction

The continuous release of anthropogenic emissions has altered shift of natural climatic patterns, resulting in major negative impacts on the built and natural environments (Masson-Delmotte et al. 2021). Forests can reduce these impacts through carbon sequestration (Bonan 2008) and in the United States there are 333 million ha of forestland (Perry et al. 2022), with 110 million ha owned by family forest owners (Butler et al. 2021). The owners of these forests can manage them in ways that preserve carbon sequestration, ensure the longevity of their forests, and ultimately help combat climate change and its impacts. These owners can also convert their forests to other land uses, specifically to development, which will ultimately have deleterious impacts on the climate. Therefore, understanding FFOs, family forest owners who own a large portion of forests in the U.S. (39%; Butler et al. 2021), and especially their attitudes towards climate change and their management practices, will help to promote climate-responsive management practices. This chapter will provide the fundamental background needed to understand the different aspects of this research. Beginning with the describing of the roles forests play in reducing climate change and moving into the importance of understanding FFOs' relationships and practices implemented on their land. Following this is a description of climate change attitudes research conducted by Yale University

and George Mason University presented in parallel with a discussion of theoretical framework on behavior, the Responsible Environmental Behavior (REB), linking an individual's beliefs to their behaviors. Finally, I present past research surrounding forest owners and professionals, inside and outside the United States, their perspectives and beliefs surrounding climate change, and their belief in managing forests to mitigate to climate change.

1.2 Climate Change

Climate change refers to a statistically identifiable change in the state of the climate of the via the changes in the mean and/or the variability of its properties and that persists for an extended period (Intergovernmental Panel on Climate Change 2022). The impacts of climate change are vast and disastrous, including the increase in frequency and intensity of heat extremes, heavy precipitation, droughts, and loss of sea and Arctic ice (Masson-Delmotte et al. 2021). These changes have accelerated rapidly due to human activities which have increased concentrations of greenhouse gases and aerosols in the atmosphere (Arias et al. 2021, Masson-Delmotte et al. 2021).

With these changes causing increasingly more harm to natural landscapes and human communities, there is a greater push now more than ever to adapt to and mitigate climate change and its impacts. Mitigation efforts have included laws to reduce greenhouse gas emissions (e.g. Massachusetts' Global Warming Solutions Act of 2008) the reduction of costs for low-emission technologies, such as solar and wind power generation, the use of carbon taxes and emissions trading (Beaton 2015, Hoesung Lee et al. 2023). Most adaptation efforts have focused on climate change risks relating to water,

mainly in agriculture dealing with water management and storage on farms and soil moisture conservation. Other adaptation efforts include the production of sustainable foods, sustainable forest management, soil organic carbon management, etc. (Hoesung Lee et al. 2023). According to the IPCC, the current adaptation and mitigation efforts in light of the levels of anthropogenic greenhouse gas emissions make it most likely that warming will exceed 1.5°C in the 21st century and harder to keep the warming below 2°C (Aldunce et al. 2023). while there has been an increase in green technologies to reduce the amounts of greenhouse gasses to be released into the atmosphere, it is also crucial to utilize the Earth's natural carbon sequestration via forests to reduce the levels of carbon dioxide in the atmosphere and thus slow down, or hopefully reverse, the effects of climate change (Masson-Delmotte et al. 2021).

1.3 Forests

Forests play a major role in climate systems via biological, physical, and chemical processes that interact with the water and carbon cycles, energy systems, and the composition of the atmosphere. Forests are able to both accelerate or inhibit anthropogenic climate change, specifically, maintaining and establishing more forestlands can help reduce climate change and its impacts via carbon sequestration (Bonan 2008).

Carbon sequestration is the process by which carbon dioxide is removed from the atmosphere and stored in the system that removed it. In the case of forests, trees capture carbon dioxide through photosynthesis and store the carbon for their growth and continue to store carbon after they die. Other carbon pools in forests include the root systems,

undergrowth, forest floors, and soils, with living trees containing the greatest carbon density (Durkay and Schultz 2016). Understanding the benefits of forest's ecosystem services to mitigating climate change, one can begin to see why it is crucial to protect and manage forests with climate change in mind.

1.3.1 Forestland in the US

Natural and planted forests and wooded land make up about 333 million ha of land (3.33 million km²) in the United States, which includes traditional forested land, urban forests, industrial forests, and forests surrounding agriculture (Oswalt et al. 2019, Perry et al. 2022). The forestland has been distinguished and grouped into 28 groups to illustrate the different forest types of the United States by the Forest Inventory and Analysis program of the U.S. Forest Service, these groups include: oak/hickory, maple/beechn/birch, loblolly/shortleaf pine, and fir/spruce/mountain hemlock (B. Ruefenacht et al. 2008, Perry et al. 2022). The distribution of these groups can be seen in **Figure 1**, also illustrating the vastness of forest land cover in the U.S.

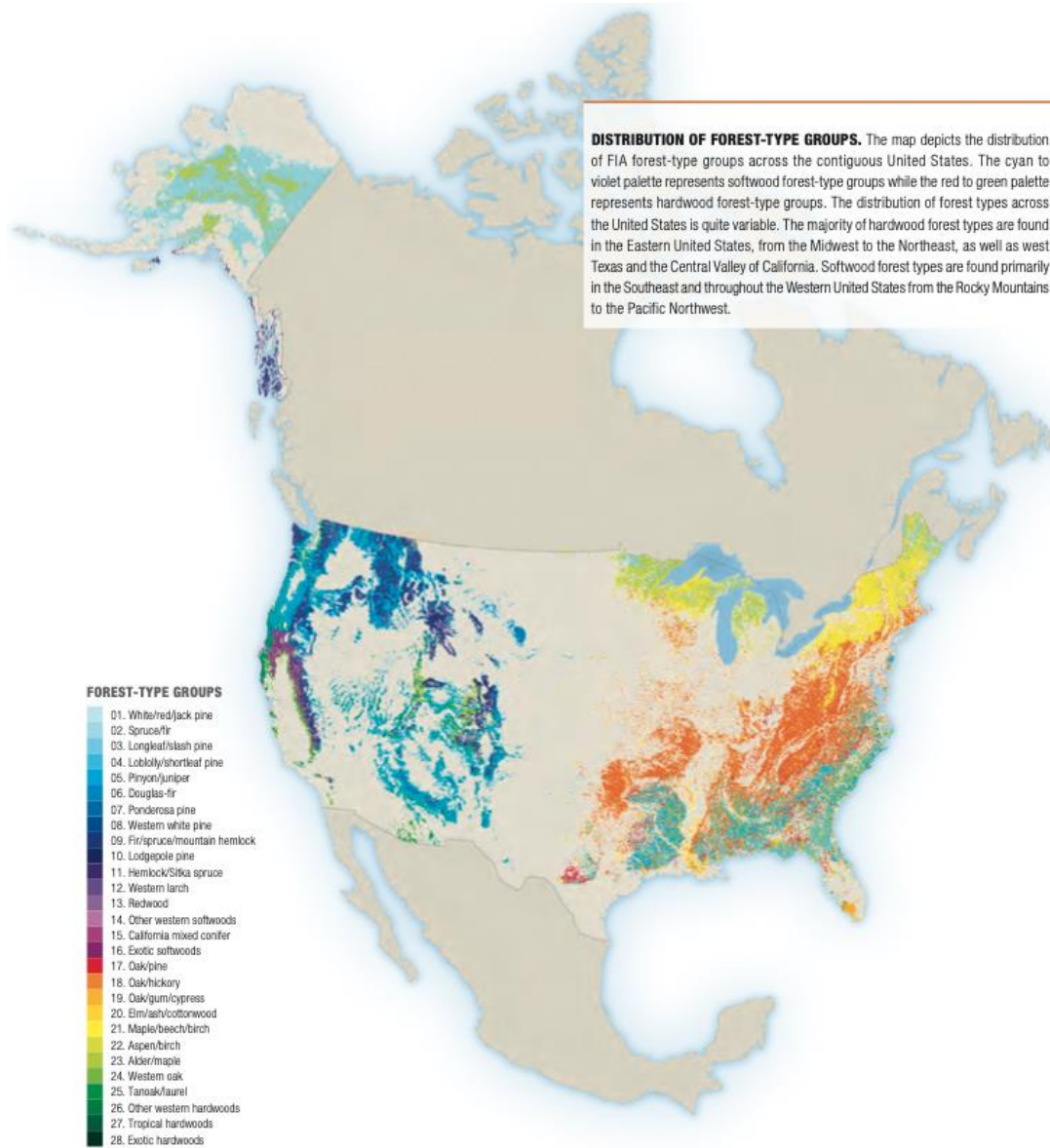


Figure 1. Map of North and Central America with the different forest-type groups of the United States illustrated (Perry et al. 2022).

It is important to understand which forest groups exist within the United States and their distribution as each group have different ecological niches when it comes to reducing climate change. The low surface albedo of boreal forests, which are confined to Alaska, during snow seasons creates a climate warming effect when compared to the

absence of trees, it has also been found that boreal forests have the greatest biogeophysical effect of all biomes on the annual mean global temperature. Tropical forests have a role in cooling surface air temperatures because of the forests' continued high rates of evapotranspiration, which offsets the warming effects of low albedo of forests. The net climate role of temperate forests is not as extreme as boreal or tropical forests. Historically, the role forests have in climate change mitigation historically has been diminished through land use change from forest to agricultural land, especially in the eastern United States (Perry et al. 2022). However, since the 1980's gross forest land across the U.S. has increased, a substantial portion from converting abandoned croplands to forests (U.S. Environmental Protection Agency 2023). With this increasing amount of forestland, taking steps to ensure the health and longevity of the existing and newly established forestland in the U.S.

1.3.2 Forest Ownership and Management

These forests exist with social, political, and economic contexts, they are managed, monitored, or owned by eight different broad categories of ownerships as determined by the US Forest Service (USFS) (Sass et al. 2020). In this thesis, I will be describing the relationship between those who have a direct interaction and impact on forested areas as 'ownership' although 'ownership' doesn't fully describe the ways in which humans, as a community or individuals, historically or currently interact with the forested land they live upon, especially within Native and Indigenous communities.

The different ownerships across the conterminous United States can be seen in **Figure 2**. When working to preserve forests and further their benefits to ecosystems as

well as their ability to combat climate change, it is crucial to understand those who own these forests and their motivations for owning and managing these forests. Understanding forest ownership can allow for more authentic interactions with forest owners, can help forest owners build more trusting relationships with local, state, and federal forestry agencies and professionals, and ultimately allow for better forest management programs and practices that help meet the forest owner's needs while also preserving forests and forest benefits in the United States.

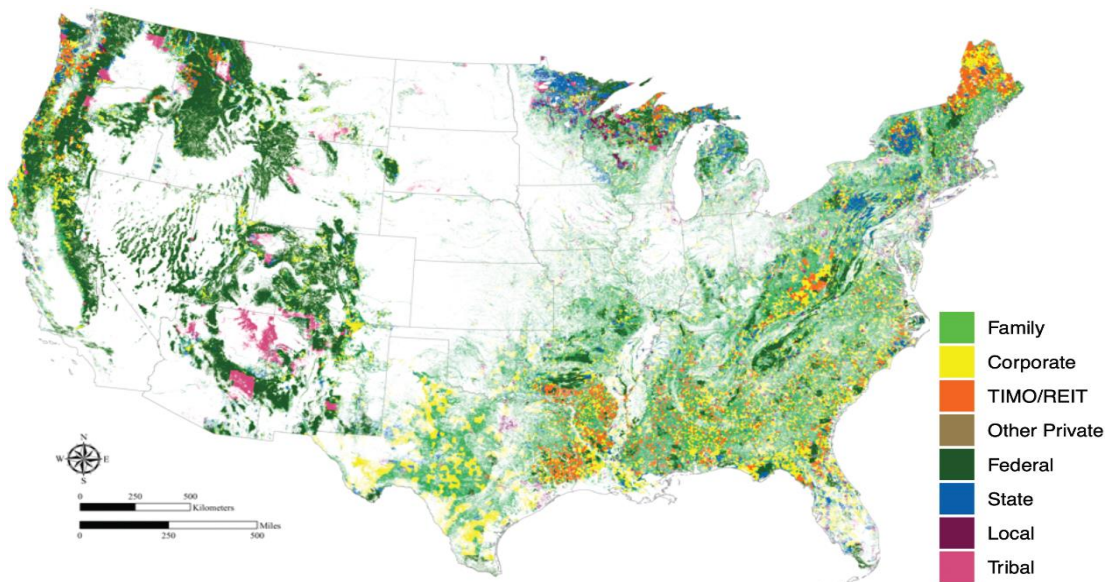


Figure 2. Forest ownership in the conterminous United States circa 2017: distribution of eight ownership types – geospatial dataset (Sass et al. 2020). TIMO/REIT = Timber Investment Management Organizations or Real Estate Investment Trusts

Forest owners have the ultimate decision on what management actions take place on the forestland they own. Management actions vary between active and passive management, active management describing the intentional actions of a forest owner on their land in order to meet specific goals (U.S. Forest Service 2010). Passive management has no one definition, but the description for passive forest owners I will be using describes the forest owners who are not making intentional decisions in relation to their

forestland (Matilainen and Lähdesmäki 2023) and those owners who have made the decision to let ‘nature run its course’ on their land. While the umbrella term of passive management only has one application, active management has an array. Active management can involve removal of trees for timber, planting drought and wildfire tolerant trees, increasing the diversity of tree species, actions to increase wildlife habitat, actions to prevent the forestland from being developed, etc. (Boag et al. 2018, Butler et al. 2021). I will be referring to any active management practices which a forest owner takes that will increase their forestland’s ability to adapt to future climate change impacts, that will help keep the forestland from being developed, or ultimately preserve or improve the level of the forest’s natural ecosystem services (i.e., the amount of carbon sequestered) as ‘climate-centered forestry practices,’ ‘climate-centered management practices,’ or ‘climate-centered forest management’ interchangeably.

1.3.3 Family Forest Owners

As depicted in **Figure 2**, private ownerships account for over half of the forestland in the United States, with federal and family ownerships making up the majority of private ownership types. **Figure 2** also highlights the geographical distinction between these two types of ownerships - the western US with a higher percentage of federal ownership and the eastern US with family. The family forest ownership type is described as “a family, individual, trust, estate, or family partnerships that owns at least [0.4 ha] of land with tree cover of at least 10 percent, and the land is not used for other purposes, such as lawn, that would impede natural processes” (Butler et al. 2021). This definition combines the FIA’s definition of forest land, “land that has at least 10 percent crown cover by live tally trees

of any size or has had at least 10 percent canopy cover of live tally species in the past, based on the presence of stumps, snags, or other evidence. To qualify, the area must be at least 1.0 acre in size and 120.0 feet wide” and their’ ownership category of family ownership: “individual and family, including trusts, estates, and family partnerships” (USDA Forest Service 2016, 2019).

Family forest owners (FFOs) own 110 million ha of forest land, excluding interior Alaska as there are currently sampling limitations of FFOs, (Butler et al. 2021) which makes up 33 percent of all forest ownerships in the U.S. It is estimated that there are 9.6 million family forest ownerships in the U.S., which can include ownerships with more than a single individual, such as a joint ownership (Butler 2011). A family forest ownership can own from 1 acre to over 5000 acres of forestland, and their management practices can have major impacts to the forest ecosystems within and surrounding their owned land. These practices range from taking actions to keep their forestland forested either through conservation easements or similar programs, altering their forests to protect wildlife habitat through plantings or removal of certain tree species, or reducing fire hazards on their land. FFOs can also take a passive management approach, in which the owner does not take intentional actions to manage their forest (Carey 2006, Matilainen and Lähdesmäki 2023) or allow nature to take its course. As family-owned forest land is owned and managed on an individual level, family forestland does not have a uniform set of management practices or motivations for owning, managing, or maintaining forest land.

With FFOs having unique needs, motivations, and forestlands, to appropriately conserve the 110 million ha of these U.S. forests and their benefits, there needs to be an

understanding of the FFO population. FFO attitudes and values surrounding forests, how they manage their forests, and the benefits they receive from their forests influence the decisions FFOs make surrounding their forestland. The Family Forest Research Center (FFRC), a joint venture between the U.S. Forest Service Northern Research Station and the University of Massachusetts Amherst, implements an annual National Woodland Owner Survey (NWOS) to increase an understanding of U.S. FFOs, specifically asking the FFOs about their forest land, “their reasons for owning it, how they use it, if and how they manage it, [...] their concerns and issues related to their forests, their intentions for the future of their forests, and their demographics”

(www.familyforestresearchcenter.org/). Other research includes studies assessing the sustainable management of family forests in the U.S. (Butler et al. 2022a), the influence of an FFO identifying as a hunter on their land management (Snyder et al. 2021), characterizing the responses of FFOs to invasive insects (Holt et al. 2020), etc. Increasing the understanding of FFOs can help generate more specific forestry programs, management practices, and resources can be provided to FFOs in a way that matches their needs and values. Forest practices that meet the FFOs’ needs and values can encourage FFOs who would not have participated would be motivated to participate in said practices and help conserve and enhance forest ecosystem functions.

1.4 Theoretical Framework

Measuring the motivations, attitudes, and values of FFOs falls under social-ecological systems research, a field that works to understand the intricacies between human and ecological systems. In social-ecological system research, the human and

ecological systems are inherently linked as humans rely on the resources from ecosystems and ecosystems are influenced by the decisions of the human on both the individual and systemic level (Jones et al. 2016). In this field of research, measuring and identifying human behaviors and drivers of behavior becomes a crucial component in understanding ecosystems, natural resources, and how to properly conserve them. Specifically, when researching the drivers of ecosystem change, studying the attitudes and values of those who interact with the ecosystems of interest generates a more complete model of ecosystem dynamics. The values and attitudes are foundational components to the individual's behavioral intentions and thus, their behaviors. Different theoretical frameworks have been used to describe this relationship such as the Theory of Planned Behavior (Ajzen 1991), the Transtheoretical Model of Behavior Change (Prochaska and DiClemente 1983), and the Responsible Environmental Behavior (REB) model (Hines et al. 1987). My research will follow the framework of the REB Model, illustrated in **Figure 3**.

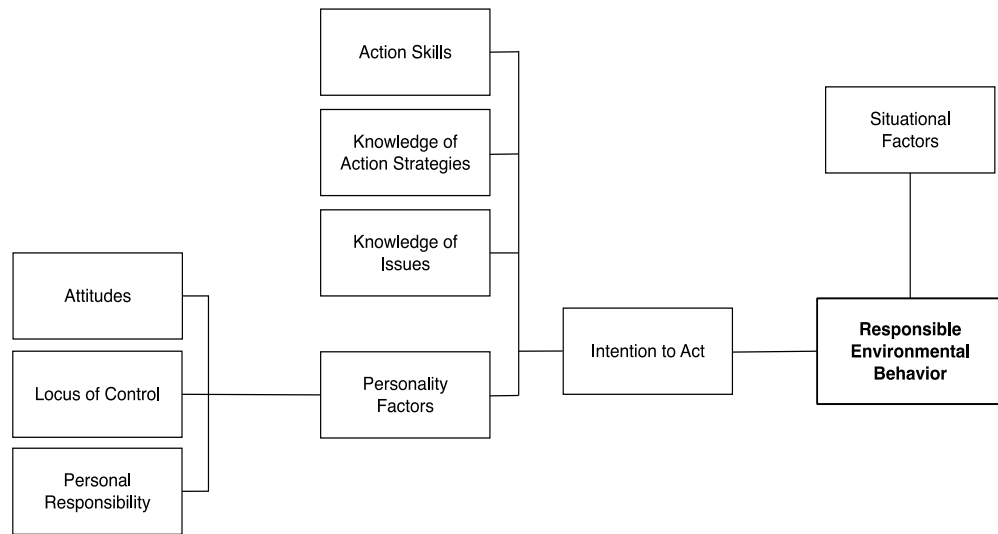


Figure 3. The framework of Hines et al.’s (1987) Responsible Environmental Behavior.

Helping to meet the goal of environmental educators to develop “environmentally responsible and active citizens” (Hines et al. 1987), the REB model was derived from a meta-analysis of environmental behavior studies by Hines et al. (1987) to understand the variable(s) that have the highest influence to motivate individuals to take a responsible environmental action. The REB model was built upon a meta-analysis of 128 studies surrounding responsible environmental behaviors and while there was no listing of all the behaviors included in those studies, some were highlighted throughout Hines et al.’s research such as recycling, petitioning, energy consumption, anti-littering, and financially contributing to a toxic waste fund. From this meta-analysis, Hines et al. (1987) highlights the cognitive and psycho-social variables that would help predict if a person would carry out a responsible environmental behavior.

First addressing the relationship between cognitive variables of the individuals and their willingness to carry out a responsible environmental behavior, Hines et al. describe cognitive variables as the knowledge of the environment, of the issues the environment faces, and the knowledge of how to act against a particular environmental issue, represented by *Knowledge of Issues*, *Knowledge of Action Strategies*, and *Action Skills* in **Figure 3**. Hines et al. concludes a person cannot hold an intention to act on an environmental issue unless they are knowledgeable of the issue and that an individual would need to have the knowledge of how to act on the issue. Hines et al. specifically include the *Action Skills* variable to this model, prior to the creation of this model it was assumed that skills evolved naturally from knowledge, but found strong evidence that this assumption was unlikely, and thus the skill(s) to apply the appropriate actions to environmental issues in tangent to the knowledge of the issues and action strategies provide a person the ability to take a responsible environmental action.

In addition to cognitive variables, Hines et al. addresses the psycho-social variables that had impacts on an individual carrying out a responsible environmental behavior, which help to establish the individual's desire to act. These variables are the individual's attitude towards the environment, their locus of control, personal responsibility to the whole environment or a facet of the environment, and their commitment or intention to act. The *Attitude* variable "deal[s] with the individual's feelings, pro or con, favorable or unfavorable, with regard to particular aspects of the environment," the *Locus of Control* is an individual's perception of if they can bring about change through their own behavior, *Personal Responsibility* is a variable to represent an individual's feelings of duty or obligation towards any facet of the

environment, and the final variables is commitment as a measure of an individual's intention to carry out a responsible environmental behavior.

Therefore, the desire to carry out a responsible environmental action would result from an individual believing their behavior(s) will bring about change, a positive attitude towards the environment and the action, and a sense of obligation to the environment (Hines et al. 1987). An individual with both a desire and the abilities to act will be more likely to act, however this can be inhibited due to the individual's situational factors.

Situational factors can both prevent or encourage an individual to carry out an environmental action and are able to act in opposition or to strengthen the already present variables. Hines et al. provides an example of a person who has the desire and knowledge to help stop pollution by donating to a toxic waste fund but is financially unable to do so, preventing them from carrying out the responsible environmental behavior. On the other hand, one may reduce their energy consumption but only with the desire to save money rather than a desire to conserve fossil fuels (Hines et al. 1987).

While the REB model was first established in 1987, the psycho-social variables that were attributed to be determinates of environmental behavior (*Attitude, Locus of Control, Personal Responsibility, and Pro-environmental Behavior Intention*) were revisited in 2007 (Bamberg and Möser 2007). The Bamberg and Möser study used studies that were conducted at least ten years after the studies used by Hines et al., reducing overlap between the studies, and provided a list of keywords for the pro-environmental behaviors they were including in their study: recycling, waste reduction, energy saving, sustainable consumption, meat consumption, travel behavior, etc. Bamberg and Möser had similar findings to that of the Hines et al. study, establishing the temporal stability of the psycho-

social variables of the REB model and allows the model to still be viable when associating them with pro-environmental/responsible environmental behaviors. The REB model has also been used to understand tourists' responsible environmental behavior with marine ecosystems in Malaysia (Abdullah et al. 2019); the relationship between Turkish consumers' attitude towards the reduction of plastic shopping bags, environmental attitude, and environmental behavior (Akyıldız and Duygu 2022), the use of electric scooters in Taiwan during a transition from fossil fuel-powered to green vehicles (Chang et al. 2021); addressing the factors that influence public support for the Individual Low-Carbon Behavior Rewarding System in China (Ji et al. 2023).

Therefore, in order to understand and predict the actions of individuals within a population and potentially the population itself via the framework of the REB Model (Hines et al. 1987), one must have an understanding of the variables that lead to action and any relationships between each of them.

1.4.1 REB vs TPB

Hines et al.'s REB Model is not the only theoretical framework that aims to explain why an individual carries out a specific behavior and isn't the only one used within literature to explain FFO behaviors (Butler et al. 2022b). Other popular theoretical frameworks include the Theory of Planned Behavior (Ajzen 1991) and the Transtheoretical Model (Quartuch et al. 2021). The Transtheoretical Model (TTM) is used to understand the readiness of an individual to change their behavior, rather than identifying the factors influencing an individual's behavior (Quartuch et al. 2021). Therefore, the TTM is not used in my study.

The Theory of Planned Behavior (TPB), like the REB model, states that an individual's behavior is generated from their beliefs and the individual is most likely to

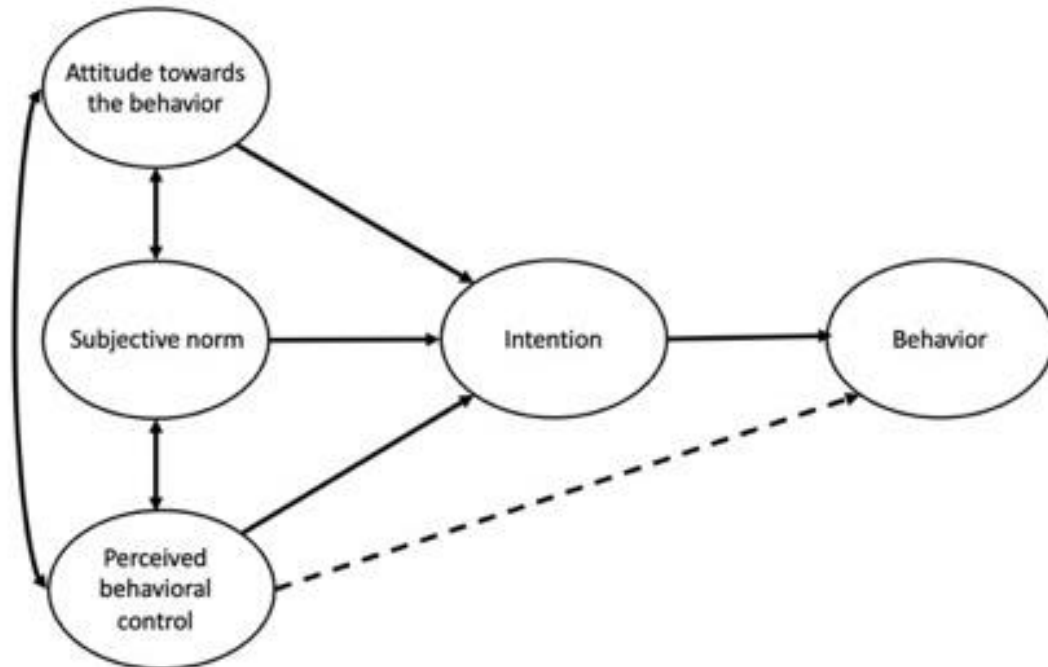


Figure 4. The framework of the Theory of Planned Behavior (Ajzen 1991).

carry out a behavior when they express some level of intent to perform said behavior (Ajzen 1991). Ajzen expresses that the intent of an individual is influenced by the individual's attitude towards the behavior, the subjective norm, and the social pressure to or not to perform a specific behavior, and the individual's perception of their behavioral control, defined as a person's "perception of the ease or difficulty of performing the behavior of interest" (**Figure 4**). This model has been used to explore the influencing variables of New England FFO responses to invasive forest insects (Holt et al. 2021). The use of an attitudinal variable related to the measured behavioral intention can have a higher correlation between the two, rather than an overarching environmental behavior as in the REB model. The correlations found between attitudes and behavioral intentions

ranged from 0.26 (a study on the intention to commit traffic violations) to 0.92 (a study on the intention of the individual to play 6 video games, correlation was the mean between subjects), with a mean of 0.54 (Ajzen 1991). With the REB model, which does not provide a direct connection between an individual's attitude towards carrying out the responsible environmental behavior, Hines et al. reported a correlation coefficient between an individual's pro-environmental attitude and their reported engagement of responsible environmental behaviors to be 0.347, with a standard error of 0.224 (Hines et al. 1987), and in the study revisiting the REB model and the psycho-social variables the coefficient was 0.42 and were able to attribute the difference to random fluctuation with their 95% confidence interval (Bamberg and Möser 2007).

Although the TPB model's attitudinal variables had an overall stronger correlation to an individual's intention to behave in a specific way, it wasn't the selected model for this study as the primary goal of this study is to measure FFOs' climate change attitudes and their influence on management practices rather than the influence of FFOs' attitudes towards the behaviors themselves. Making the REB model a more ideal model for this study to follow with an attitudinal variable measuring an FFO's overall feelings towards an environmental facet, in this case, climate change. The REB model was also selected for this study because it addresses the role an environmental attitude, the knowledge of an environmental issue and of the action strategies, and the situational factors influence the decision of an individual to carry out a responsible environmental behavior.

1.5 Climate Change Attitude Research

1.5.1 The American Public and Climate Change

The foundational goal of this research project is to begin measuring FFOs' attitudes towards climate change, and from this to understand the relationship between these attitudes towards climate change and specific management practices that help their forest either adapt to or mitigate the impacts of climate change (i.e., responsible environmental behaviors). To collect accurate data on FFO attitudes, I explored past attitudinal research regarding climate change to provide examples of attitude-based questions, guide the question generation process, and give potential insight of attitudinal categories for climate change beliefs.

Since 2008, Yale and George Mason University have conducted studies measuring the global warming/climate change attitudes of the American adult population and has formulated a spectrum of attitudes with six segments, known as 'Global Warming's Six Americas' (Leiserowitz et al. 2009, Maibach et al. 2009). These studies are survey-based and work to measure multiple variables surrounding and influencing the different climate change responses such as beliefs, attitudes, behaviors, and underlying barriers to action. The established segments include: *Alarmed*, *Concerned*, *Cautious*, *Disengaged*, *Doubtful*, and *Dismissive* and range from the American adults who are "fully convinced of the reality and seriousness of climate change and already are taking [...] action to address it" to those who "are very sure it [climate change] is not happening and are actively involved as opponents of a national effort to reduce greenhouse gas emissions" (Maibach et al. 2009). These segments were established using Latent Class Analysis with 36 variables to represent the construct categories: global warming beliefs, issue involvement, policy

preferences, and behaviors. In the 2009 study, 18% of the American public were in the *Alarmed* segment and 7% in the *Dismissive*, the largest segment was the *Concerned* with 33% of the American public (Maibach et al. 2009). In the newest Six Americas iteration, conducted in December 2022, 26% of Americans fall into the *Alarmed* segment, 27% in the *Concerned*, 17% in the *Cautious*, 7% in the *Disengaged*, 11% in the *Doubtful*, and 11% in the *Dismissive* (Leiserowitz et al. 2023).

When comparing the first Six Americas survey to the most recent, there has been a shift towards the *Alarmed* segment on the spectrum of response types – indicating that more of the American public have become increasingly more aware of climate change, its impacts, and have taken action(s) to address it. This research is particularly insightful, as the US.FFO population is a facet of the American adult’s population of the Six Americas study. Because of this, the response categories and attitudes towards climate change should follow a similar trend and if the spreads are significantly statistically different then it can be assumed that U.S. FFOs statistically differ from the general American population.

Although the Six America research does not explicitly follow the REB Model, as the study sought to define attitudinal segments, they do measure variables that overlap with the REB model. In addition to establishing the attitudinal segments, the Six Americas study measured personal actions and intentions surrounding climate responsible behaviors such as contacting elected officials to urge action on global warming, improving energy efficiency in homes, intention to engage in consumer activism, etc. with respect to the segment the individual belongs to. The barriers to and the perceived effectiveness of these behaviors as well as the perceived knowledge of global warming

were also measured. These variables correspond with the responsible environmental behavior, the situational factors, the locus of control, and the knowledge variables of the REB model.

1.5.2 U.S. Private Forest Owners and Climate Change

While there has not been a study to measure the climate change attitudes and their influence on the management practices of FFOs across the U.S., there has been some regional and state focused research which provides initial insight to climate belief distributions and patterns of U.S. FFOs. These studies have included a mailed survey of Non-Industrial Private Forest (NIPF) owners in 11 southern states (Khanal et al. 2016b), semi-structured interviews of NIPF owners in eastern Oregon (Boag et al. 2018), focus-group discussion of FFOs in the Pacific Northwest (Grotta et al. 2013), and needs assessments of family forest landowners in Alaska, Idaho, and Washington also through focus-group discussions (Creighton et al. 2011, Kantor et al. 2011, Schnepf et al. 2011).

The study conducted by Khanal et al. (2016) focused on southern NIPF landowners in Alabama, Arkansas, East Oklahoma, East Texas, Georgia, Florida, Louisiana, Mississippi, North Carolina, South Carolina, and Virginia who owned forestland in counties which had loblolly/shortleaf or longleaf/slash pine forest groups. A NIPF landowners are private forestland owners who do not own or operate a primary wood processing facility (Harrison et al. 2002). Family forest ownerships are then a subset of NIPF ownerships. This study did not solely focus on climate change attitudes but rather paired together southern NIPF landowner beliefs towards climate change and carbon sequestration to establish three clusters of belief: *Skeptical*, *Neutral*, and *Supportive*.

These clusters were determined using the landowners' responses to seven Likert scale ratings of climate change and carbon sequestration statements, and found 47% of southern landowners were *Neutral*, 35% *Supportive*, and 18% *Skeptical*. In comparing the levels of education among the landowners, it was indicated landowners in the *Supportive* cluster had relatively higher levels of education in comparison to landowners in the *Skeptic* and *Neutral* clusters. In this study, gender did not differ significantly between the clusters (Khanal et al. 2016b).

Khanal et al. posit that the different beliefs of NIPF landowners have towards climate change are influenced by the landowners' other beliefs, their experiences or observations related to climate change impacts, and the beliefs of other individuals or organizations the landowners receive forestry advice. The researchers also express the impact of the sensitivity of climate change in politics also plays a role in the splitting of climate change beliefs among NIPF landowners (Khanal et al. 2016b).

The spread of climate change beliefs can be seen regionally, potentially due to the regional differences of the influences of the beliefs as pointed out by Khanal et al. (2016). Through semi-structured interviews of 50 NIPF owners in eastern Oregon, 19 landowners) believed that climate change was occurring due to natural cycles, 11 owners believed climate change was due solely to human activities, and 9 owners believed it was a combination of the two causes (Boag et al. 2018). Although Khanal et al. (2016) and Boag et al. (2018) cannot be compared directly, as the two studies sought to answer different research questions, the climate change beliefs among NIPF landowners begins to diverge regionally.

Again, Boag et al. (2018) primarily sought to address the barriers to climate change adaptive land management NIPF landowners and found that intentional adaptation to climate change was of low salience among the eastern Oregon NIPF owners but had found that a large majority were utilizing incidentally adaptive actions. The incidentally climate adaptive forest practices included thinning and fuels management while meeting other management goals, such as “timber growth and yield, wildlife habitat, and wildfire risk mitigation” (Boag et al. 2018). It was found that forest owners who performed or considered performing intentional climate adaptation actions (or responsible environmental behavior if working through the REB model) were more likely to believe that human caused climate change was occurring. These intentional climate adaptation actions included planting tree species that will be better adapted to a future climate, managing forest density and composition outside of the historic variation range, cutting water-stressed trees, thinning stands, creating defensible spacing, underbrush clearing, and prescribed burnings to return historic burn patterns. The perception of local environmental changes (i.e., reduced snowpack) was not associated with the NIPF owner’s adaptive actions or intentions, however the barriers to adaptation action were found to be needs for light logging equipment, more grant/cost-share funding, weak forest product markets (no financial incentive for active management), ecological education, labor, and time. All these barriers can be integrated into some factor of the REB model, many of these barriers were the financial needs of the forest owners (equipment, grant/cost-share, and forest product markets) making finances a major input to the *Situational Factors*, in addition to time needed. The need for more, in-depth education of the local ecosystems would be a facet of the Knowledge factors and the need

for skilled forestry labor plays a major role in the *Action Skills* factor. Boag et al.'s study shows while climate belief has a role in a NIPF owner's willingness to intentionally carry out climate adaptive management practices there are other factors that influence their willingness and some factors, specifically management goals, can influence forest owners to carry out adaptive practices despite having a more skeptical climate belief.

Grotta et al.'s (2013) study of FFOs in the Pacific Northwest also found the diverse spread of climate belief and knowledge across FFOs. Through 24 focus groups of FFO's owning land in Alaska, Idaho, Oregon, and Washington, participants were asked to discuss where they got information about climate change, their validity of climate science, how climate change may or may not impact their forest, and if they are managing their forests any differently in anticipation of climate change to ensure that new research and forest extension efforts surrounding climate change is relevant to participants. It was found that participants had a lack of trust in the validity of climate information from media, due to a perception of climate change as being highly politicized. Although the participants found that the scientific community was more credible than the media, there was still concern with scientific bias, especially in climate models with some participants believing climate models can be manipulated to produced desired results. The participants placed the most trust in the climate information they received from their personal connections who were highly educated or worked in the environmental sciences. Specifically in Alaska, the participants, both Native and non-Native, "cited longtime residents and specifically Native elders as knowledgeable sources" (Grotta et al. 2013). Participants from all four states were unsure about the future climate impacts will affect their forests, while some were able to identify increased

fire, invasive species, increased insect or disease, and failure of reforestation they were uncertain about the magnitude of these impacts. Other landowners believed the climate change impacts would have positive results, of increased tree growth due to increased levels of carbon dioxide, longer growing seasons, and increased precipitation.

Similar to Boag et al.'s research of eastern Oregon NIPF owners, only a few of the FFOs in the focus groups reported any changes or adapting management practices in anticipation of climate change. In general, the participants' goals for their forest management were to provide wildlife habitat, increase biodiversity, improve forest health, and seek financial gain. When asked about changing management practices, many participants reported that they lacked the necessary knowledge but managing for forest resilience, species diversity, and reducing stand density were all understandable (Grotta et al. 2013).

With these studies, the climate change beliefs and potential attitudes of U.S. FFOs start to become clear as well as their relation to the FFOs' climate centered management practices (responsible environmental behaviors). The pattern that has begun to become apparent is that despite climate belief varying across FFOs and NIPF owners, they may be carrying out climate adaptive forest management practices to meet other management goals (Boag et al. 2018, Grotta et al. 2013). Other factors influencing the FFOs management behaviors and intentions to behave are also addressed, namely the FFO's financial needs, their knowledge of climate change and adaptive management practices, and their own ability to carry out the management practice(s) in question (Boag et al. 2018). To help generate a more encompassing foundation to U.S. FFO climate change

beliefs, attitudes, and management practices, looking at these factors in U.S. foresters and FFOs/NIPF owners outside of the U.S. will be beneficial.

1.5.3 U.S. Forest Professionals and Climate Change

In addition to smaller-scaled FFO climate attitude research, understanding the climate change attitudes and beliefs of forest professional in the U.S. can strengthen the foundational understanding of climate attitudes surrounding U.S. FFOs. A forester, forestry or natural resource professional would be an individual who received an academic education, or equivalent experience, surrounding forests and their resources. Being a forest professional does not inherently mean that the individual is also a family forest owner and most family forest owners have not received the education to be a forestry professional. However, the attitudes toward climate change of forest professionals may be helpful indicators of the patterns between attitudes towards climate change and the demographics of the population. Forest professionals and FFOs share a higher exposure to forests, and a knowledge of forest ecosystems and management practices than the general public. In addition, foresters act as a primary source of forestry, silvicultural, and ecological data for FFOs (Butler et al. 2021).

In an online survey, Morris et al. (2016) sought to measure the climate change beliefs of forestry professionals in the Southeastern U.S. **Figure 5** highlights the sample area of this study and the distribution of nonfederal forest ownership shaded in green using data from Wear and Greis (2013). Of the southern foresters surveyed, 61% responded with a belief that climate change was occurring in some capacity and 33% indicated a belief that climate change was not occurring, and further specified the beliefs

by pairing the climate belief with the individual's belief of the cause of climate change (naturally caused, human caused, equal human and natural, or uncertain). It was found that political ideology, education level, employer, state of residence, gender, and years of forestry experience were statistically significant factors associated with climate change acceptance. Liberal and moderate foresters were found to be more likely to accept climate change than their conservative counterparts. Foresters with stronger ties to academia, either having a PhD or academic employers, were more likely to accept climate change than those with a master's degree or lower and foresters not in academic appointments. It was also found that female foresters and foresters with less forestry experience were more accepting than male and more experienced foresters. Morris et al. also found that climate change acceptance predicted the forester's likelihood to see the impacts of climate change, connect and feel concerned about climate change's impact on forestry, and agree that different management strategies are needed to adapt to climate change which also correlated with the forester's perceived need to utilize adaptive management. The ability for a forester to see how climate change impacts the environment and connect those impacts to the forests can be attached to the variable *Knowledge of the Issue* from the REB model (Hines et al. 1987), the agreement with different management strategies to the *Knowledge of the Action Strategies* and the perceived need to utilize adaptive management to both the *Personal Responsibility* and *Locus of Control* variables.

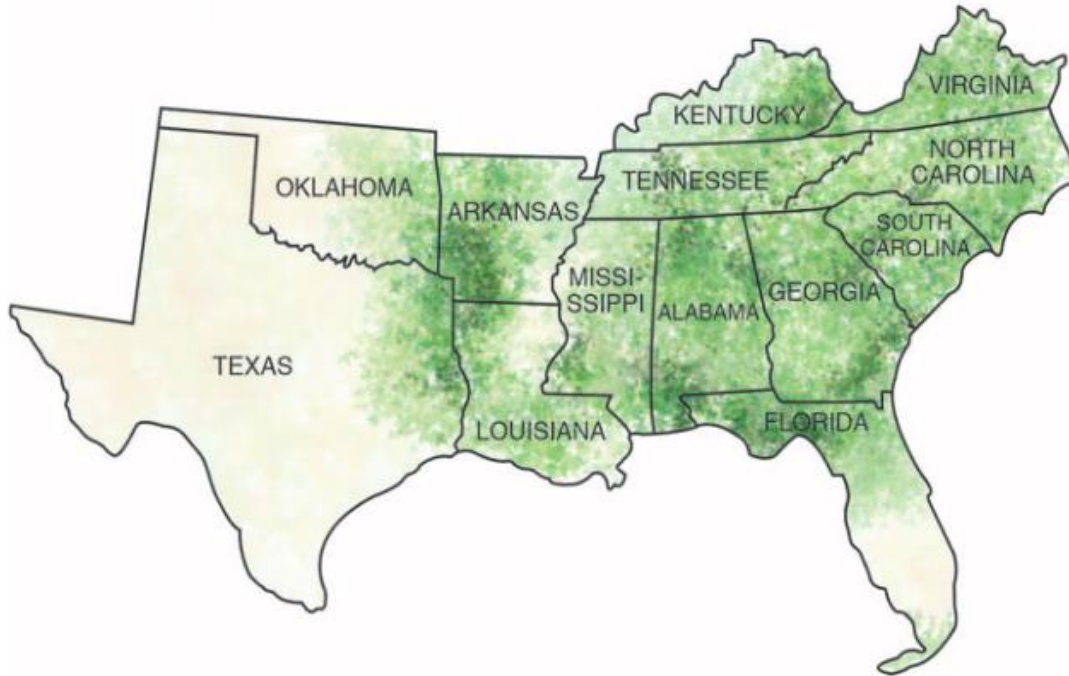


Figure 5. Study area of Morris et al. (2016) with nonfederal forest ownership shaded in green, created with data from Wear and Greis (2013).

In a similar online survey, the perceptions of climate change were measured among members of the New York Society of American Foresters (NYSAF) (Labriole and Luzadis 2011). This survey sought to measure both the perceptions members of NYSAF have towards climate change globally and in New York, as well as measured the member’s climate change knowledge, perception of social norms, general environmental attitudes, and demographic data. This study followed the framework of the Theory of Planned Behavior (**Figure 4**; Ajzen 1991). It was found that 68% of respondents were either completely or mostly convinced that climate change was happening *generally* and 30% were not convinced climate change was occurring, a similar finding among Southern forestry professionals (Morris et al. 2016). Of those 68% of respondents who believed climate change was occurring, 76% felt strongly and 23% felt moderately strong that climate change was occurring *within NY state*. The separation of local versus global

climate change attitudes is an important factor in the forester's perception of their role in reducing climate change and its impacts, if they believe that their actions will make a difference feeds into the *Locus of Control* and *Personal Responsibility* factors of the REB model. Lanriole and Luzadis also found that the employers of NYSAF members, their years of forestry service, and political views were statistically significant variables to the member's climate change belief. Again, finding that members employed in an academic setting, those with 10 years or less of experience, and identified liberal and moderate foresters were more likely to believe climate change was occurring. It was also found that while a major percentage of the NYSAF members were completely or mostly convinced that climate change was occurring, less than a half of the same members felt that other foresters would also believe that climate change is occurring. This perception can also alter the forester's intention to utilize forestry practices that mitigate climate change impacts. The misconception may make the foresters less likely to perform these 'responsible environmental behaviors' as their locus of control may shift from internal to external and their personal responsibility may decrease as they may think their actions would be inadequate if other foresters are not doing the same. The authors address that this finding could be due to the lack of communication between foresters or the perception that those in the forestry community leans more conservative than they actually do (Labriole and Luzadis 2011).

The common demographic factors of age, gender, political affiliation, and education level and their relationship to climate change attitudes have also been noted in Six America studies. Finding a higher proportion of American individuals in the *Alarmed*

segment identifying as liberal and Democrat, are more educated than the national average, and tend to be younger and female (Leiserowitz et al. 2021).

These studies help to begin filling the gaps in the foundation of this research project from the existing research on climate change and FFOs by specifically measuring climate change beliefs, attitudes, and the factors that influence those beliefs. Within U.S. foresters, Southeastern extension workers, and the American public climate change believers tend to be younger, female, politically liberal/Democratic, and have higher levels of education (Labriole and Luzadis 2011, Leiserowitz et al. 2021, Morris et al. 2016).

1.5.4 Nordic Private Forest Owners and Climate Change

Exploring research conducted outside of the U.S. that sought to measure FFO climate change belief and its influence on FFOs' management practices in any capacity can provide further confirmation of these relationships and spread of climate beliefs. A majority of FFO, NIPF owner, and/or private forest owner research outside of the U.S. has been conducted in Europe and more specifically in the Nordic countries, which will be the focus of this section.

In eastern Finland, Laakkonen et al. (2018) performed 'forest walk' interviews with 20 FFOs within the forest the interviewee owned. This study sought to understand (1) the role climate change has in the FFO's perception of change in their forest, (2) the FFO's concerns of climate change impacting their forestland, and (3) if FFOs have adapted their management practices with climate change in mind and how the level of concern about climate change impacting their forest changes their willingness to adapt.

Similar to the study of NYSAF members (Labriole and Luzadis 2011), the Theory of Planned Behavior is the theoretical framework, but Laakkonen et al. also includes the tripartite model of attitudes. The tripartite model of attitudes places emphasis on the cognitive, affective, and behavioral components of an individual to form their attitude (Rosenberg and Hovland 1960). These components are addressed in the previously mentioned goals of this study: Question (1) addresses the cognitive element, Question (2) address the affective, and Question (3) address the behavioral. The final combined theoretical framework is shown in **Figure 6**.

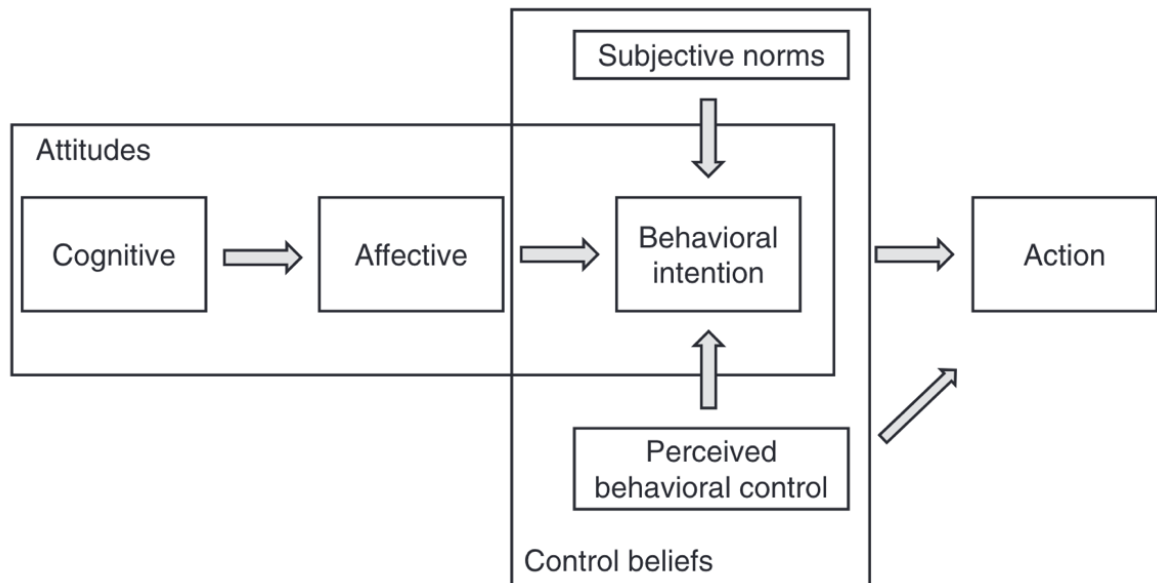


Figure 6. Theoretical framework for Laakkonen et al.’s (2018) study of Finnish family forest owners’ attitudes and behaviors towards climate change.

The forest-walk interviews were conducted in separate phases, in which the forest owner is asked to describe the changes they have noticed during their time of ownership or the time they have observed the forest’s development. The interviewees were then asked to take the interviewer to the 2 spots they had noticed changes or were planning to alter their forest management practices according to the changes they perceived. These

phases were used to create a cognitive map for each forest owner, each map was created with the different changes the forest owner perceived and these changes were then grouped by the forest owner. The interviewer, up to this point of the interview, had not mentioned the term climate change, unless the forest owner had mentioned it or closely mentioned it and then the interview was steered towards the topic of climate change. The interviewer then shared Finnish research surrounding climate change, its potential impacts on forests, and how forests can adapt to those changes. In this phase, the forest owner was then asked to share their opinion on the research and climate change itself.

The results of the interviews are summarized on a plot between the forest owner's strength of belief toward climate change (x-axis) and strength of belief on their behavioral control (y-axis), shown in **Figure 7**. During the cognitive mapping phases of the interviews, five of the forest owners had mentioned a change in their forest that directly related to climate change. Of these five owners, three had considered climate change a threat and the rest were either neutral towards climate change or pointed out the benefits of some impacts (longer summers, similar to the FFOs in the Pacific Northwest; Grotta et al. 2013). Overall, half of the FFOs interviewed had brought up the issue of climate change without prompting but indicated they did not have strong intentions to change their management practices due to climate change. Laakkonen et al. (2018) mentioned other limiting factors towards the forest owners' behavioral intentions towards climate change, whether it be that the forest owners considered themselves unable to affect change, unsure of how to manage their forests in a way to make a meaningful difference, or that their age limited their ability to carry out the necessary action. Although this study did not use the REB model as their framework, these factors

correlate with the *Locus of Control* (the owners considering themselves not able to affect change), *Knowledge of Action Strategies* (uncertainty of how to manage their forests), and *Action Skills* (limitations due to age) variables.

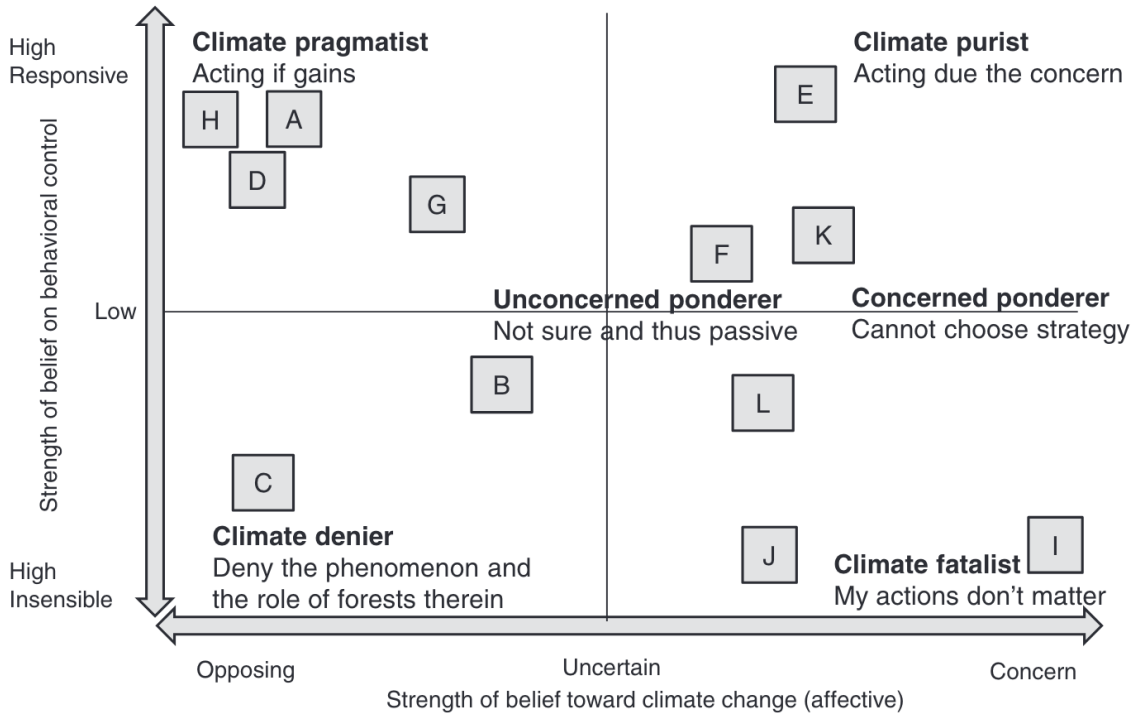


Figure 7. Results of Laakkonen et al.’s (2018) study with direct quotations from the interviews indicated by a boxed letter.

Another Finnish study sought to understand the factors that influenced a NIPF owner’s willingness to carry out forest management practices surrounding carbon sequestration, climate change adaptation, and conservation of biodiversity (Husa and Kosenius 2021). To meet this goal, the researchers utilized a systematic literature review to determine which factors affect the NIPF owner’s forest management decision and a survey to assess the willingness of the respondents to adopt thirteen management practices that “contribute to climate change mitigation, adaptation to climate change, or biodiversity” (Husa and Kosenius 2021).

In the literature review, Husa and Kosenius identified forest owner demographics, the forest characteristics, past practices, and owner motivations and objectives as factors affecting the acceptance of forest management practices. They also found that the NIPF owners' perceptions of the quality of national forest management impacted the owner's forest practices – hinting at the *Locus of Control* and *Personal Responsibility* variables of the REB model (Hines et al. 1987). The survey portion of Husa and Kosenius' study found that of the 405 Finnish NIPF owners who responded on average, were willing to adopt one of the thirteen listed management practices and the willingness to accept each individual practice shown in **Figure 8**.

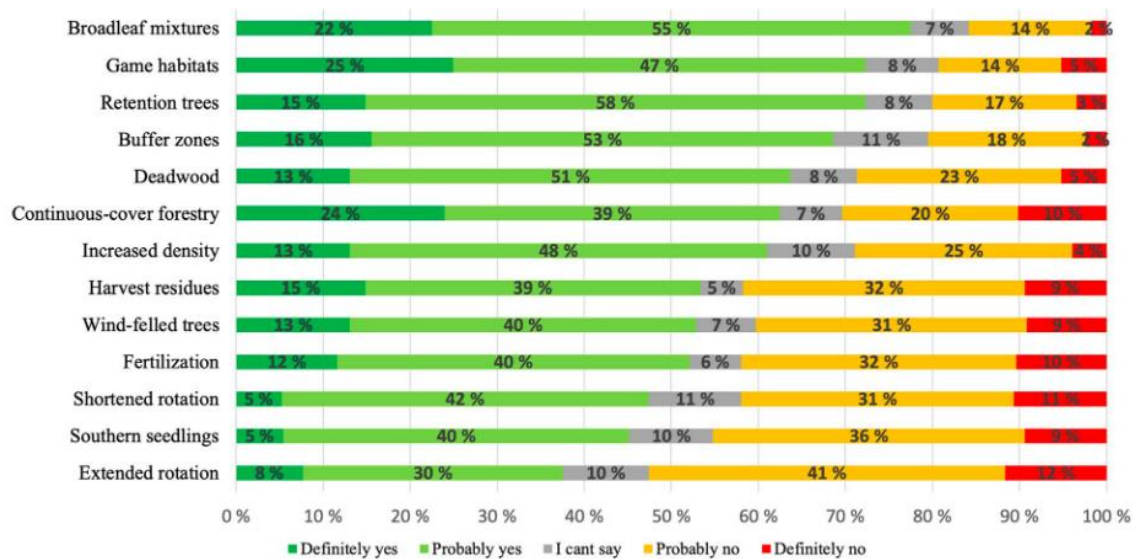


Figure 8. Finnish NIPF owners' willingness to adopt specific forest management practices (Husa and Kosenius 2021).

The patterns found between the factors identified in the literature review portion of this study and the willingness to adopt a specific practice followed the same patterns between demographics and climate change belief identified before (Labriole and Luzadis 2011, Leiserowitz et al. 2021, Morris et al. 2016). These patterns included: older forest owners were less likely to adopt practices that increased the amount of deadwood, owners

with higher education tended to have a greater willingness to accept practices associated with deadwood, and owners with greater incomes were more likely to extend their rotation period. However, the overall acceptance of each practice varied within the Finnish NIPF owners due to the fact that the management intentions were guided largely by the forest owner's motivations (Husa and Kosenius 2021). Although this study lacks the attitudinal component between forest owners and climate change, it does provide insight to other factors that influence behavior or the forest owner's willingness to adopt a management practice – their management goals. The significance of a forest owner's management goals to the practices they utilize on their forestland was also indicated by the focus group discussions of FFOs in the Pacific northwest (Grotta et al. 2013).

1.6 Conclusions

Based on past research, the patterns between forest owner's/professional's age, education level, and income are demographic factors have been shown to influence both the individual's attitudes and belief towards climate change as well as their willingness to adopt alternative management practices that coincide with climate change mitigation and adaption (Labriole and Luzadis 2011, Morris et al. 2016, Husa and Kosenius 2021, Leiserowitz et al. 2021). Other crucial factors include the relationship between the forest owner's motivations and objectives for their forest into their decisions for the forest practices they use (Boag et al. 2018, Grotta et al. 2013), which are both shown to be impacted by the owner's attitudes by the REB and TBP models (Ajzen 1991, Hines et al. 1987). With the understanding that these factors are associated with management decisions, creating a survey to measure these variables along with U.S. FFOs' attitudes

towards climate change can reveal and define the patterns to make climate change mitigation and adaption practices more accessible to and accepted by U.S. FFOs. Thus, allowing U.S. forests to persevere through climate change impacts and strengthening their ability to combat and reduce global climate change.

CHAPTER 2
CLIMATE CHANGE ATTITUDES OF UNITED STATES FAMILY FOREST
OWNERS AND THEIR INFLUENCE ON FOREST MANAGEMENT
PRACTICES

2.1 Introduction

2.1.1 Climate Change and Forests

Climate change impacts continue to increase in both frequency and intensity due to the release of anthropogenic greenhouse gases and aerosols, resulting in major negative impacts on the built and natural environments (Arias et al. 2021, Masson-Delmotte et al. 2021). With this, efforts to combat climate change in the political, scientific, energy, and natural resource management spheres need to utilize both green technologies and protect Earth's natural carbon sequestration processes to mitigate these impacts. Climate-centered forestry management and stewardship is one of the most effective ways to protect forests' natural carbon sequestration process, through adaptation practices to protect forests as a whole from climate impacts, practices that ensure the longevity of forests, and by establishing more forestland (Bonan 2008). Carbon sequestration in forests is the process by which trees capture carbon dioxide through photosynthesis and store the carbon for their growth and in other carbon pools: root systems, undergrowth, forests floors, soils, and dead trees. Therefore, actions to ensure the survival of forests will help result in greater success to capture anthropogenic carbon emissions and reduce climate change and its impacts.

2.1.2 Forests in United States

As mentioned in Chapter 1, these forests do not exist on their own, they are managed, monitored, or owned by eight different types of entities as classified by the United States Forest Service (USFS) (Sass et al. 2020). In this thesis, I will be describing the relationship between those who have a direct interaction and impact on forested areas as ‘ownership’ although ‘ownership’ doesn’t fully describe the ways in which humans, as a community or individuals, historically or currently interact with the forested land they live upon, especially within Native and Indigenous communities.

Of the 333 million ha of forestland in the United States, excluding interior Alaska, 110 million ha are owned by family forest owners (FFOs) (Butler et al. 2021, Perry et al. 2022) as shown in **Figure 2**. Family forest ownership is described as “a family, individual, trust, estate, or family partnerships that owns at least 1 acre of land with tree cover of at least 10 percent, and the land is not used for other purposes, such as lawn, that would impede natural processes” (Butler et al. 2021). FFOs can own from 1 acre to over 5000 acres of forestland and their management practices not only can impact their owned forestland, but the surrounding ecosystems as well. The management practices of FFOs are selected and carried out on the individual level, therefore there are no uniform practices.

Understanding the unique needs, motivations, attitudes, and forest types of FFOs helps forest conservation efforts to ensure the survival of 33% of U.S. forestland while also meeting the FFO’s goals and values surrounding their forests. To measure these goals and values, the Family Forest Research Center (FFRC), a joint venture between the U.S. Forest Service Northern Research Station and the University of Massachusetts

Amherst, implements an annual National Woodland Owner Survey (NWOS) to increase an understanding of U.S. FFOs, specifically asking the FFOs about their forest land, “their reasons for owning it, how they use it, if and how they manage it, [...] their concerns and issues related to their forests, their intentions for the future of their forests, and their demographics” (www.familyforestresearchcenter.org/). The FFRC uses the NWOS, to aid forest policy, management practices, and extension foresters to better aid U.S. FFOs while also conserving U.S. forests. In addition to the NWOS the FFRC conducts other research projects that cover a range of topics such as, sustainable management (Butler et al. 2022c), the influence of FFOs identifying as hunters on their forest management (Snyder et al. 2021), and FFO responses to invasive insects (Holt et al. 2021). By considering FFO needs and values when creating and promoting climate-centered forest practices, FFOs would be more encouraged to participate when they would not prior.

Again, I refer to climate-centered forestry practices as any active management practices which a forest owner takes that will increase their forestland’s ability to adapt to future climate change impacts, that will help keep the forestland from being developed, or ultimately preserve or improve the level of the forest’s natural ecosystem services (i.e., the amount of carbon sequestered). These practices are important as they allow both FFOs and their forests to prepare for climate change impacts, so the forestland is able to continue mitigating climate change via carbon sequestration.

While there has been some research conducted to understand the various aspects of U.S. FFO’s beliefs and management practices surrounding climate change (Creighton et al. 2011, Kantor et al. 2011, Schnepf et al. 2011, Grotta et al. 2013, Khanal et al. 2016a,

Boag et al. 2018), there has yet to be a comprehensive study of climate change attitudes of U.S. FFOs or one conducted across the different regions of the U.S. Understanding these climate change beliefs and attitudes of FFOs will help to promote climate-centered forest management that reflects the beliefs of the FFOs.

2.1.3 Theoretical Framework

To comprehend the complexity of the factors that drive an FFO to carry out a climate-centered management practice, I used the Responsible Environmental Behavior (REB) Model as the theoretical framework. The REB model was established to meet the goal of environmental educators to develop “environmentally responsible and active citizens” through a meta-analysis of environmental behavior studies to understand the variable(s) that have the highest influence to motivate individuals to take responsible environmental action (Hines et al. 1987). The meta-analysis comprised of studies that addressed recycling, petitioning, energy consumption, anti-littering, and financially contributing to a toxic waste fund as the responsible environmental behaviors of focus. The meta-analysis highlights an array of psycho-social and cognitive variables as predictors of an individual carrying out a responsible environmental behavior, and the full model is illustrated in **Figure 3**.

The psycho-social variables are seen on the far-left of the model in **Figure 3**, comprising of the *Attitudes*, *Locus of Control*, and *Personal Responsibility* factors. The *Attitudinal* variable consider “the individual’s feelings, pro or con, favorable or unfavorable, with regard to particular aspects of the environment” (Hines et al. 1987). *Locus of Control* indicates an individual’s perception of if they can bring about change

through their own behavior and the *Personal Responsibility* variable represents the individual's feelings of duty or obligation towards any facet of the environment. The *Intention* to enact a specific behavior is also included as a psycho-social variable in the REB model (Hines et al. 1987). The cognitive variables include the *Knowledge of Issues*, *Knowledge of Action Strategies*, and *Action Skills* which are seen in the center of **Figure 3**. When formulated together, the model suggests that an individual who believes their behavior(s) will bring about change, has a positive attitude towards the environment and the action, a sense of obligation, the knowledge of both the environmental issues and of different action strategies, and has the action skills to perform the REB will have a greater intention to perform the behavior. However, the intention may be superseded by *Situational Factors*, which can both prevent or encourage an individual to carry out an REB and are able to act in opposition or strengthen the already present intention.

Within FFO behavior research, the REB model has not been used to measure behavior, but rather previous studies have used the Theory of Planned Behavior (TPB; (Ajzen 1991, Holt et al. 2021, Thompson and Hansen 2013) and the Transtheoretical Model on behavior change (Quartuch et al. 2021). TPB suggests that the intent of an individual is determined by the individual's attitude towards the behavior, the subjective norm, or the social pressure to or not to perform a specific behavior, and the individual's perception of their behavioral control. The decision to use the REB model rather than TPB was made because the attitudinal variable of focus in this study is the FFO's climate change attitude rather than the attitude towards climate-centered forest management practices, making the REB model's variable of an attitude toward the environment or environmental issue more useful.

2.1.4 Climate Change Attitudes

Yale and George Mason University have conducted global warming attitude research of the American public since 2008, and have been able to generate six attitudinal segments known as ‘Global Warnings Six Americas’ (Leiserowitz et al. 2009, Maibach et al. 2009). These ordered segments are the *Alarmed*, *Concerned*, *Cautious*, *Disengaged*, *Doubtful*, and *Dismissive* which range from American adults who are “fully convinced of the reality and seriousness of climate change and already are taking [...] action to address it” to those who “are very sure [climate change] is not happening and are actively involved as opponents of a national effort to reduce greenhouse gas emissions” respectively (Maibach et al. 2009). An explanation for each segment can be seen in **Table 1**.

Table 1. The six segments of American’s attitudes toward global warming (Maibach et al. 2009), with the term *global warming* replaced with *climate change* to reflect the terminology used in this study.

Six America’s Attitude Segment	Description
Alarmed	The most engaged in the issue of climate change; very convinced it is happening, it is human caused, and a serious and urgent threat. They are already making changes in their lives and are supportive of a more aggressive national response.
Concerned	Convinced that climate change is a serious issue, less involved and less likely to make personal changes than the <i>Alarmed</i> segment but do support a vigorous national response.
Cautious	Believe climate change is a problem but are less certain that it is happening compared to the <i>Alarmed</i> and <i>Concerned</i> segments. They don’t view climate change as a personal threat and don’t have a sense of urgency to deal with it.
Disengaged	Haven’t considered climate change at all, don’t know a lot about it, they are the most likely segment to say they could change their minds about climate change.
Doubtful	Evenly split among those who think climate change is happening, who think it isn’t, and who don’t know. Of those who believe climate change is occurring, believe that it is caused by natural changes, and it won’t harm humans for many decades if at all. They believe America is already doing enough as a response to climate change.
Dismissive	Believe climate change is not happening, isn’t a threat to humans or non-human nature, and strongly believe it is not a problem that needs a national response.

When first conducted, the American public had the highest percentage in the *Concerned* segment with 33%, 18% were in the *Alarmed* segment and 7% in the *Dismissive* (Maibach et al. 2009). In the most recent iteration of the Six Americas study, conducted in December 2022, the *Alarmed* segment consisted of 26% of the American public, 27% in the *Concerned*, 17% in the *Cautious*, 7% were *Disengaged*, 11% were *Doubtful*, and 11% in the *Dismissive* (Leiserowitz et al. 2023). This study shows that, in

2022, over half of the respondents are in the highest two believing categories reflecting a higher climate awareness and concern of the American public, this awareness may or may not be reflected amongst FFOs. To start to get a more accurate understanding of how U.S. FFOs might perceive climate change, I explored other studies that measured climate change beliefs and/or attitudes among those with more forestry experience than the American public, namely: U.S. FFOs by state and region, U.S. Forestry professionals, and private forest owners outside of the U.S.

2.1.4.1 Climate Change Attitudes of United States Private Forest Owners and Forest Professionals and International FFOs

Despite the lack of studies surrounding FFOs across the U.S., their climate change attitudes, and how their attitudes impact the management practices they use, there have been regional and state-level studies of private forest owners. Of these studies, many show a varying spread of climate change belief and concern among private forest owners within and across regions. Khanal et al. (2016) surveyed Non-Industrial Private Forest (NIPF) owners in the southern U.S. NIPF ownerships are private forestland ownerships that do not own or operate a primary wood processing facility, an umbrella term of which FFOs are included. This study measured NIPF owners' paired beliefs towards climate change and carbon sequestration, generating three clusters: *Skeptic*, *Neutral*, and *Supportive*, finding, 47% of the respondents were *Neutral*, 35% were *Supportive*, and 18% were *Skeptical* (Khanal et al. 2016a). A study consisting of 50 interviews of FFOs in eastern Oregon had 19 landowners who believed climate change was solely due to natural cycles, 11 who believed climate change was caused solely by human activities, 9 who

believed it is caused by a combination of the two, 6 who believed climate change is occurring but don't know why, and the final landowners either did not believe climate change was occurring or they didn't know (Boag et al. 2018). And in focus groups of FFOs in the Pacific Northwest, when asked about how future climate impacts would affect their forests there again was a variety of response, those who identified the negative impacts (fire, invasive species, and failure of reforestation), those who believed there would be positive impacts (longer growing seasons, increased tree growth from higher levels of carbon dioxide, and increased precipitation), and those who were uncertain.

Although the spread of beliefs varies across the regions, these studies did find a similarity across the private forest owners climate-centered management practices in which many owners were carrying out these practices unintentionally to meet other management goals in addition to the owners intentionally managing their forests for climate change (Boag et al. 2018, Grotta et al. 2013, Khanal et al. 2016a). Some of these other management goals include: timber growth and yield, wildlife habitat, and wildfire risk mitigation (Boag et al. 2018). Barriers to these climate resilience practices were also addressed, of which can be placed into the different variables of the REB model:

Situational Factors (Financial needs/concern; equipment, grant/cost-share, and forest product markets), *Knowledge of Issue* (need for education of local ecosystems), and *Action Skills* (need for skilled labor; (Boag et al. 2018).

Studies measuring climate change beliefs and perceptions of foresters and forest professionals in the U.S. show patterns between climate change acceptance with age, political ideology, education level, state of residence, gender, and years of forestry

experience (Labriole and Luzadis 2011, Morris et al. 2016). Particularly finding that of those who believe climate change is occurring are often younger, identified as liberal or moderate, had higher levels of education, identified as female, and had less years of forestry experience (Morris et al. 2016). The relationship between forest owner/forester demographics and their management goals with their climate change belief was also measured among FFOs and NIPF owners in Finland (Husa and Kosenius 2021, Laakkonen et al. 2018) and among American public (Leiserowitz et al. 2021).

2.1.5 Research Goals

From these studies, we can begin to understand the potential spread of climate change attitudes U.S. FFOs hold, what influences their attitudes, and how their attitudes influence the FFO's decision to use a climate-centered management practice. This leads to the major goals of my research, which are to:

1. Measure U.S. FFOs' attitudes towards climate change in Alabama, Oregon, and Wisconsin,
2. Determine the factors that influence those attitudes, and
3. Employ the REB model to understand how climate attitudes and other factors influence the FFO's intention to carry out three different climate-centered forest management practices.

The climate-centered management practices I am measuring for my third objective are (1) the FFO taking any action to keep their forested land a forest in the future (having conversations with their heirs, included keeping their forestland forested in their will, enrolling in a Current Use tax program, having a conservation easement, or another

action listed by the FFO), (2) the FFO increasing the tree species diversity on their land, and (3) the FFO increasing the tree age diversity on their land. The actions I selected to measure were all active management practices, as the framework of the REB Model was established surrounding individual's active choices to conduct a specific environmentally responsible behavior (Hines et al. 1987). From this, the climate-changed forest management practices I selected also needed to be applicable to FFOs and their forests across the U.S. and included both mitigation and adaptation practices. These decisions resulted in the management practices I listed previously.

2.1.6 Funding and Approval

My research was funded by the U.S. Forest Service and was approved by the UMass Institutional Review Board (IRB) of the American Association for Public Opinion Research (AAPOR) at both the interview and survey phases of my project.

2.2 Methods

2.2.1 Study area and Sampling

I conducted this study in three different states, each to represent the region of the U.S. they are a part of – Alabama representing the South, Oregon the West, and Wisconsin the North. These states were selected based on their amounts of family forestland and if the FFOs in the state had been recently or is frequently studied. I aimed to send out 1,000 surveys to each state, this was chosen to receive 333 surveys back from each state with an 33% response rate. I selected 1,000 respondents in order to have statistically reliable

group sizes in each attitude segment while also keeping the number of mailed out surveys to a feasible level.

The process to select which FFOs received surveys began with a simple random sampling of geospatial points in Alabama, Oregon, and Wisconsin. A total of 27,610 points were selected, 3,054 in Alabama, 21,645 in Oregon, and 2,911 in Wisconsin. These numbers were based on the percentage of simple random sample points being forested and family owned based on past iterations of this process. With these points, I categorized each plot of land as “Forested” or “Non-Forested,” removing any non-forested plots in my data and any forested plots with less than one acre of forested land.

From the forested points, mailing addresses were retrieved by a third-party organization. These addresses contained the names of the individuals, companies, organizations, or government bodies that owned the forestland as well as the best last known address of those owners. I cleaned the address information and removed any ownerships that were not indicative of family ownership such as federally protected land, national timber or logging industries, power companies, non-family-owned businesses, etc.

After this process a total of 2,703 FFOs were mailed surveys (1,000 in Alabama, 985 in Oregon, and 718 in Wisconsin), 124 were undeliverable, 6 were sent to a deceased recipient, and 45 did not have any forested land making the adjusted sample 2,528. Each landowner was randomly assigned a barcode id, so identifiable information was not collected on the survey itself.

2.2.2 Question Creation and Cognitive Interviews

The survey questions were created using past questions from the NWOS (Butler et al. 2021) and the Six Americas questionnaire (Maibach et al. 2009) to measure FFO demographics (age, education level, race, ethnicity, gender, annual income, and percent income from forestland), the characteristics of the property (size of property and size of forested land), and climate change attitudes (belief in existence, cause of climate change, if humans can reduce climate change, level of concern of climate change, likelihood of future impacts, and if the FFO has a role in addressing climate change through their forest management). For questions related to the different climate-centered management practices, the REB model guided the question creation process to measure if the FFO was performing the management practice, how important finances were to carry out the practice, how important their level of knowledge and abilities to carry it out, and if the FFO believed that performing each management practice would help reduce climate impacts and make their forests more resilient to climate impacts. The questions were pretested through interviews of Wisconsin FFOs and foresters. FFOs across the three sample states were attempted to be recruited, however only those in Wisconsin agreed to participate in the pretesting interviews. A total of two FFOs and four foresters were interviewed. Of the two FFOs, one was a single ownership while the other was a joint ownership type, making the total number of interviewees seven. From these interviews, I was able to gauge survey readability and question comprehension, and I modified the surveys to improve both based on the feedback of the interviewees. The final version of the survey can be seen in **Appendix 1**.

2.2.3 Mailing Process

The mailing process of the surveys follows the Tailored design method, which uses up to four contact points for each FFO to increase response rates (Dillman et al. 2014). In this process, each FFO is mailed a pre-survey postcard on Day 1, then on Day 7 the first survey packet is mailed, on Day 12 a follow-up postcard is sent out, and finally a second survey packet is sent on Day 28. Before the second survey is delivered, survey packets were pulled from being mailed if the FFO had returned a survey, either completing it or declining to, if the addressed FFO was deceased, if the address was undeliverable, or if the landowner did not own any forestland.

2.2.4 Data Collection

Each of the completed and returned surveys were digitally scanned. Information was captured using optical character/mark recognition and underwent verification to ensure the FFO's responses were recorded correctly and then compiled into a CSV file, again without any identifiable information of the responding FFOs.

2.2.5 Survey Returns

Of the 2,702 surveys delivered, there were 585 responses, 28 refusals, and 175 that were undeliverable, the landowners did not own forestland, or the listed FFO was deceased. This gives an overall cooperation rate of 23.1%. Survey response data by state can be seen in **Table 2**.

Table 2. Survey responses, refusals, un-deliverables, and cooperation rates by state. Undeliverable surveys were survey packets that got sent back because the address was incorrect or not viable. The number of surveys that were sent to landowners who did not own forested land or the addressed FFO was deceased was determined by the surveys being returned with either ‘No Wooded Land’ or ‘Deceased’ indicated on the packet. The cooperation rate is calculated by removing the number of undeliverable surveys, the number surveys sent to landowners without forested land, and the number of surveys sent to deceased FFOs from the total number of surveys delivered, the number of responded was then divided and then multiplied by 100.

State	Number Surveys Delivered	Number Responded	Number Refused	Number undeliverable, no wooded land, or deceased FFO	Cooperation rate
AL	1,000	138	5	58	14.6%
OR	984	237	14	75	26.1%
WI	718	210	9	42	31.1%

2.2.6 Data Analysis

FFOs were placed into Global Warming’s six Americas segments (Maibach et al. 2009), based on their responses to questions as outlined in **Figure 9**.

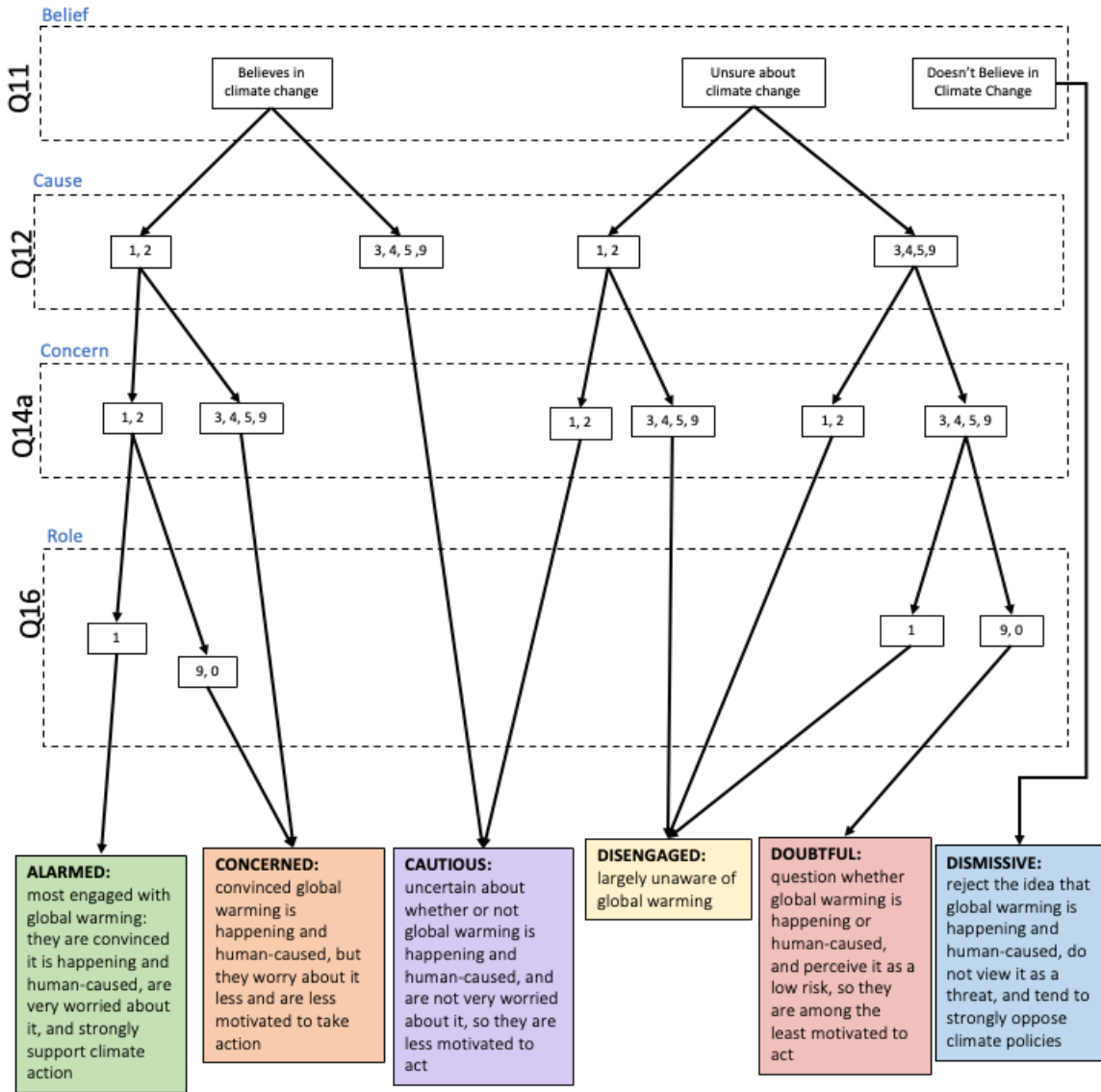


Figure 9. Heuristic flowchart of survey question and responses into the different segments from global warming’s six Americas (Maibach et al. 2009). The corresponding responses for each of the codes listed in this figure can be found in **Table 3**.

The questions used to determine which attitude segment an FFO would be placed in were:

Question 11: Do you think climate change is happening?

Question 12: What do you think causes climate change?

Question 14a: How worried are you *in general* about climate change in the next 50 years?

Question 16: Do you believe that you hold a role in addressing climate change through the management practices of your wooded land in [STATE]?

The response options, with the numbers as shown in **Figure 9**, can be seen in **Table 3**.

Table 3. Questions and responses from survey used to place each FFO into a climate change attitude segment.

Question	Response	Figure 9 Code
11. Do you think climate change is happening	Yes	Believes in climate change
	No*	Doesn't believe in climate change
	I don't know	Unsure about climate change
12. What do you think causes climate change?	Caused entirely by human activities	1
	Caused mostly by human activities	2
	Caused about equally by human activities and natural changes	3
	Caused mostly by natural changes in the environment	4
	Caused entirely by natural changes in the environment	5
	I don't know	9
14a. How worried are you <i>in general</i> about climate change in the next 50 years?	Extremely worried	1
	Very worried	2
	Somewhat worried	3
	A little worried	4
	Not at all worried	5
	I don't know	9
16. Do you believe that you hold a role in addressing climate change through the management practices of your wooded land in [STATE]?	Yes	1
	No	0
	I don't know	9

*No: FFOs who responded "No" to Question 11 followed a skip pattern in the survey and did not answer the other listed questions.

While the attitude segments and descriptors are from the Six Americas study, the questions used to establish the segments and the questions used in the shortened survey

(Chryst et al. 2018) were not the same used in this study. The questions selected to filter the respondents into the different segments were heuristically chosen to best represent the attributes listed in the segment definitions. In the segment descriptions (**Table 1**), climate change belief, the cause of climate change, the individual's concern towards climate change, and their willingness to take action are all addressed (Maibach et al. 2009); therefore, questions measuring the FFO's climate change belief, what they think causes climate change, their general concern about climate change, and if they believe they have a role in addressing climate change via their forest management were chosen. All the potential answer combinations are shown in the attitude flowchart (**Figure 9**) and each of these combinations lead to the attitude segment they best fit in. Each of the potential combinations of responses were placed into the Six America's attitude segment that best represented the combination. For example, an FFO who believes climate change is occurring and is mostly caused by human activity, they are worried about climate change and believe they hold a role in addressing climate change through their forest management would be placed into the *Alarmed* segment.

I used Pearson's Chi-squared, ANOVA, and Kruskal-Wallis analyses to determine significant relationships across the FFOs' climate change attitudes with demographic data, if they have seen any climate change impacts, and if they have carried out any of the climate-centered management practices. Pearson's chi-square analysis was also performed to determine relationships across the FFO's use of, or lack of, climate-centered practices against their climate change attitude segment. I also used an ordinal logistic regression model to understand the different factors that influence the FFO's climate change attitude. Finally, I ran 3 different binomial logistic regression models for

each of the different climate-centered management practice: keeping forestland forested in the foreseeable future, increasing tree species diversity, and increasing tree age diversity. Each of these practices will represent a *Responsible Environmental Behavior* for the REB model and the variables included in the model will reflect those in the REB model (Hines et al. 1987).

The questions/variables that align with factors in the REB model are shown in **Table 3**. However, due to the skip patterns included in the survey, the REB factors noted with an asterisk (*) were unable to be measured as only the FFOs who carried out the climate-centered practice answered those questions. Therefore, the asterisked variables are unable to predict if an FFO would carry out the specific practice. The variable used to represent the FFO's *Situational Factor* (Financial concern with carrying out a climate-centered management practice) is also unable to be directly measured, as again this question was within a skip pattern. However, the financial variable can be indirectly measured by using the objectives the FFO has for owning their forestland. If the FFO indicated that owning their land for timber or nontimber forest products was either *Very Important* or *Important*, then they were noted for having financial objectives and if they did not indicate importance for those objectives, they were noted for not having a financial objective. This financial objective is used in place of the financial importance for the situational factor(s).

Table 4. Factors from the REB Model (Hines et al. 1987) and the corresponding variables from the survey question(s).

REB Factor	Corresponding Survey Metric
Attitude	Six America’s Attitude Segment
Locus of Control	Belief that the management practice will help reduce or adapt to climate impacts
*Personal Responsibility	If the FFO believes they have a role in addressing climate change through the management of their forests
*Action Skills	The importance of the FFO’s ability to carry out the action(s) for each management practice
*Knowledge of Action Strategy	The importance of the FFO’s knowledge of how to implement each practice
Knowledge of Issue	If the FFO receives climate change information or advice
Situational Factors	The importance of finances when the FFO decides to carry out the action(s) for each management practice.
REB	The three climate-centered management practices

*Factors unable to be measured by survey questions due to skip patterns

^Factor unable to be measured due to skip patterns but a different question can be used in place

For a number of the variables I measured, I created either a binary variable associated with the original variable or reduced a Likert scale into a binary. For example, the FFOs were asked to indicate the highest level of education they had received and are provided the responses “Less than 12th grade”, “High school/GED”, “Some college”, “Associate degree”, “Bachelor’s degree”, and “Advanced Degree” from these options I created a binary variable to indicate if the FFO had received any college degree (1 if the FFO selected “Associate degree”, “Bachelor’s degree”, or “Advanced Degree”) or not (0 if the FFO selected “Less than 12th grade”, “High school/GED”, or “Some college”). I did a similar reduction for the variables measuring if the FFO had seen a specific climate change impact or not, where I created a new variable that would measure if the FFO had seen any climate change impact (1) or not (0). For reducing unipolar Likert scales into a binary, I combined “Extremely worried” and “Very worried” as “Worried” (= 1) and

“Somewhat worried”, “A little worried”, “Not at all worried”, and “I don’t know” as “Not worried” (= 0). For reducing bipolar Likert Scales, “Very important” and “Somewhat important” were combined into “Important” (1) and “Neither important or unimportant”, “Somewhat important”, and “Very unimportant” were combined into “Not important” (0).

2.2.7 Non-Response Analysis

Once the mailed surveys had stopped returning, non-response calls were conducted with the FFOs who had received a survey and not responded in any capacity. The FFOs who completed the survey, refused to complete the survey, indicated that the addressed FFO had deceased or that they did not own forestland, and surveys that were undeliverable were removed from the sample list of FFOs contacted. The numbers of FFOs were retrieved by a third-party organization. These FFOs were asked a selection of questions from the survey, of which were chosen because they highlighted a key attribute of my study or were factors that I believed would be different between the responding and non-responding FFOs. A power analysis showed that 40 FFOs would be needed for the non-response sample size, based on a 95% confidence interval, for 80% power, with 70% of the responding FFOs believing in climate change, and the need for 40% of the non-responding FFOs to believe climate change is occurring. However, only 5 of the contacted FFOs were willing to respond to the non-response calls. Therefore, I compared the spread of attitude beliefs between a random selection of 50 FFOs from those that first responded and 50 FFOs randomly selected from the last responding batch. Conducting a Pearson’s chi-square analysis between the first and last batches’ spread of FFOs in the

different attitude segments, there was no significant difference between the batches (p-value = 0.2424).

2.3 Results

2.3.1 Objective 1: Measuring Climate Change Beliefs and Attitudes of FFOs in Alabama, Oregon, and Wisconsin

Of the responding FFOs, 69% (340 FFOs) indicated they believe climate change is occurring 19% (96 FFOs) indicated they do not believe climate change is occurring, and 12% (57 FFOs) were uncertain climate change was occurring (**Figure 10a**). FFOs who did not select a response to the climate change belief questions were excluded from the overall percentages. Of the responding FFOs in Alabama, 53% (59 FFOs) believed climate change was occurring (**Figure 10B**), as well as 78% of FFOs in Oregon (155 FFOs) (**Figure 10C**), and 69% in Wisconsin (126 FFOs) (**Figure 10D**).

Figure 10a

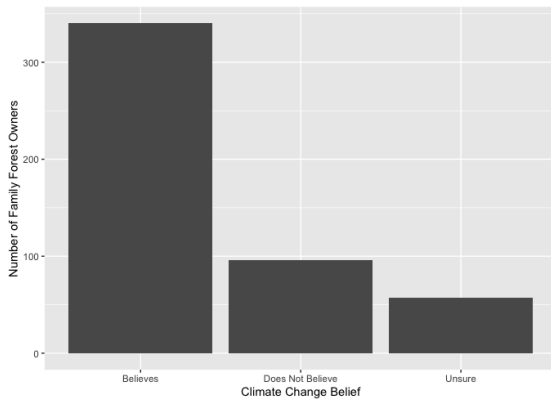


Figure 10b

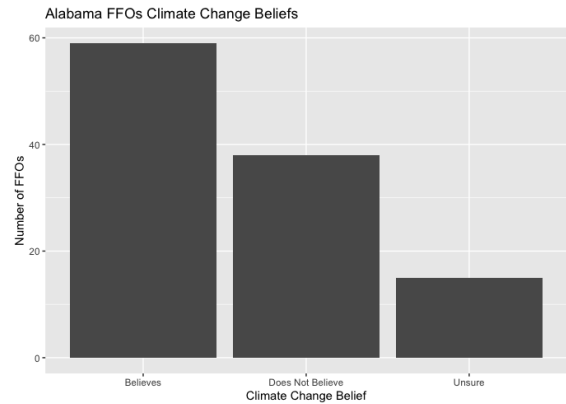


Figure 10c

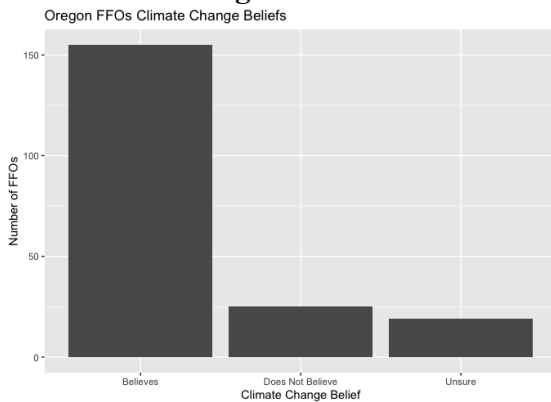


Figure 10d

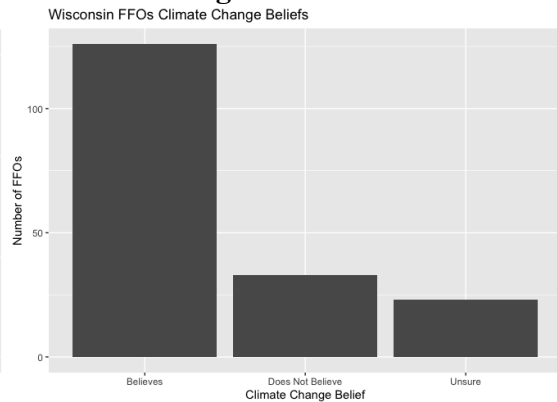


Figure 10: Bar charts of indicated climate change beliefs across all FFOs (A), FFOs owning forestland in Alabama (B), FFOs owning forestland in Oregon (C), and FFOs owning forestland in Wisconsin (D).

Using the heuristic flowchart (Figure 9), the distribution of climate change attitudes following the Six Americas segments (Maibach et al. 2009) revealed 16% of the FFOs fell into the *Alarmed* segment, 16% in the *Concerned*, 37% in the *Cautious*, 2% in the *Disengaged*, 9% in the *Doubtful*, and 20% in the *Dismissive* segment. Figure 11 shows this spread as well as indicates the state composition of each segment and the numbers of FFOs in each segment, separated by state, can be seen in Table 5.

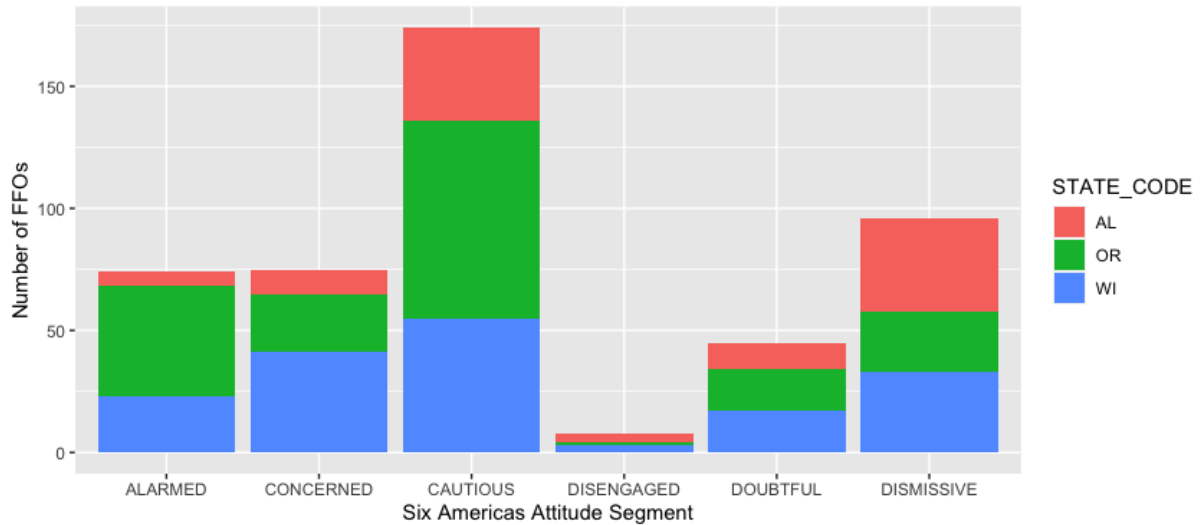


Figure 11. Stacked bar chart showing the distribution of FFOs into the six climate attitude segments of the Six Americas (Maibach et al. 2009). The corresponding state for each FFO is indicated by color: Red for Alabama, green for Oregon, and blue for Wisconsin. The total number of FFOs in each segment are 74 (16%) in *Alarmed*, 75 (16%) in *Concerned*, 174 (37%) in *Cautious*, 8 (2%) in *Disengaged*, 45 (9%) in *Doubtful*, and 96 (20%) in *Dismissive*.

2.3.2 Objective 2.1: Identifying factors that influence FFO climate change attitudes

The demographic factors I tested for significance with FFO climate change attitude segments were the FFO's age, gender, education level, annual income, income from forestland, and the state where the FFO owned their forestland in. These specific demographic factors were selected due to past research finding significance between the factors and an individual's climate change belief and/or attitude (Labriole and Luzadis 2011, Wojcik et al. 2014, Khanal et al. 2016a, Morris et al. 2016, Husa and Kosenius 2021, Leiserowitz et al. 2021). I also tested for significance between if the FFO had seen any of the listed climate change impacts (increased droughts, floods, ice storms, or wildfires, shorter and/or less intense winters, or an increase in wind damage, invasive plants, or unwanted insects or diseases) as a relationship between climate change

attitudes and seeing climate change impacts has been significant in past research among forest professionals in the southern U.S. (Morris et al. 2016).

There was no significant difference between the age of an FFO and the attitude segment they belong to (Kruskal-Wallis' chi-squared = 3.659, p-value = 0.5994) (**Figure 12**). There was also not a significant difference with the FFO's highest level of education and their attitude segment ($X^2 = 35.34$, p-value = 0.0823) (**Figure 13**) at the 0.05 level, nor was there a significant difference with the binary variable measuring whether the FFO received a college degree and their attitude segment ($X^2 = 5.740$, p-value = 0.3323). The FFO's gender and their climate change attitude was not significantly different either ($X^2 = 4.431$, p-value = 0.4891). Of the reported genders, 307 FFOs identified as *Male*, 106 identified as *Female*, and 59 did not respond to the question item.

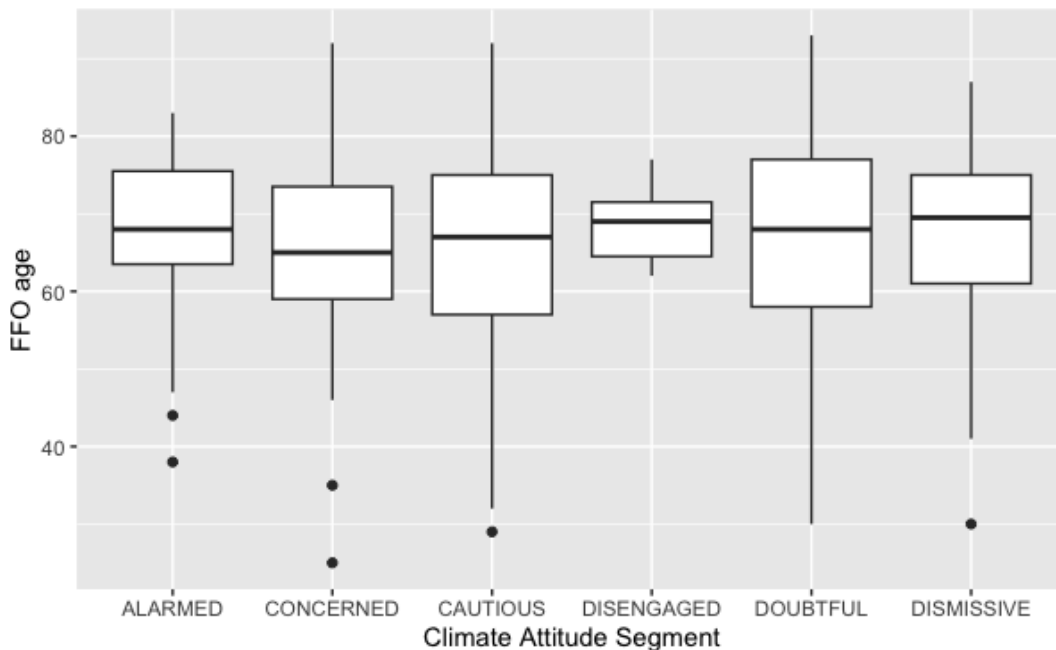


Figure 12. FFOs' reported ages across the six attitude segments.

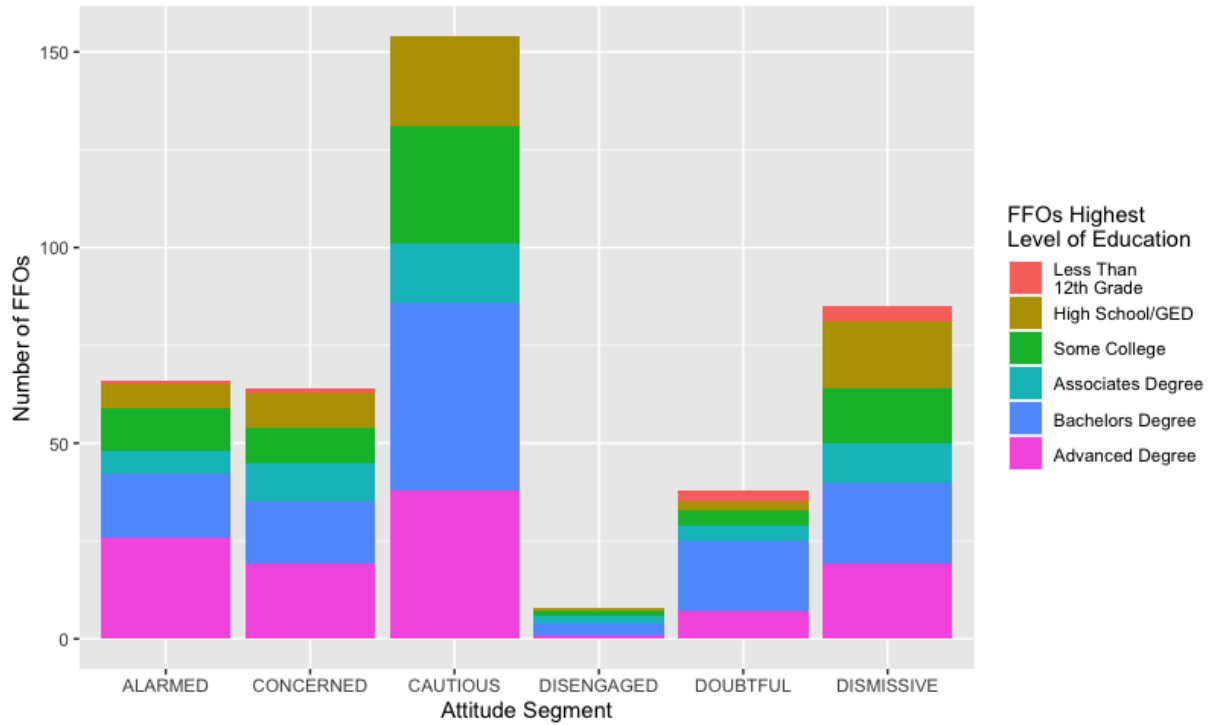


Figure 13. Bar chart depicting the distribution of FFOs' reported highest level of education within the six attitude segments.

The annual income of the FFO across the FFO's climate change attitude segment also was not significantly different ($X^2 = 23.782$, $p\text{-value} = 0.252$), the spread can be seen in **Figure 14**. When testing for the significance of the binary income variable (either under \$100,000 or \$100,000 and over), there was also no significant difference ($X^2 = 8.9832$, $p\text{-value} = 0.1097$).

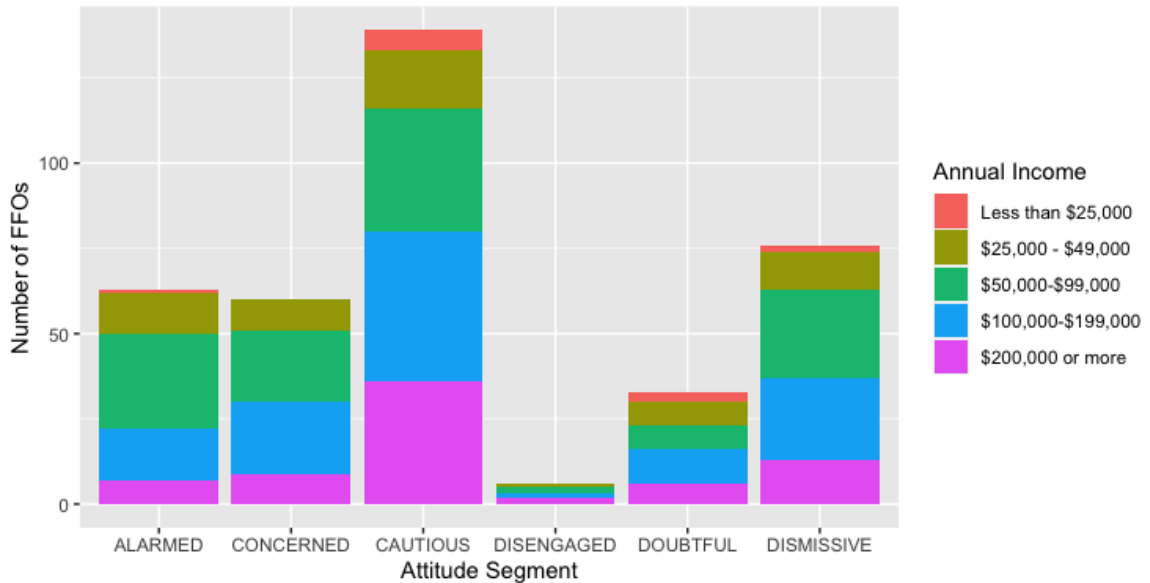


Figure 14. Bar chart depicting the distribution of FFOs’ reported annual income within the six attitude segments.

There was a significant difference across the FFO’s attitude segments and the state they owned their forestland in ($X^2 = 50.198$, $p\text{-value} < 0.001$), with FFOs in Alabama having lower percentages in the *Alarmed* and *Concerned* segments (8.1% of 74 FFOs and 13.3% of 75 FFOs, respectively) and higher percentages in the *Disengaged* and *Dismissive* segments (50% of 8 FFOs and 39.6% of 96 FFOs, respectively). FFOs in Oregon had the highest percentage in the *Alarmed* segment with 60.8% and FFOs in Wisconsin had the highest percentage in the *Concerned* segment making up 54.7% of the segment (**Figure 15**).

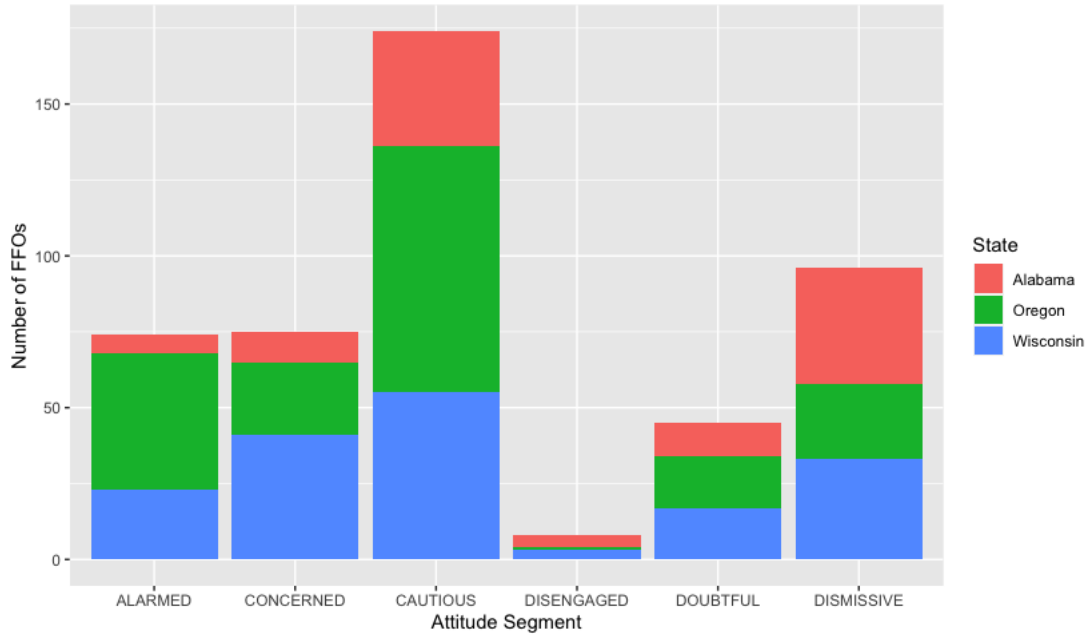


Figure 15. Bar chart of climate change attitude segments with FFOs’ state of ownership (Alabama, Oregon, or Wisconsin) indicated within each segment.

The amount of forestland owned by an FFO was significantly different in term of their attitude segment (ANOVA analysis: $F = 5.0866$, $p\text{-value} < 0.001$; Kruskal-Wallis rank sum test: Kruskal-Wallis chi-squared = 23.667, $p\text{-value} = < 0.001$). The boxplots of the log-transformed amount of acres of forestland across attitude segments (**Figure 16**) show the median amount acres of forestland owned by FFOs in the *Doubtful* and *Dismissive* segments were greater than those in the *Alarmed* and *Concerned* segments. There is also a significant difference between whether the FFO has seen any of the listed climate change impacts or not and the attitude segment they are in ($X^2 = 27.438$, $p\text{-value} = 4.686e-5$) (**Figure 17**).

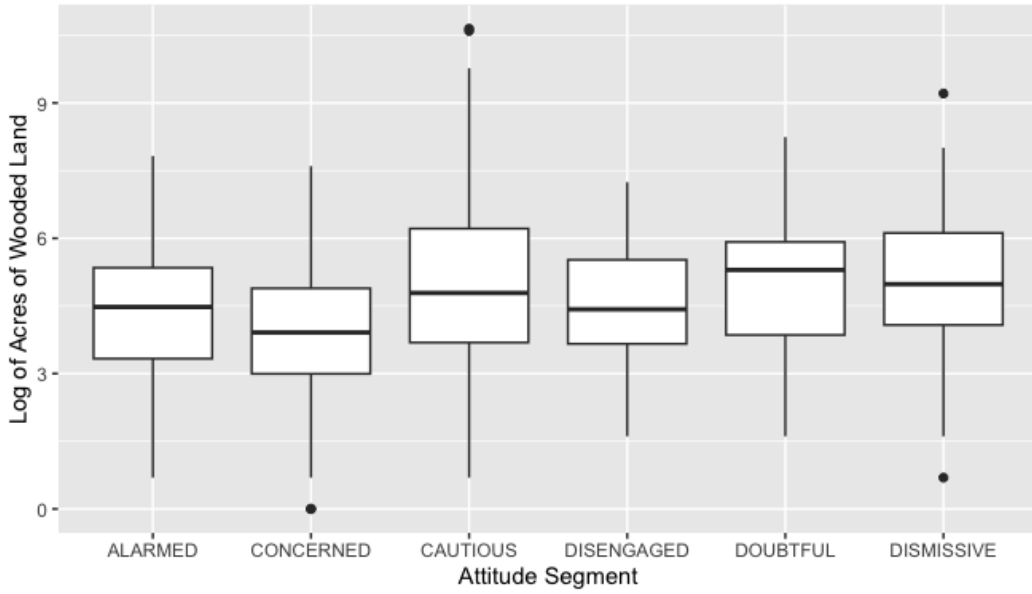


Figure 16. Boxplots depicting the log-transformed spread of the acres of wooded land owned by the FFOs across the six attitude segments.

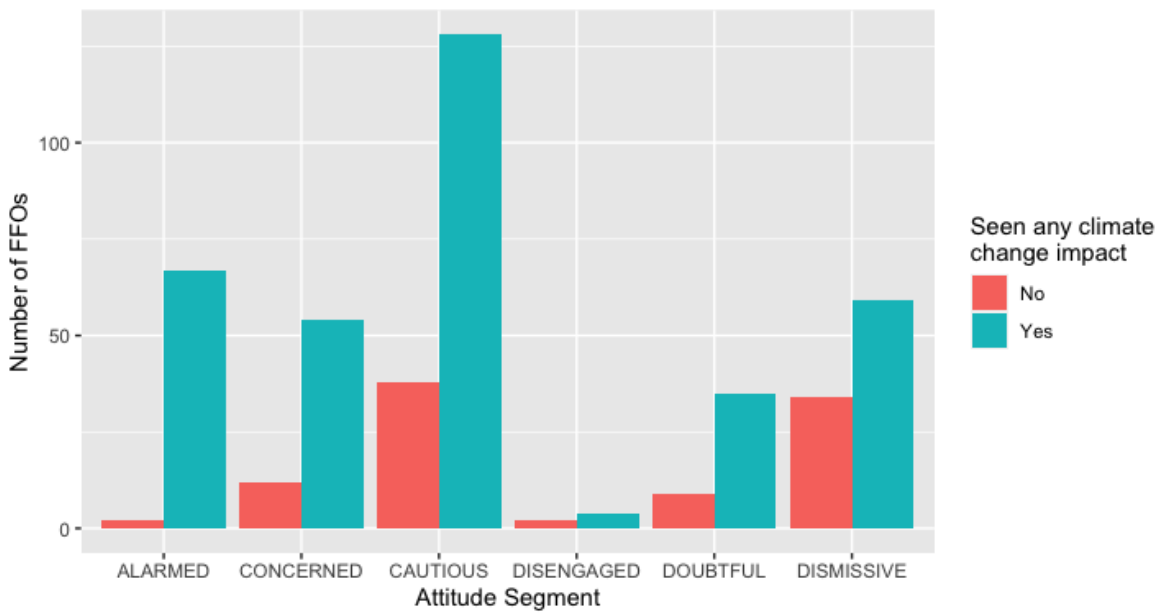


Figure 17. Bar chart of climate change attitude segments for FFOs' who have seen a climate change impact (blue) and those who have not (red).

2.3.2.1 Objective 2.2: Modeling Attitude Segments

Before running an ordinal logistic model for the factors that influence the FFO's attitude segment, I combined the *Disengaged* and *Doubtful* segments into a *Disengaged/Doubtful* segment due to the low number of FFOs in the two groups. I combined them so I could run a logistic model analysis, as the number of variables allowed in a logistic model is dependent on the number of observations in the smallest group. Specifically, the number of variables allowed in a logistic model is 1/10 of the number of observations in the smallest group (Austin and Steyerberg 2017). By combining the *Disengaged* and *Doubtful* segments, the smallest group shifts from 5 FFOs to 34 FFOs allowing for three variables to be used in the ordinal logistic model. This is also possible because the model shows the probability of moving from an attitude segment with lowest belief in climate change/global warming, the least concerned, and least motivated to the highest.

In order to decide which three factors to select for my model, I first ran a full model with all of the factors I thought would have some influence on the FFOs' climate change segment to test the assumptions of the ordinal logistic model. These factors included the FFO's age, income, gender, highest level of education, the state they own their forest and in, the acres of forestland they own, the if the FFO had any management objectives related to ecological systems (to protect nature or biological diversity, protect water resources, or to protect or improve wildlife habitat) or to the future of their land (for land investment, to pass land on to the FFO's children or other heirs, or for the FFO to raise their family), and if the FFO had seen any climate change impact.

Ordinal logistic models assumes that the dependent variable is an ordered categorical variable, which the attitude segments are, and that the relationship between each pair of outcome groups (for this study, the attitude segments) is the same, known as the proportional odds assumption (Agresti 2012). Multicollinearity was first tested on the full model with the variables indicated previously, finding no collinearity across any of the predictor variables (VIF under 2 for all variables). The proportional odds assumption was tested with the *Brant* function in the R statistical environment, which indicated that the proportional odds assumption is not violated when the p-values are greater than 0.05. The acres of forestland, the log-transformed acres of forestland, highest level of education, and reported annual income all violated this assumption. However, the binary variable for if the FFO has a college degree or not does not violate the proportional odds assumption, while the binary variable of the FFO's income (under \$100,000 or \$100,000 and over) does.

From the list of variables that do not violate the assumptions I decided to not use the FFO's age due to a low range of ages, neither of the management objective variables as they have not been addressed in past research, nor did I use the variable measuring if the FFO had seen a climate change impact as FFOs who believe climate change is occurring, or who are in the *Alarmed* segment, may have a greater sensitive to pointing out more minor changes in the environment around them than their counterparts in the *Dismissive* segment (Morris et al. 2016). Thus, the three variables I selected for my climate change attitude mode to be (1) the state the FFO owns their forestland in, (2) the FFO's gender, and (3) if the FFO has a college degree or not.

Table 5 shows the coefficient values of the variable levels for the attitude model.

The significant variables (indicated with ***) are FFOs who own land in either Oregon or Wisconsin compared to Alabama and if the FFO has a college degree compared to those who do not. The FFO identifying as female rather than male was not a significant factor in this model. The probabilities of an FFO being in each attitude segment based on the different variable level combinations is visualized in **Figure 18**.

Table 5. Table of the coefficient value, standard error, t value, and p value for each variable and intersection of the attitude model. The state ownership variables in Oregon and Wisconsin are compared to FFOs who own land in Alabama. The variable of an FFO having a college degree is compared to the FFOs who do not. The FFOs who identify as Female is compared to those identifying as male. *** indicates significance.

Variable Level	Coefficient	Standard Error	t value	p value
Owens in Oregon	0.9607	0.2741	3.5054	0.0005 ***
Owens in Wisconsin	1.0412	0.2806	3.7101	0.0002 ***
Has a college degree	0.4938	0.2258	2.1866	0.0288 ***
Female	0.1843	0.2340	0.7876	0.4309
Intercepts	Coefficient	Standard Error	t value	p value
Dismissive Doubt/Diseng.	-0.2964	0.2985	-0.9931	0.3207
Doubt/Diseng. Cautious	0.3093	0.2961	1.0444	0.2963
Cautious Concerned	2.0194	0.3169	6.3717	0.0000 ***
Concerned Alarmed	2.8883	0.3366	8.5815	0.0000 ***

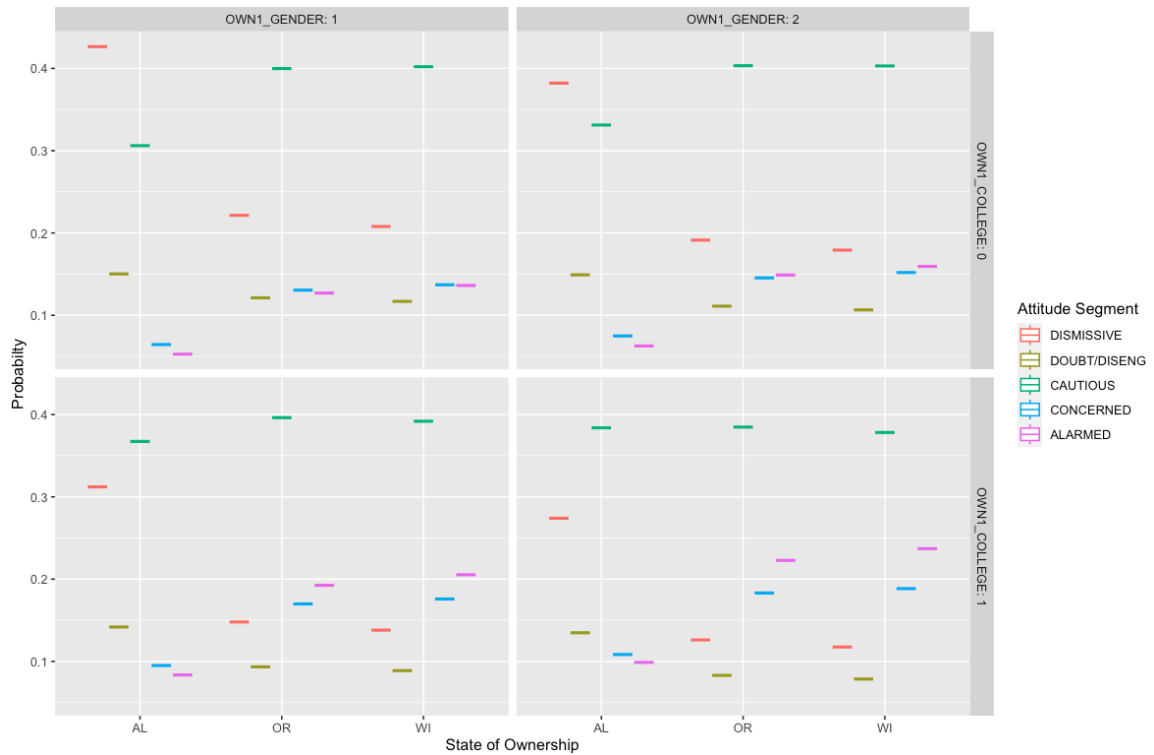


Figure 18. A chart showing the probability of an FFO being in a climate change attitude segment based on their gender (1= Male, 2 = Female), their education level (1 = Has a college degree, 0 = Does not have a college degree), and their state of ownership.

Converting the coefficients from log odds to odds ratios (**Table 6**), the model shows when keeping all other variables constant, an FFO who owns their forestland in Oregon rather than in Alabama the odds of being in an attitude segment with greater climate change belief is 2.6135 times higher, and 2.8326 times higher if the FFO is in Wisconsin. When the FFO has a college degree rather than not, their likelihood of being in an attitude segment with greater climate change belief is 1.6385 times greater when other variables are held constant. While not statistically significant, the odds of an FFO being in an attitude segment with greater climate change belief are 1.2024 times greater when the FFO identifies as female rather than male given the other variables are held constant.

Table 6. Odds ratios and their 95% confidence intervals of an FFO being in an attitude segment with greater climate change belief.

Variable Level	Odds	2.5%	97.5%
*Owns in Oregon vs. Alabama	2.6135	1.5316	4.4898
*Owns in Wisconsin vs. Alabama	2.8326	1.6392	4.9313
*Has a college degree vs. not	1.6385	1.0540	2.5569
Identifies female vs. male	1.2024	0.7601	1.9039

*Statistically significant based on p-values given in **Table 5**.

The model had an acceptable goodness of fit in comparison to the observed number of FFOs in the different climate change attitude segments as it had p-values over 0.05 for the Lipsitz goodness of fit test (p-value = 0.07161), the Hosmer-Lemeshow goodness of fit test (p-value = 0.3724), and the Pulkstenis-Robinson chi-squared (p-value = 0.5419) and deviance test (p-value = 0.3189). These tests all came from the *generalhoslem* R package.

Interaction models were run to test for any significance between the state of forest ownership, the FFO's gender, and if the FFO's had a college degree or not, however, the interactions were not significant at the 0.05 level.

2.3.3 Objective 3.1: Measuring the influence of an FFO's climate change attitudes on their willingness to carry out a climate centered management practice.

There was not a significant relationship between the FFO's attitude segment and if they had taken any action to keep their forestland forested in the future ($X^2 = 10.56$, p-value = 0.0609) (**Figure 19a**) at the 0.05 level nor was there a significant relationship for if the FFO had increased the tree species diversity on their forestland ($X^2 = 7.765$, p-value

= 0.1697) (**Figure 19b**). There was a significant relationship between the attitude segment and the FFO increasing the tree age diversity on their forestland ($X^2 = 13.598$, p-value = 0.01837) (**Figure 19c**).

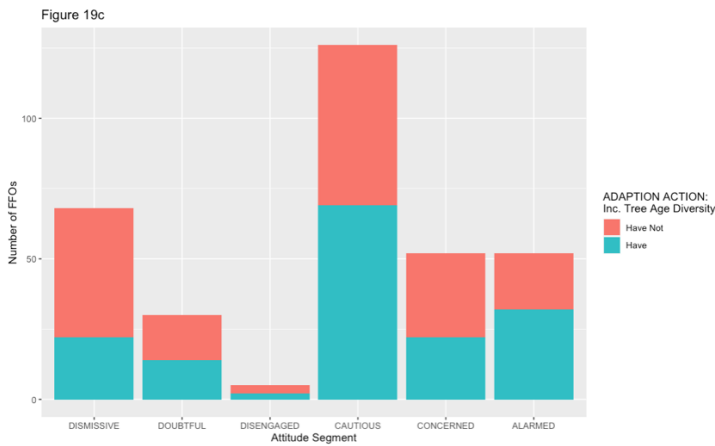
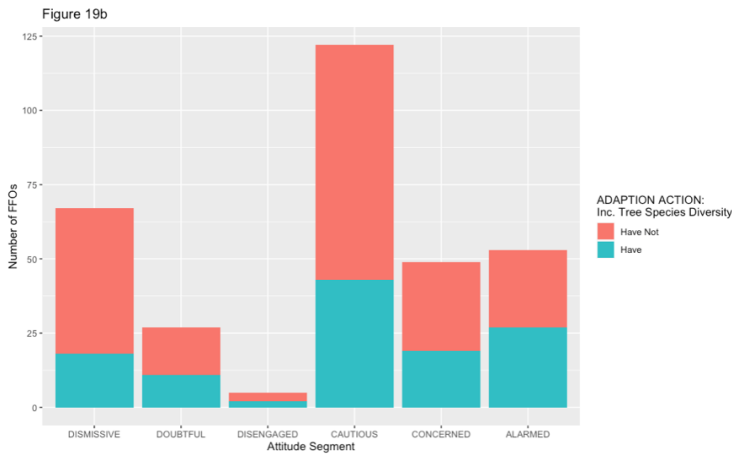
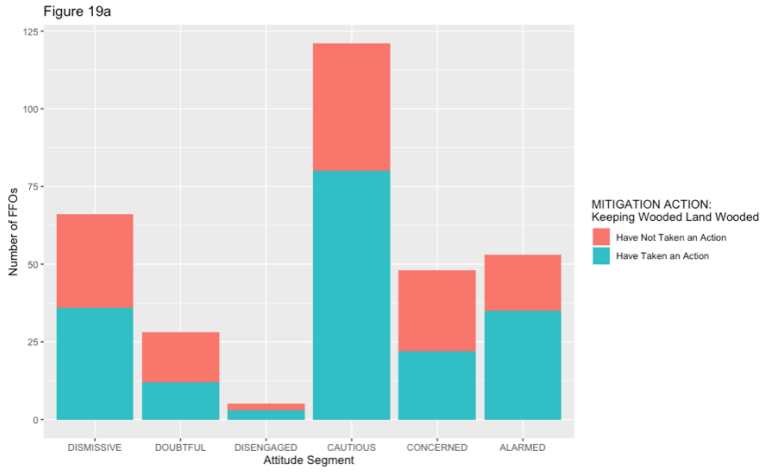


Figure 19. Bar charts depicting the FFOs in each attitude segment broken up by FFOs who have carried out the climate-centered management practice (**blue**) and those who have not (**red**). Bar chart **A** shows the brake up by any action of the FFO to keep their forestland forested, **B** for any action to increase tree species diversity, and **C** for any action to increase tree age diversity.

There was, however, a significant relationship between the FFO's attitude segment and their belief that keeping forestland forested would help reduce future climate change impacts ($X^2 = 68.126$, p-value < 0.001) (**Figure 20a**). As well as with the FFO's belief that increasing tree species diversity is a viable way for forestland to adapt to future climate impacts ($X^2 = 40.625$, p-value < 0.001) (**Figure 20b**) and their belief that increasing tree age diversity is also a viable way for forestland to adapt to future climate impacts ($X^2 = 13.598$, p-value = 0.01837) (**Figure 20c**).

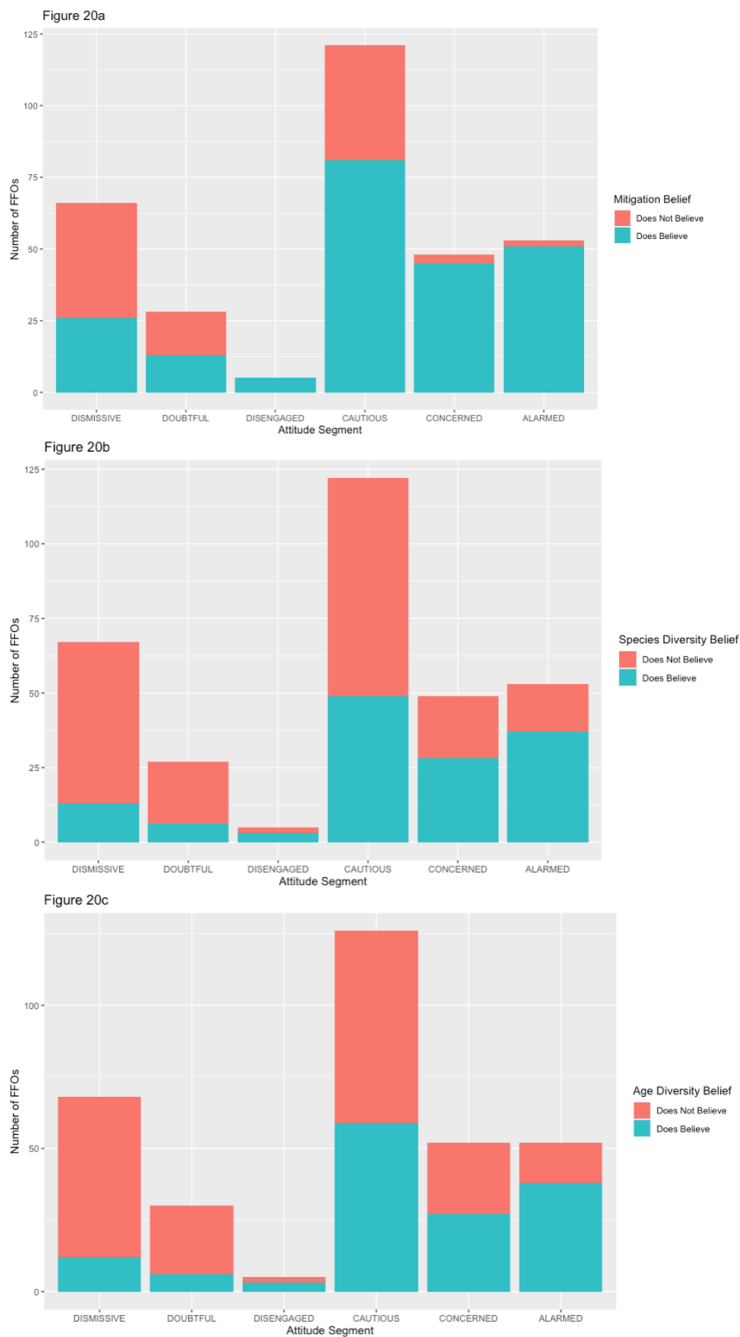


Figure 20. Bar charts depicting the FFOs in each attitude segment broken up by FFO belief in carrying out the climate-centered management practice will aid forestland with future climate impacts (**blue**) and those who do not (**red**). Bar chart **A** shows the belief brake up for FFOs who believe keeping forestland forest will help reduce future climate change impacts, **B** for the belief that increasing tree species diversity helps forestland adapt to future climate impacts, and **C** or the belief that increasing tree age diversity helps forestland adapt to future climate impacts.

2.3.3.1 Objective 3.2.1: Measuring the significance of REB factors for an FFO to take action(s) to keep their forestland forested

Using a binary logistic regression model to follow the REB model, the variables that had a significant relationship to whether the FFO had carried out any action(s) to keep their forestland forested in the foreseeable future was if the FFO had any financial objectives for owning their forestland (p-value = < 0.001). The variables for the attitude segment, the FFO's belief in keeping forestland forested helps reduce climate change impacts, and if the FFO receives any information or advice related to climate change all were not statistically significant (p-values shown in **Table 7**). When converting the log-odds coefficient to odds ratios, it showed that when all other variables are held constant, FFOs who have any financial objectives were 2.7613 times more likely to have taken any action to keep their forestland forested than FFOs who did not have any financial objectives with their forestland. Tjur's R-squared and the Hosmer-Lemeshow tests were used to measure goodness of fit. Tjur's R-squared was measured to be 0.0849, indicating a high variability of the model while the Hosmer-Lemeshow test had a p-value of 0.617 indicating an acceptable goodness of fit.

Table 7. Table of the coefficient value, standard error, z value, and p value for each variable and intersection of the binary logistic regression model which follows the REB model for FFO’s action(s) to keep their forestland forested. The independent variables for this model are the FFO’s attitude segment, if the FFO has any financial objectives, the FFO’s belief in carrying out the listed REB, and if the FFO receives any climate change related information or advice. The reference level for the attitude segments is the Alarmed Segment. *** indicates significance.

Variable Level	Odds Ratio	2.5%	97.5%	p value
Intercept	0.8177	0.3772	1.779	.6100
Concerned Segment	0.5159	0.2414	1.086	0.0836
Cautious Segment	0.9227	0.4701	1.789	0.8131
Disengaged Segment	0.3639	0.0745	1.767	0.1985
Doubtful Segment	0.5508	0.2181	1.376	0.2026
Dismissive Segment	0.7259	0.3239	1.613	0.4329
Has any Financial Objectives	2.761	1.773	4.352	8.96e-6 ***
Believes that keeping forestland forested helps reduce climate change impacts	1.352	0.8057	2.274	0.2539
If the FFO gets any information or advice related to climate change	1.432	0.9035	2.273	0.1264

2.3.3.2 Objective 3.2.2: FFOs taking action(s) to increase tree species diversity

The model used to predict if an FFO had taken any action(s) to increase the tree species diversity on their forestland had shown a significant relationship with the variables measuring if the FFO had financial objects (p-value = 2.93e-3) and if the FFO believed that having increase tree species diversity would help adapt to future climate impacts (p-value = 2.55e-9). FFOs who have financial objectives are 2.0192 times more likely to increase tree species diversity than FFOs who don’t, with all other variables held

constant. FFOs who believe that increased species diversity will help adapt to future climate impacts were 4.3824 times more likely to increase their tree species diversity, while all other variables are held constant. Again, the attitude segment variable and climate knowledge variable did not have a significant relationship with increasing tree species diversity (**Table 8**). Tjur's R-squared (= 0.1426) shows there is variability in the model, although less than that of the previous REB model, and the Hosmer-Lemeshow test gives an adequate goodness of fit with a p-value of 0.7899.

Table 8. Table of the coefficient value, standard error, z value, and p value for each variable and intersection of the binary logistic regression model which follows the REB model for FFO's action(s) to keep their forestland forested. The independent variables for this model are the FFO's attitude segment, if the FFO has any financial objectives, the FFO's belief in carrying out the listed REB, and if the FFO receives any climate change related information or advice. The reference level for the attitude segments is the Alarmed Segment. *** indicates significance.

Variable Level	Odds Ratio	2.5%	97.5%	p value
Intercept	0.2186	0.1020	0.4547	6.42e-5
Concerned Segment	0.6469	0.2989	1.3963	0.27124
Cautious Segment	0.7604	0.3895	1.4850	0.42120
Disengaged Segment	1.3698	0.2765	6.7863	0.69236
Doubtful Segment	1.2103	0.4728	3.0771	0.68837
Dismissive Segment	0.8730	0.3840	1.9824	0.74499
Has any Financial Objectives	2.0192	1.2760	3.2259	2.93e-3***
Believes that increasing tree age diversity helps adapt to future climate impacts	4.3824	2.7153	7.1922	2.55e-9***
If the FFO gets any information or advice related to climate change	1.3486	0.8362	2.1782	0.21982

2.3.3.3 Objective 3.2.3: FFOs taking action(s) to increase tree age diversity

The model used to predict if an FFO had taken any action(s) to increase the tree age diversity on their forestland had the same significant variables as the model for increased tree species diversity: the financial objective (p-value = $9.017e-6$) and belief that increasing tree age diversity is a viable way to adapt to future climate impacts (p-value = $3.09e-10$). With these significant variables, an FFO is 2.8267 times more likely to increase their tree age diversity when they have financial objects verse when they don't, holding all other variables constant. An FFO is 4.8172 times more likely to increase their tree age diversity if that FFO believes that increasing tree age diversity helps their forestland adapt to future climate impacts rather than not believing with all other variables held constant. Again, the variables for attitude segment and climate change knowledge were not significant (**Table 9**). Tjur's R-squared was the greatest for this model of the three, but still indicates a level of variability in the model at 0.1819, and the Hosmer-Lemeshow test gives an adequate goodness of fit with a p-value of 0.7975.

Table 9. Table of the coefficient value, standard error, z value, and p value for each variable and intersection of the binary logistic regression model which follows the REB model for FFO’s action(s) to keep their forestland forested. The independent variables for this model are the FFO’s attitude segment, if the FFO has any financial objectives, the FFO’s belief in carrying out the listed REB, and if the FFO receives any climate change related information or advice. The reference level for the attitude segments is the Alarmed Segment. *** indicates significance.

Variable Level	Odds Ratio	2.5%	97.5%	p value
Intercept	0.3485	0.1675	0.7148	0.00429 ***
Concerned Segment	0.6991	0.3237	1.499	0.35874
Cautious Segment	1.1185	0.5704	2.190	0.74359
Disengaged Segment	0.3779	0.0413	2.920	0.34922
Doubtful Segment	1.174	0.4695	2.931	0.73016
Dismissive Segment	0.5287	0.2318	1.191	0.12590
Has any Financial Objectives	2.827	1.798	4.507	9.017e-6 ***
Believes that increasing tree age diversity helps adapt to future climate impacts	4.817	2.977	7.941	3.09e-10 ***
If the FFO gets any information or advice related to climate change	0.9180	0.5714	1.464	0.72100

2.4 Discussion

2.4.1 Climate Change Attitudes

My findings indicate that there is not a significant difference between the global warming/climate change attitudes of FFOs in Alabama, Oregon, and Wisconsin and the American public, but there are differences between these states. Overall, a majority of the FFOs (69%) believe that climate change is occurring in some capacity and 11% were uncertain it was happening. In the December 2022 Six America’s study, 70% of the responding American adults believed that climate change is occurring in some capacity

and 18% were unsure (Leiserowitz et al. 2023). When breaking up the FFOs into the Six America's global warming attitude segments, the majority of FFOs fell into the *Cautious* segment (37%), and the next largest segment of 20% in the *Dismissive*— which has the lowest belief, concern, and motivation to act towards climate change. The segment with the highest climate change belief, concern, and motivation to act, the *Alarmed* segment, had 16% of the responding FFOs.

Comparing the spread of FFOs in the Six America's attitude segments with the most recent iteration of the American public survey, conducted in December 2022 (Leiserowitz et al. 2023), there was no significant difference between the two ($X^2 = 24$, p -value = 0.2424).

While the spread of FFOs in the different attitude segments did not significantly differ from the spread of the December 2022 Six America survey (Leiserowitz et al. 2023), the significance of different demographic variables which influenced the attitude segments in the Six America's study and the climate change beliefs of U.S. foresters did differ from the significant patterns of the FFOs. Past research patterns have found that American individuals, private forest owners, and foresters who were younger (Leiserowitz et al. 2021, Morris et al. 2016), had higher levels of education or worked for academic employers (Labriole and Luzadis 2011, Leiserowitz et al. 2021, Morris et al. 2016), and were female had higher climate change beliefs (Leiserowitz et al. 2021, Morris et al. 2016, Wojcik et al. 2014). My study of FFOs did not find a significant difference of FFO ages across climate change attitude segments.

The lack of a significant difference of FFO age distribution and attitude segments could be due to the higher median of my sample's age (68 years old) and lower spread of

age (1st quartile at 60 years old and 3rd at 75 years old) (**Figure 21**) compared to the samples and populations of past studies (Leiserowitz et al. 2021, Morris et al. 2016) and the general American population. While the Six America's study did not provide the spread of respondent ages their sample population was that of American adults. By using data from the U.S. Census, the mean age of the American population older than 20 years old is between 45-49 years, the 1st quartile is between 30-34 years old, and the 3rd quartile is between 60-64 years old (US Census Bureau 2019). I used the starting range for American adults at 20 years old rather than 18 years old as the US Census age data were listed as ranges with 18 years in the 15 – 19 years age range. The higher median age and lower spread of ages in the FFO respondents could be the reason why the age of responding FFOs did not have differ significantly between climate change attitudes, rather than a lack of a significant difference.

Figure 21a

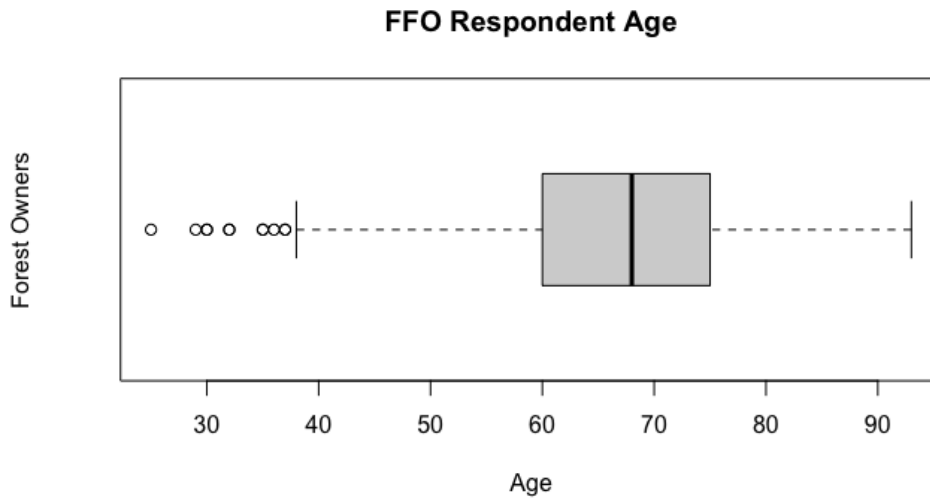


Figure 21b

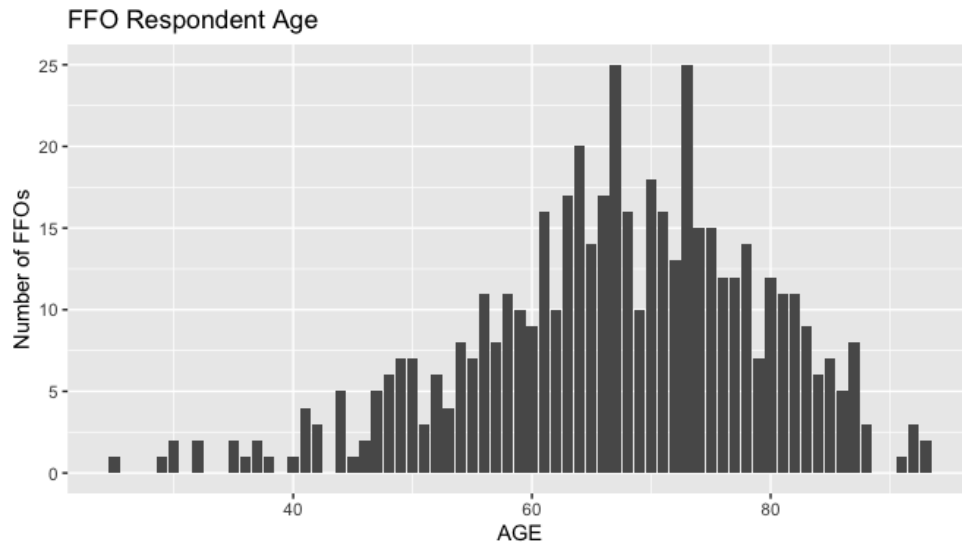


Figure 21. A boxplot (A) and bar chart (B) depicting the spread of the FFO respondent ages.

FFO's climate change attitudes were significantly related to the state they own their forestland in, if they have a college degree or not, and if they had seen any climate change impact on their forested land. Finding that FFOs owning forestland in Oregon or Wisconsin would result in the FFO having a climate change attitude with greater belief in climate change than those in Alabama, not taking if the FFO has a college degree and their gender into account. Although FFOs with forested land in Oregon had the highest

percentage in the *Alarmed* segment, the FFOs in Wisconsin had greater odds of being in a higher climate belief attitude segment than Alabama compared to Oregon. This could be due to the greater number of Wisconsin FFOs in the *Concerned* and *Cautious* attitude segments, as the attitude model described the likelihood of an FFO being in any attitude segment with greater climate belief.

My survey data also indicates that an FFO with a college degree is also more likely to have an attitude segment with greater climate change belief, concern, and motivation than those who do not – not considering the state of forestland ownership nor the FFOs gender. This pattern confirms past climate attitude research of the American public and U.S. foresters (Labriole and Luzadis 2011, Leiserowitz et al. 2021, Morris et al. 2016), in which foresters with higher climate change beliefs or attitudes tended to have higher levels of education.

However, unlike past research (Leiserowitz et al. 2021, Morris et al. 2016), the gender of the FFO did not have a significant relationship with the climate change attitude segment of the FFO – holding the state of ownership and college degree variables constant. From the spread of FFO respondent genders, 75% identified as male and 25% identified as female, it is difficult to confirm whether the lack of a significant relationship between FFO gender and climate change attitude is applicable across the population of U.S. FFOs. Further research can help confirm or deny this lack of a significant relationship.

There was also a significant difference between FFOs who indicated they had seen any climate change impact on their forestland and their attitude segment. Past research of southern foresters had found a significant relationship between a forest professional

seeing a climate impact and their acceptance of climate change (Morris et al. 2016). However, as Morris et al. (2016) explains, this significant difference and relationship between seeing and believing in climate change could be due to confirmation bias. As “[...] climate change accepters observe climate variability in the environment because they are predisposed to find it” (Morris et al. 2016, pg. 537). Confirmation bias can also cause FFOs who don’t believe in climate change to not notice the more subtle climate change impacts on their forestland, and/or contribute those changes to other causes.

2.4.2 Climate-Centered Management Practices

There were no significant differences or relationships between an FFO’s climate change attitude segment and if they had carried out any action(s) to keep their forestland forested or to increase tree species diversity. While there was a significant difference across attitude segments and the FFO taking any action(s) to increase tree age diversity, **Figure 12c** shows the *Alarmed* and *Cautious* segments had higher percentages of FFOs increasing tree species age diversity compared to the *Dismissive* segment. However, there was a significant difference between the FFO’s attitude segment and their beliefs that each of the actions would have a positive impact on the climate, believing that keeping their forestland forested would reduce future climate change impacts, believing that increasing the tree species diversity will help their forestland adapt to future climate impacts, or believing that increasing the tree age diversity will help their forestland adapt to future climate impacts. This indicates that FFOs in the *Alarmed* segment are more encouraged to carry out any of the listed climate-centered management practices due to the action’s positive climate influences than those in the *Dismissive* segment. The

relationship between a private forest owner's belief in climate change's existence and their willingness to carry out a climate centered management practice was also found among NIPF owners in Eastern Oregon and in the Southern U.S. (Boag et al. 2018, Khanal et al. 2016a).

When following the REB model to understand the significance of the relationship each variable identified in the model has to the FFO carrying out one of the climate-centered management practices, I was unable to use all the variables indicated by Hines et al. (1987), due to the skip patterns in my survey (as identified in **Table 3**). Future iterations of this survey need to have all FFO respondents answer the questions measuring their belief if they have a role in addressing climate change through the management of their forest (*Personal Responsibility*), the importance of their knowledge and abilities to carry out the management practices (*Action Skills* and *Knowledge of Action Strategies*), and the importance of finances when deciding to conduct any of the management practices (*Situational Factors*).

With the variables of the REB model, I was able to include in the binary logistic regression (*Attitude, Locus of Control, Knowledge of Issue, and Situational Factors* – using financial objects to measure), the FFO having any financial objectives had a significant relationship to all three of the climate-centered management practices. In which, FFOs who indicated either timber products or nontimber forest products were important reasons for owning their forests were more likely to be conducting any of the three listed management practices than the FFOs who did not list those objectives as important, *ceteris paribus*. These findings are similar to past research of barriers and motivations of private forest owners to utilizing climate change adaptive management

practices, in which a majority of forest owners were incidentally taking adaptive actions to meet other management goals relating to financial and forest health rather than to intentionally adapt to climate change (Boag et al. 2018, Grotta et al. 2013). From this, I infer that the FFOs who financially rely on their forests are more likely to take action(s) to increase their forest's resiliency in the face of other disturbances despite whether they believe in climate change or not. These disturbances include wildfires (Boag et al. 2018), insect pest damage (Jactel et al. 2021), small mammalian herbivores, etc. (Jactel et al. 2017) and while these disturbances may be related to climate change (Seidl et al. 2017) the belief in their relationship to climate change and the human influence of climate change is not necessary for an FFO to take action to increase their forest's resilience in light of these disturbances. Therefore, to increase the participation in climate-centered management practices among FFOs who fall into the *Doubtful* or *Dismissive* attitude segments and own their forestland for financial objective those practices should not be promoted solely for climate change resilience and mitigation but rather for increasing the forest's overall resilience. Other strategies to increase FFOs' participation in climate-centered forest management practices is to present climate change impacts on a local level, to provide more specific practices for those impacts, and the risks and benefits associated with those practices (Boag et al. 2018, Grotta et al. 2013, Morris et al. 2016).

The FFO's belief that the management practice would have a positive influence on the climate or help forests adapt to future climate impacts had a significant relationship with the FFO carrying out any action(s) to increase tree species or tree age diversity. Specifically, the FFOs believed that increasing the diversity of forests, either by tree species or age, would allow forests to adapt to future climate impacts were more likely to

carry out action(s) to do so with their forests, holding all other variables constant. This further supports the finding in my previous paragraph, in which FFOs are taking actions to increase their forest's resilience in the face of increasing levels of disturbance, both in frequency and intensity (Hoesung Lee et al. 2023). Although these beliefs have a significant relationship to the corresponding management practice, the belief that keeping forestland forested for the foreseeable future helps to mitigate future climate change impacts did not have a significant relationship to the FFO taking actions to carry out actions to do so. With this difference of significance across beliefs surrounding practices, I believe that the differing levels of significance in these relationships may be due to the FFOs having a stronger desire or motivation to ensure their forest's resilience than to mitigate global climate change. The disconnect between an individual's personal actions and how they view global issues would need to be properly studied in the future for it to be statistically significant.

2.4.3 The REB Model

Overall, the use of the REB model was successful in the capacity I was able to employ it to measure the influence of an FFO's climate change attitude towards their management practices. I was not able to use the REB and all the variables it addresses due to the skip patterns I integrated into my survey. For future iterations of this survey, the questions that measure the REB variables should not have the option to be skipped to fully understand what influences FFOs to carry out climate-centered management practices. Another benefit of the REB was the inclusion of the FFO's situational factors was also a major benefit to this model, as it places the FFO into a larger context,

addressing other factors that may hinder an FFO from carrying out a behavior or encourage them outside their own attitudes, ability, and knowledge. However, the REB did not directly account for social influence or pressure the FFO may face. These social influences could include the perception of what other FFOs or forest owners are doing in the surrounding landscape, which make encourage them do perform the same practices that seemingly increase their neighbor's forest health. The opposite can also be true, in which an FFO could be discouraged to use a climate-centered management practice to help mitigate climate change if they believe their neighbor's actions do the opposite. The social influence could be accounted for by the REB in the *Locus of Control* variable, however the importance of it could be diminished. In the future, this social influence should be addressed specifically and within the REB framework, it could be included in the *Situational Factors*.

I do believe the REB model was a good choice of theoretical frameworks for an individual's behavior to use in this project, especially to meet the goal of understanding how and FFO's climate change attitude influences their forest management practices.

2.4.4 Survey Error

It is also important to note that while bias and error were minimized as much as possible throughout the process of creating, distributing, and analyzing the survey – bias and error will likely still exist. Nonresponse error and measurement error are the largest potential sources of error in my study, due to the nature of my topic: climate change. I believe that FFOs who may feel passive about climate change or who are strongly against the topic have a greater likelihood of not responding to my survey then the FFOs who

believe in some capacity that climate change is occurring, resulting in a source of nonresponse error. This pattern has been found in past research regarding response rates and the survey topic (Stedman et al. 2019, Zha et al. 2020). Measurement error can result in the FFO providing inaccurate responses to survey questions, particularly I believe FFOs could have response that they do carry out some of the listed management practices to appear in a more positive light. No model is perfect; however, I believe the patterns found in my models can provide helpful insight into understanding FFOs, their climate change attitudes, and their climate-centered management practices.

2.5 Conclusion

This study lays the foundation for understanding U.S. FFO attitudes towards climate change and the factors that influence those attitudes. It also provides the groundwork for future climate change attitude studies of FFOs across the entirety of the United States and for other private natural resource owners.

From this study, I found that current FFOs in Alabama, Oregon, and Wisconsin will carry out climate centered management practices despite their attitude towards climate change. FFOs who have a lower belief towards, level of concern of, and motivation to act to reduce climate change were utilizing the same climate centered management practices as the FFOs who had a higher level of belief, concern, and motivation. This result raises the question: “As long as someone is performing a responsible environmental behavior, does the intention to do so matter?” If the answer is “Yes,” more resources would need to be delegated to change FFOs’ attitudes. There is no assurance that FFOs’ attitudes may be changed within a feasible timeframe to make

necessary changes. However, if the answer is “No” resources can be used to understanding FFO values and attitudes further and to market sustainable forestry practices to meet those values and attitudes.

Furthermore, it is crucial for researchers, policymakers, extension foresters, and other people working with FFOs to understand that while models can highlight common, significant variables that influence FFO’s attitudes and actions, the attitudes, values, motivations, and goals for owning forests are unique to each FFO. That the best way to promote sustainable forestry practices to conserve and improve the wellness of 110 million ha of forestland is to work alongside the FFOs who own that land. Establishing trustworthy relationships between FFOs and researchers, policymakers, and/or extension foresters is the most efficient way to utilize forests and combat climate change (Vainio et al. 2018, Vulturius et al. 2017, Winter and Cvetkovich 2010).

APPENDIX 1: SURVEY INSTRUMENT (ALABAMA)

Woodland Owner Survey



Family Forest Research Center, Woodland Owner Survey

160 Holdsworth Way, Amherst MA 01003
Phone: (413) 324-8030
Email: lmiller@umass.edu
Internet: www.familyforestresearchcenter.org

Instructions

- ✓ Please provide answers for all the wooded land that you own in Alabama. If you are part of more than one group that owns wooded land, please respond for the group that is listed on the outside of the envelope.
- ✓ The owner who makes most of the decisions about your wooded land in Alabama should answer this survey.
- ✓ If this survey is received by a company or other organization, please have a person knowledgeable about the organization's wooded land in Alabama answer this survey. If the company listed on the envelope is a subsidiary of a larger company, please respond for the larger, parent company.

General Questions About Your Land

1. How many total acres of land do you currently own in Alabama?

--	--	--	--	--	--	--	--

Acres of land in Alabama

2. Wooded land covers 71% of Alabama.

Wooded land includes:

- ✓ Woods, woodlots, timberland, and forests
- ✓ Land at least 1 acre in size, 120 feet wide, and has at least 10% forest cover
- ✓ Land at least 1 acre in size, where trees were removed and trees will grow again

Wooded land does *not* include:

- ✓ Christmas tree farms, orchards, or nurseries
- ✓ Land that is mowed for lawn

How many acres of wooded land do you currently own in Alabama?

--	--	--	--	--	--	--	--

Acres of wooded land in Alabama

*If you **own any** wooded land in Alabama, please complete this survey.*

*If you **do not own** wooded land in Alabama, please return this survey in the postage-paid envelope provided and write on the cover "No Wooded Land".*

General Questions about Your Ownership

3. Which category below best describes your ownership?

Select only one.

- Individual
- Joint, with husband or wife
- Joint, such as with other family members or friends
- Family partnership or family LLC or LLP
- Family trust or estate
- Corporation or business
- Other (please specify): _____

4. Is your home (primary residence) on or within a mile of any of your wooded land in Alabama?

- Yes
- No
- Not applicable

5. How likely is it that you will sell or give away any of your wooded land in Alabama in the next 5 years?

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Extremely
likely | Likely | Undecided | Unlikely | Extremely
unlikely |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

6. Development rights for land can be sold or voluntarily given away. This is usually in the form of a Conservation Easement.

a. How familiar are you with this concept?

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Extremely
familiar | Moderately
familiar | Somewhat
familiar | Slightly
familiar | Not at all
familiar |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

b. Have development rights been sold or voluntarily given away on any of your wooded land in Alabama by either you or a previous owner?

- Yes
- No
- I don't know

c. If No or Don't know, how likely are you to do so in the next 5 years?

- | | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Extremely
likely | Likely | Undecided | Unlikely | Extremely
unlikely | Not
applicable |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |



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Your Reasons for Owning Wooded Land

7. How important are the following as reasons for why you currently own your wooded land in Alabama?

If you own one property, check one box for each item.

If you own more than one property in Alabama, consider them all and check one or more boxes for each item.

	Very important	Important	Moderately important	Of little importance	Not important	Not applicable
To enjoy beauty or scenery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
To protect nature or biological diversity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
To protect water resources	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
To protect or improve wildlife habitat	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
For land investment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
For privacy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
To raise my family	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
To pass land on to my children or other heirs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
For firewood	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
For timber products, such as logs or pulpwood	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
For nontimber forest products, such as berries or maple syrup	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
For hunting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
For recreation, other than hunting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
↳ (Please specify):	<input type="text"/>					

Forest Activities

8. Which of the following have occurred on your wooded land in Alabama **in the past 5 years**?

Select all that apply.

- Cut and/or removed trees for sale
- Cut and/or removed trees for own use
- Collected nontimber forest products, such as berries or ginseng
- Reduced fire hazard
- Controlled burn/prescribed fire
- Eliminated or reduced invasive plants
- Eliminated or reduced unwanted insects or diseases
- Road construction or maintenance
- Trail construction or maintenance
- Improved wildlife habitat
- Livestock grazing
- Other (please specify): _____
- None of the above

9. Which of the following will likely occur on your wooded land in Alabama **in the next 5 years**?

Select all that apply.

- Cut and/or remove trees for sale
- Cut and/or remove trees for own use
- Collect nontimber forest products, such as berries and ginseng
- Reduce fire hazard
- Controlled burn/prescribed fire
- Eliminate or reduce invasive plants
- Eliminate or reduce unwanted insects or diseases
- Road construction or maintenance
- Trail construction or maintenance
- Improve wildlife habitat
- Livestock grazing
- Other (please specify): _____
- None of the above
- Don't know



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10. Which of these listed impacts have you seen occur on your wooded land in Alabama since you have owned it?

a. Droughts have increased in frequency and/or intensity

Yes No I don't know

b. Floods have increased in frequency and/or intensity

Yes No I don't know

c. Ice storms have increased in frequency and/or intensity

Yes No I don't know

d. Wildfires have increased in frequency and/or intensity

Yes No I don't know

e. Winters are shorter and/or less intense

Yes No I don't know

f. Growing seasons are longer

Yes No I don't know

g. An increase in wind damage

Yes No I don't know

h. An increase in invasive plants

Yes No I don't know

i. An increase in unwanted insects or diseases

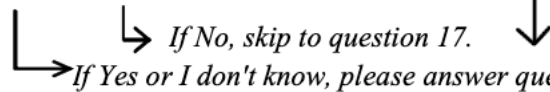
Yes No I don't know

Climate Change

Climate change, sometimes referred to as global warming, is described as the long-term shift in global and regional weather patterns. These shifts can result in changes in average temperatures, levels of precipitation, and more intense weather events.

11. Do you think that climate change is happening?

Yes No I don't know



12. What do you think causes climate change?

Select only one.

- Caused entirely by human activities
- Caused mostly by human activities
- Caused about equally by human activities and natural changes
- Caused mostly by natural changes in the environment
- Caused entirely by natural changes in the environment
- I don't know

13. Which of the following statements comes closest to your view towards reducing climate change?

Select only one.

- Humans can reduce climate change, and we are going to do so successfully
- Humans can reduce climate change, but it's unclear at this point whether we will do what's needed
- Humans could reduce climate change, but people aren't willing to change their behavior, so we're not going to
- Humans can't reduce climate change, even if it is happening



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14. a. How worried are you *in general* about climate change in the next 50 years?

- Extremely worried
- Very worried
- Somewhat worried
- A little worried
- Not at all worried
- I don't know

b. How worried are you about climate change impacting *any* wooded land in Alabama in the next 50 years?

- Extremely worried
- Very worried
- Somewhat worried
- A little worried
- Not at all worried
- I don't know

c. How worried are you about climate change impacting *your* wooded land in Alabama in the next 50 years?

- Extremely worried
- Very worried
- Somewhat worried
- A little worried
- Not at all worried
- I don't know



15. Please indicate your level of agreement or disagreement about each of the following statements about climate change potentially impacting your wooded land in Alabama.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	I don't know
Droughts will increase	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Flooding will increase	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ice storms will increase	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wildfires will increase in frequency and intensity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Winter will be shorter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The growing season will be longer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wind damage will increase	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Invasive plants will increase	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Unwanted insects or diseases will increase	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

16. Do you believe that you hold a role in addressing climate change through the management practices of your wooded land in Alabama?

- Yes No I don't know

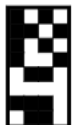
Management Plan

17. A management or stewardship plan can help guide the landowner meet their goals and objectives for their wooded land.

a. Do you have a written management or stewardship plan for any of your wooded land in Alabama?

- Yes No I don't know

↳ If No or I don't know, skip to question 18.
 ↳ If Yes, please answer 17b and c.



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17. b. Have you taken actions to implement it?

Yes No I don't know

c. Does your plan take climate change into account?

Yes No I don't know

18. a. How do you get general information or advice related to your wooded land?

Select all that apply.

Talk to a neighbor

Talk to an expert

Have someone visit my land

Written materials, such as brochures

Online resources, such as publications or webinars

Conference or workshop

Relevant organization

Other (please specify): _____

I don't get/need information or advice

b. How do you get information or advice related to climate change to manage your wooded land?

Select all that apply.

Talk to a neighbor

Talk to an expert

Have someone visit my land

Written materials, such as brochures

Online resources, such as publications or webinars

Conference or workshop

Relevant organization

Other (please specify): _____

I don't get/need information or advice

Keeping Your Wooded Land Wooded

19. a. Have you taken any action to keep your wooded land in Alabama as wooded land for the foreseeable future?

- Yes No
 ↳ *If No, skip to question 21.*
 ↳ *If Yes, please answer b.*

b. Which of the following have you implemented?

Select all that apply.

- Conversation with heir(s) of my land
 Included the desire to keep my land wooded in my will
 Enrolled in a Current Use tax program
 I have a Conservation Easement
 Other (please specify): _____

20. How important or unimportant is each listed factor for you when considering the actions to *keep your wooded land in Alabama as wooded land*?

a. **Finances**

- | | | | | |
|--------------------------|--------------------------|---|--------------------------|--------------------------|
| Very
important | Somewhat
important | Neither
important nor
unimportant | Somewhat
unimportant | Very
unimportant |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

b. **The knowledge of how to implement the action(s)**

- | | | | | |
|--------------------------|--------------------------|---|--------------------------|--------------------------|
| Very
important | Somewhat
important | Neither
important nor
unimportant | Somewhat
unimportant | Very
unimportant |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

c. **Your own ability to carry out the action(s)**

- | | | | | |
|--------------------------|--------------------------|---|--------------------------|--------------------------|
| Very
important | Somewhat
important | Neither
important nor
unimportant | Somewhat
unimportant | Very
unimportant |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |



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21. Do you believe keeping wooded land as wooded land helps reduce future climate change impacts?

Yes No I don't know

↳ If Yes, please answer question 22.
↳ If No or I don't know, skip to question 23.

22. Do you believe keeping **your wooded land** in Alabama as wooded land will help to reduce climate change impacts?

Yes No I don't know



Increasing Tree Diversity

23. Have you taken any action(s) to increase the **diversity of tree species** on your wooded land in Alabama?

Yes No

↳ If No, skip to question 25.
↳ If Yes, please answer question 24.

24. How important or unimportant is each of the factors listed below for you when considering implementing actions to increase the *diversity of tree species* on your wooded land in Alabama?

a. **Finances**

Very important	Somewhat important	Neither important nor unimportant	Somewhat unimportant	Very unimportant
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

b. **The knowledge of how to implement the action(s)**

Very important	Somewhat important	Neither important nor unimportant	Somewhat unimportant	Very unimportant
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

c. **Your own ability to carry out the action(s)**

Very important	Somewhat important	Neither important nor unimportant	Somewhat unimportant	Very unimportant
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

25. Do you believe the action of increasing *the diversity of tree species* is a viable way for wooded land to adapt to future climate change impacts?

Yes No I don't know

↳ If No or I don't know please skip to question 27.
↳ If Yes, please answer question 26.

26. Do you believe that the action of increasing *the diversity of tree species* on *your wooded land* in Alabama is a viable way for it to adapt to future climate change impacts?

Yes No I don't know



27. Have you taken any action(s) to increase the *age diversity* of the trees on your wooded land in Alabama?

- Yes No
↳ If no, skip to question 29
↳ If yes, please answer 28

28. How important or unimportant is each listed factor for you when considering implementing actions to increase or maintain the *age diversity* of the trees on your wooded land in Alabama?

a. **Finances**

- | | | | | |
|--------------------------|--------------------------|-----------------------------------|--------------------------|--------------------------|
| Very important | Somewhat important | Neither important nor unimportant | Somewhat unimportant | Very unimportant |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

b. **The knowledge of how to implement the action(s)**

- | | | | | |
|--------------------------|--------------------------|-----------------------------------|--------------------------|--------------------------|
| Very important | Somewhat important | Neither important nor unimportant | Somewhat unimportant | Very unimportant |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

c. **Your own ability to carry out the action(s)**

- | | | | | |
|--------------------------|--------------------------|-----------------------------------|--------------------------|--------------------------|
| Very important | Somewhat important | Neither important nor unimportant | Somewhat unimportant | Very unimportant |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

29. Do you believe the action of increasing the *age diversity* of trees is a viable way for wooded land to adapt to future climate change impacts?

- Yes No I don't know
↳ If No or I don't know, please skip to question 31.
↳ If Yes, please answer question 30.

30. Do you believe that the action of increasing the *age diversity* of the trees on *your wooded land* in Alabama is a viable way for it to adapt to future climate change impacts?

- Yes No I don't know

General Questions About You

If you are responding on behalf of a company or other organization, please skip this section.

31. What is your age? Years

32. What is your gender?

Male Female

33. What is the highest degree or level of school you have completed?

- Less than 12th grade
- High school/GED
- Some college
- Associate degree
- Bachelor's degree
- Advanced degree

34. Are you of Hispanic or Latino origin?

Yes No

35. What is your race?

Select one or more.

- American Indian or Alaska Native
- Asian
- Black or African-American
- Native Hawaiian or Other Pacific Islander
- White



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36. a. What is your household's annual income?

Select only one.

- Less than \$25,000
- \$25,000 to \$49,999
- \$50,000 to \$99,999
- \$100,000 to \$199,999
- \$200,000 or more

b. On average, what percentage of your household's annual income comes from the wooded land that you own?

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 Percent




If there are any additional comments or concerns that you would like to share, please write them below.



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Thank you for participating in this survey!
Please return the survey in the
postage-paid envelope provided.

If you would like a copy of the results of this survey, print
your name and address on the back of the return envelope.

Comments or questions?
Please contact us:
Family Forest Research Center
Woodland Owner Survey
160 Holdsworth Way
Amherst, MA 01003
Telephone: (413) 324-8030
Email: lmiller@umass.edu
Internet: www.familyforestresearchcenter.org

Version: Alabama CC 1.0



APPENDIX 1: GENERAL NOTES

1. University of Massachusetts' written Land Acknowledgement
(<https://www.umass.edu/diversity/umass-land-acknowledgement>)

BIBLIOGRAPHY

- Abdullah, S. I. N. W. et al. 2019. The impact of knowledge, attitude, consumption values and destination image on tourists' responsible environmental behaviour intention. - 10.5267/j.msl: 1461–1476.
- Agresti, A. 2012. *Categorical Data Analysis*. - John Wiley & Sons, Incorporated.
- Ajzen, I. 1991. The theory of planned behavior. - *Organizational Behavior and Human Decision Process* 50: 179–211.
- Akyıldız, B. and Duygu, K. 2022. Charging plastic bags within the demarketing: measuring the environmental attitude and environmental behaviour in Denizli: a structural equality model. - *pesd*: 35–50.
- Aldunce, P. et al. 2023. *Climate Change 2023 Synthesis Report: Summary for Policymakers*.
- Arias, P. A. et al. 2021. *Technical Summary: Climate Change 2021: The Physical Science Basis*.
- Austin, P. C. and Steyerberg, E. W. 2017. Events per variable (EPV) and the relative performance of different strategies for estimating the out-of-sample validity of logistic regression models. - *Statistical Methods in Medical Research* 26: 796–808.
- B. Ruefenacht et al. 2008. *National Forest Type Groups*.
- Bamberg, S. and Möser, G. 2007. Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. - *Journal of Environmental Psychology* 27: 14–25.
- Beaton, M. A. 2015. *Massachusetts Clean Energy and Climate Plan for 2020*.
- Boag, A. E. et al. 2018. Climate change beliefs and forest management in eastern Oregon: implications for individual adaptive capacity. - *Ecology and Society* in press.
- Bonan, G. B. 2008. Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests. - *Science* 320: 1444–1449.
- Butler, B. J. 2011. Family forest owners rule! - *Forest History Today* 17: 87–91.
- Butler, B. J. et al. 2021. Family forest ownerships of the United States, 2018: Results from the USDA Forest Service, National Woodland Owner Survey.: 52.
- Butler, B. J. et al. 2022a. An assessment of the sustainability of family forests in the U.S.A. - *Forest Policy and Economics* 142: 102783.

- Butler, B. J. et al. 2022b. Studies of Family Forest Owners in the USA: A Systematic Review of Literature from 2000 through 2019. - *Small-scale Forestry* in press.
- Butler, B. J. et al. 2022c. Cross-boundary sustainability: Assessment across forest ownership categories in the conterminous USA using the Montréal Process Criteria and Indicators framework. - *Forests* 13: 992.
- Carey, A. B. 2006. ACTIVE AND PASSIVE FOREST MANAGEMENT FOR MULTIPLE VALUES. - *Northwest Nat* 87: 18.
- Chang, T.-W. et al. 2021. How to weigh in on sustainability trends? Sustainable consumption by electric scooter customers and its implications for green marketing. - *Sustainable consumption* in press.
- Chryst, B. et al. 2018. Global Warming's "Six Americas Short Survey": Audience Segmentation of Climate Change Views Using a Four Question Instrument. - *Environmental Communication* 12: 1109–1122.
- Creighton, J. H. et al. 2011. Climate change and family forest landowners in Washington: A needs assessment.: 12.
- Dillman, D. A. et al. 2014. Internet, phone, mail, and mixed-mode surveys: The tailored design method. - Wiley & Sons.
- Durkay, J. and Schultz, J. 2016. The Role of Forests in Carbon Sequestration and Storage. - *National Conference of State Legislatures Legisbrief* in press.
- Grotta, A. T. et al. 2013. Family forest owners and climate change: Understanding, attitudes, and educational needs. - *Journal of Forestry* 111: 87–93.
- Harrison, S. et al. 2002. Non-industrial, smallholder, small-scale and family forestry: What's in a name? - *Small-scale Forestry* 1: 1–11.
- Hines, J. M. et al. 1987. Analysis and Synthesis of Research on Responsible Environmental Behavior: A Meta-Analysis. - *The Journal of Environmental Education* 18: 1–8.
- Hoesung Lee et al. 2023. SYNTHESIS REPORT OF THE IPCC SIXTH ASSESSMENT REPORT (AR6): Longer Report.
- Holt, J. R. et al. 2020. Landowner functional types to characterize response to invasive forest insects. - *People and Nature* 2: 204–216.
- Holt, J. R. et al. 2021. Using the theory of planned behavior to understand family forest owners' intended responses to invasive forest insects. - *Society & Natural Resources* 34: 1–18.

- Husa, M. and Kosenius, A.-K. 2021. Non-industrial private forest owners' willingness to manage for climate change and biodiversity. - *Scandinavian Journal of Forest Research*: 1–12.
- Intergovernmental Panel on Climate Change 2022. Annex I: Glossary. In *Global Warming of 1.5°C: IPCC Special Report on Impacts of Global Warming of 1.5°C above Pre-industrial Levels in Context of Strengthening Response to Climate Change, Sustainable Development, and Efforts to Eradicate Poverty.*: 541–562.
- Jactel, H. et al. 2017. Tree Diversity Drives Forest Stand Resistance to Natural Disturbances. - *Current Forestry Reports* 3: 223–243.
- Jactel, H. et al. 2021. Tree Diversity and Forest Resistance to Insect Pests: Patterns, Mechanisms, and Prospects. - *Annual Review of Entomology* 66: 277–296.
- Ji, Z. et al. 2023. Factors influencing public support for the individual low-carbon behavior rewarding system: Evidence from a large-scale longitudinal survey in China. - *Journal of Cleaner Production* 409: 137187.
- Jones, N. A. et al. 2016. The study of human values in understanding and managing social-ecological systems. - *E&S* 21: art15.
- Kantor, S. et al. 2011. Climate change and family forest landowners in Alaska: A needs assessment.: 13.
- Khanal, P. N. et al. 2016a. Nonindustrial private forest landowner beliefs toward climate change and carbon sequestration in the Southern United States. - *Journal of Forestry* in press.
- Khanal, P. N. et al. 2016b. Nonindustrial Private Forest Landowner Beliefs Toward Climate Change and Carbon Sequestration in the Southern United States. - *Journal of Forestry* 114: 524–531.
- Laakkonen, A. et al. 2018. Forest owners' attitudes toward pro-climate and climate-responsive forest management. - *Forest Policy and Economics* 87: 1–10.
- Labriole, M. M. and Luzadis, V. A. 2011. New York Society of American Foresters' Perceptions of Climate Change. - *Journal of Forestry* in press.
- Leiserowitz, A. et al. 2009. Climate Change in the American Mind: Americans' Climate Change Beliefs, Attitudes, Policy Preferences, and Actions. - *SSRN Journal* in press.
- Leiserowitz, A. et al. 2021. Global Warming's Six Americas: a review and recommendations for climate change communication. - *Current Opinion in Behavioral Sciences* 42: 97–103.
- Leiserowitz, A. et al. 2023. Global Warming's Six Americas, December 2022.

- Maibach, E. et al. 2009. Global warming's six Americas 2009: an audience segmentation analysis.: 140.
- Masson-Delmotte, V. et al. 2021. Climate Change 2021: The physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.
- Matilainen, A. and Lähdesmäki, M. 2023. Passive or not? – Examining the diversity within passive forest owners. - *Forest Policy and Economics* 151: 102967.
- Morris, H. L. C. et al. 2016. Climate Change Attitudes of Southern Forestry Professionals: Outreach Implications. - *Journal of Forestry* 114: 532–540.
- Oswalt, S. N. et al. 2019. Forest resources of the United States, 2017: A technical document supporting the Forest Service update of the 2020 RPA Assessment.: 223.
- Perry, C. H. et al. 2022. Forest Atlas of the United States. - FS-1172 in press.
- Prochaska, J. O. and DiClemente, C. C. 1983. Stages and processes of self-change of smoking: Toward an integrative model of change. - *Journal of Consulting and Clinical Psychology* 51: 390–395.
- Quartuch, M. R. et al. 2021. Applying the Transtheoretical Model of Change to Legacy Planning Decisions. - *Small-scale Forestry* 20: 457–478.
- Rosenberg, M. J. and Hovland, C. I. 1960. Cognitive, Affective and Behavioral Components of Attitudes. - In: *Attitude Organization and Change: An Analysis of Consistency among Attitude Components*. Yale University Press, in press.
- Sass, E. M. et al. 2020. Estimated Distribution of Forest Ownerships Across the Conterminous United States, 2017.
- Schnepf, C. et al. 2011. Climate change and family forest landowners in Idaho: A needs assessment.: 24.
- Seidl, R. et al. 2017. Forest disturbances under climate change. - *Nature Climate Change* 7: 395–402.
- Snyder, S. A. et al. 2021. Does having a hunter identity influence land management behaviors of family forest owners? - *Human Dimensions of Wildlife*: 1–16.
- Stedman, R. C. et al. 2019. The End of the (Research) World As We Know It? Understanding and Coping With Declining Response Rates to Mail Surveys. - *Society & Natural Resources* 32: 1139–1154.

- Thompson, D. W. and Hansen, E. N. 2013. Carbon Storage on Non-industrial Private Forestland: An Application of the Theory of Planned Behavior. - *Small-scale Forestry* 12: 631–657.
- US Census Bureau 2019. Table 1. Annual Estimates of the Resident Poulations: April 1, 2010 to July 1, 2019 (PEPANNRES).
- U.S. Environmental Protection Agency 2023. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2021.
- U.S. Forest Service 2010. Glossary and List of Acronyms: March 2010.
- USDA Forest Service 2016. FOREST INVENTORY AND ANALYSIS NATIONAL CORE FIELD GUIDE VOLUME I: FIELD DATA COLLECTION PROCEDURES FOR PHASE 2 PLOTS.
- USDA Forest Service 2019. Forest Inventory and Analysis national core field guide: Volume I - field data collection procedures for phase 2 plots, version 9.0.
- Vainio, A. et al. 2018. How are forest owners' objectives and social networks related to successful conservation? - *Journal of Rural Studies* 62: 21–28.
- Vulturius, G. et al. 2017. The relative importance of subjective and structural factors for individual adaptation to climate change by forest owners in Sweden. - *Reg Environ Change*: 1–10.
- Wear, D. N. and Greis, J. G. 2013. The Southern Forest Futures Project: Technical report.: 542.
- Winter, P. L. and Cvetkovich, G. T. 2010. Trust Mediates Conservation-Related Behaviors. - *Ecopsychology* 2: 211–219.
- Wojcik, D. J. et al. 2014. Message in a Bottleneck? Attitudes and Perceptions of Climate Change in the Cooperative Extension Service in the Southeastern United States. - *jhse* in press.
- Zha, N. et al. 2020. Factors Affecting Response Rates in Medical Imaging Survey Studies. - *Academic Radiology* 27: 421–427.