AN EVALUATION OF CLIMATE CHANGE RISK PERCEPTIONS AND POLICY PREFERENCES OF UNITED STATES FOREST SERVICE FOREST SUPERVISORS AND DEPUTY SUPERVISORS

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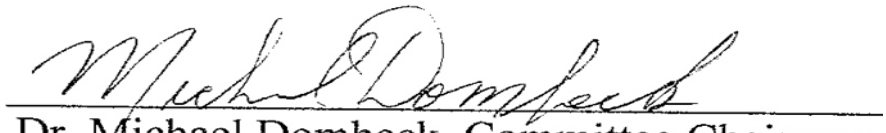

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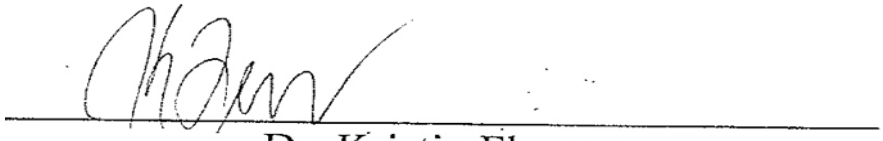

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ABSTRACT

Climate change is arguably the most pressing environmental threat facing Earth's natural systems and has come to the forefront in decision-making circles as to how these systems should be managed. Despite the vast amount of attention being devoted to the issue, the complexity and uncertainty associated with climate change impacts has caused difficulty for policy makers in the formulation of policies to address the issue.

Currently, research being conducted within the human dimensions of natural resources and other social sciences (particularly risk management) is looking at how the public perceives climate change risk perceptions and resulting behaviors. These questions are important for policy makers attempting to deal with climate change issues because the development of policies is driven primarily through the support or rejection of proposed rules by the public. The decisions made regarding climate change will undoubtedly be influenced by how the public and policy makers view the perceived risks associated with a changing climate at any agency level.

Forest Supervisors and Deputy Forest Supervisors are responsible for the overall management activities of U.S. National Forests. Their perception of the risks associated with climate change will undoubtedly drive the direction of forest management. This thesis used survey methods to investigate climate change knowledge, risk perceptions and policy preferences of those responsible for the well-being and management of forests within the United States National Forest System. By doing so, this research adds to the field of risk perception by identifying drivers of risk as well as the field of environmental policy by developing a set of recommendations for how to manage systems under altered climatic patterns.

Results of this research indicate that there is a heightened level of risk associated with climate change and the USFS has a role in addressing such issues, but there is a lack of urgency to do so. Forest Supervisors indicated a clear need for a clear strategy in relationship to climate change in addition for the appeal to climate change researchers to relay information in a way that it can be translated to direct on the ground management.

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CHAPTER 1: LITERATURE REVIEW

Introduction

"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level." (IPCC 2007)

Climate change is arguably the most pressing environmental threat of modern time and has come to the forefront in environmental policy circles regarding how to manage natural systems under altered and uncertain climatic conditions. Many state and federal natural resource agencies are exploring the idea of incorporating climate change issues into management policy. Further, research being conducted within the human dimensions of natural resources and other social sciences, particularly risk management, is investigating how the public perceives climate change, i.e. whether it is viewed as a risk to people in their daily lives, their future lives or the lives of their children, and how they behave as a result of their perceptions. These questions are important for policy makers attempting to deal with climate change issues because policy is driven primarily through the support or rejection of proposed rules by the public. The decisions made regarding climate change will undoubtedly be influenced by how the public and policy makers view the predicted risks associated with a changing climate.

Climate change is already disrupting Earth's natural systems and is poised to have much greater impacts. The IPCC (2007) reports that,

> "The resilience of many ecosystems is *likely*[1] to be exceeded this century by an unprecedented combination of climate change associated disturbances (e.g. flooding, drought, wildfire, insects, ocean acidification) and other global change drivers (e.g. land use change, pollution, fragmentation of natural systems, overexploitation of resources)," further, "Approximately 20 to 30% of plant and animal species assessed so far are *likely* to be at increased risk of extinction if increases in global average temperature exceed 1.5 to 2.5°C."

[1] Treatments of uncertainty are defined by the IPCC in Appendix I

Despite the fact that the majority of climate change literature has been focused on the current and potential impacts of climate change natural systems and human health, only a limited number of studies have been concerned with the social aspects of climate change. Those studies that have been carried out have focused primarily around the risk perceptions pertaining to climate change as identified by the general public (e.g. Leiserowitz 2006; O'Connor et al. 1999). Similarly, little work has been conducted within the social sciences regarding the perceptions of climate change by natural resource managers who are directly responsible for the proper management of approximately 12 percent of the Earth's surface (Schliep 2008). The perception of climate change by natural resource managers is extremely critical in that any policy created to respond to climate change will by undoubtedly be carried out by these professionals. Therefore, it is imperative to understand how natural resource managers view climate change.

Forests play substantial roles in the planet's biochemical cycles, notably the vast amount of gas exchange with the atmosphere; these systems are quite literally the lungs of the planet. Approximately 30 percent of the world's and about one-third of all land cover in the United States is forested (approximately 304 million ha). This makes the U.S. the fourth largest forest estate of any nation; only exceeded by Russia, Brazil and Canada. Of this, the United States Forest Service (USFS) manages approximately 77 million hectares, or about 25 percent of the nation's forests (an area about the size of Texas) totaling about nine percent of the total land area in the country. Furthermore, 60 million ha. are designated as National Forests, which include tropical, boreal and temperate forest systems (USFS 2009). The management of forest systems in the U.S. falls on the shoulders of only a handful of professionals relative to size of the land area covered. These people are responsible for the overall management activities within their assigned forest systems. Thus, their perception of the risks associated with climate change will

undoubtedly drive the direction of forest management. Survey methods were used to investigate climate change knowledge, risk perceptions and policy preferences of those responsible for the well-being and management of forests within the United States National Forest System (NFS).

Climate Change

"The greenhouse effect has been detected and it is changing our climate now (Dr. James Hansen, testimony before Congress, 1988)."

Within the context of this thesis, climate change refers to the enhanced greenhouse effect resulting from anthropogenic, or human-caused, emissions of greenhouse gases into the atmosphere. The greenhouse effect is the natural process that traps heat in the lower portion (troposphere) of the Earth's atmosphere; without it, our planet would be on average about 60º cooler. Simply, short-wave radiation emitted from the sun penetrates the atmosphere and is absorbed by the Earth's surface. The radiation is then converted into long-wave radiation (heat) and emitted back toward space. The unique composition of Earth's atmosphere captures some of this heat and retains it primarily in the troposphere making the Earth much warmer than it would be otherwise; this process is cumulatively known as the greenhouse effect. A number of key gasses including: carbon dioxide (CO_2), methane (CH_4), water vapor (H_2O), ozone, nitrous oxide (N_2O), and halocarbons (including cholorofluorocarbons [CFCs] and hydrochlorofluorocarbons) are all major contributors to the warming process. These gasses have all (with the exception of anthropogenic halocarbons) been present in the atmosphere for billions of years; however, human activities have unnaturally increased the concentrations of many of these gasses since the 1700s thereby enhancing the greenhouse effect.

The gas most concerning to scientists is carbon dioxide (CO_2). CO_2 isn't the most potent heat trapping gas on a per-molecule basis (e.g. methane's heat trapping potential is 23x greater than that of CO_2) but its abundance in the atmosphere relative to other gasses is quite large, and growing, meaning it plays a greater role in the greenhouse effect (IPCC 2001 in Withgott and Brennen 2006, See Figure 1).

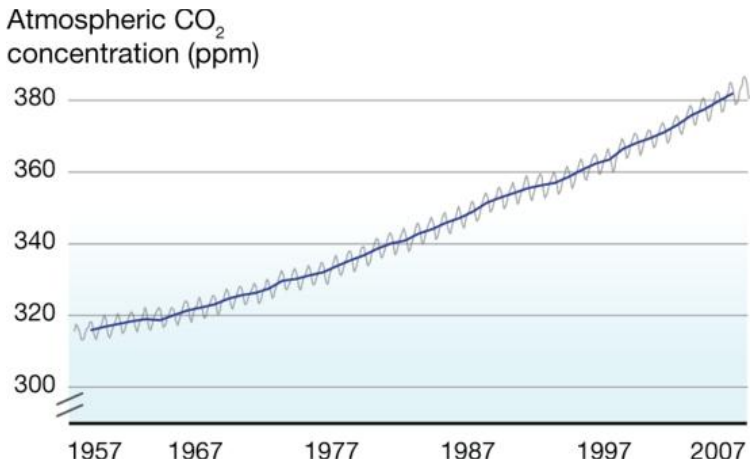


Figure 1. *The Keeling Curve depicting atmospheric concentrations of CO_2 at Mauna Loa Observatory, Hawaii from 1958-2007(UNEP 2008)*

Concentrations of CO_2 have increased from a level of approximately 280 parts per million (ppm) during pre-industrial times to a level of approximately 385 ppm now (CCRP 2009). The present concentration is the highest during the last 650,000 years (Siegenthaler et al. 2005) and probably during the last 20 million years (Pearson and Palmer 2000). Although changes in concentrations of atmospheric gasses are part of natural cycles, the recent and dramatic changes in levels of greenhouse gasses are a direct result of human activities, primarily the burning of fossil fuels such as coal, oil and natural gas (IPCC 2007; CCRP 2009).

The Earth's crust contains vast amounts of carbon storage in the forms of oil, coal and natural gas. The plethora of plants that grew during the Carboniferous Period (394-290 million years ago) sequestered enormous amounts of CO_2 from the atmosphere. When these plants died,

they fell into the swamps and wetlands around which they grew and became covered in sediment. Through geological processes, this organic matter was converted to coal, oil and natural gas. These deposits are essentially vast stores of carbon that existed in the Earth's atmosphere millions of years ago. Until the 1700s, these deposits lay untouched, buried below the planet's surface. The onset of the industrial revolution lead to the mining and burning of immense amounts of these ancient carbon stores and as the result, we have transferred the carbon captured and stored during one place in time (the Carboniferous Period) to another (our present atmosphere). The result is an atmosphere that is unnaturally rich in CO_2 due to anthropogenic activities.

Global average atmospheric CO_2 increased from 280 ppm at the start of the industrial revolution to approximately 385 ppm currently. The growth rate of global average atmospheric CO_2 for 2000–2006 was 1.93 ppm y^{-1}. This rate is the highest since the beginning of continuous monitoring in 1959 and is a significant increase over growth rates in earlier decades: the average growth rates for the 1980s and the 1990s were 1.58 and 1.49 ppm y^{-1}, respectively (Canadell et al. 2007).

Carbon dioxide is a compounding problem because it has a long atmospheric life. Roughly one-half of the carbon dioxide released from fossil fuel burning remains in the atmosphere after 100 years with roughly one-fifth remaining after 1,000 years (CCRP 2009). In 2000, the IPCC developed a set of scenarios in a Special Report on Emissions Scenarios (SRES). These reports have been used to predict the impacts and trends associated with climate change under different emission scenarios reflecting the impacts of population growth, economic development, and other factors (excluding policies to reduce emissions). Findings reported in the SRES indicate that emissions of CO_2 from energy use will grow between 40 to 110% between

2000 and 2030 (CCRP 2009). The assessed ‘‘likely range’’ (66–90%) of global temperature increase by 2100 for the lowest emissions scenario (SRES B1) is 1.1 °C to 2.9 °C, whereas the likely range for the highest scenario (SRES A1FI) is 2.4 °C to 6.4 °C (Smith et al. 2008). Current carbon emissions are above the highest scenario developed by the IPCC. Thus, unless policies are developed to curb greenhouse gas emissions quickly, we are likely to feel the most severe effects of climate change far into the future.

Climate Change, Ecosystems and Biodiversity

“Of the more than 29,000 observational data series, from 75 studies, that show significant change in many physical and biological systems, more than 89% are consistent with the direction of change expected as a response to warming” (IPCC 2007).

Anthropogenic influence on the Earth’s climate system is predicted have a wide range of impacts- many of which are viewed as both negative and severe- on human society and natural systems. Impacts include such things as: ocean acidification, increase in global average surface temperatures, altered precipitation patterns, rising sea levels, increased severity of weather events, severe pest outbreaks, severe drought, more frequent and severe wildfires, altered flood regimes, and widely varying unknown implications for the world’s biodiversity.

The IPCC predicts with high confidence that climate change will result in extinction of many species and reduction in the diversity of ecosystems (Schneider et al. 2007). The vulnerability of biodiversity and ecosystems to changes in climate is greatly increased when taken in concert with the more traditional human influence associated with species loss including, development, habitat fragmentation, pollution, introduction of invasive species, etc. The effects of climate change are already having observable impacts on biodiversity around the world. Parmesan and Yohe (2003) synthesized the results of numerous independent studies that describe long-term observations of almost 1,600 species across the globe. The report concludes

that “the meta-analyses of 334 species and the global analyses of 1,570 species (or functional/biogeographic groups) show highly significant, nonrandom patterns of change in accord with observed climate warming in the twentieth century (Parmesan and Yohe 2003).” About half of the species analyzed showed significant variation in phonology and/or distribution over the past 20 to 140 years (Parmesan & Galbraith, 2004). Further, the IPCC gives estimates of the potential consequences of temperature increases on ecosystems and biodiversity. They report that a warming of 1°C above 1990 levels would result in a mass bleaching of coral reefs and upwards of 10 percent of all global ecosystems being transformed. A warming of 2°C above 1990 levels will result in mass mortality of coral reefs globally, with one-sixth of the Earth’s ecosystems being transformed, and about one-quarter of known species being committed to extinction. And an additional degree of warming, to 3°C, is likely to result in global terrestrial vegetation becoming a net source of carbon, over one-fifth of ecosystems being transformed, up to 30 percent of known species being committed to extinction and half of all nature reserves being unable to meet conservation objectives (Schneider et al. 2007).

Importance of Forest Ecosystems

Forests systems account for approximately 30 percent of global land cover yet contain one of the greatest concentrations and assemblages of species within any terrestrial ecosystem. These systems are widely adaptable and have given rise to distinct types found in almost every region of the Earth. The World Bank reports that forests ecosystems harbor approximately 80 percent of Earth’s terrestrial biodiversity (World Bank 2009). Tropical rainforests account for only two percent of the global land area yet these incredibly diverse systems account for nearly 50 percent of all biodiversity found on Earth. Although incomparable to the biodiversity found in tropical settings, forests in temperate climates are hotspots for biodiversity. The distribution and

unique assemblages of plants and animals that make up these systems are driven through their climatic tolerances. These assemblages have competed, shifted, and evolved together over thousands of years and now represent the current structure, composition, and function we identify as a forest ecosystem.

Forest ecosystems serve important functions for both society and natural processes including: water storage, flood control, erosion control, improvement of water quality, renewable energy sources, timber products, and wildlife habitat. Forests provide opportunities for recreation such as hiking, camping, fishing, and wildlife viewing and are valued for their aesthetic values as well. The make-up and ecological balance within these systems relies heavily on the global and, often more importantly, regional climate systems (Solomon and Freer-Smith 2007). The components that make up forest systems have adapted to the climatic conditions where they are found and rely on these favorable environmental conditions in order to flourish (Fischlin et al. 2007). Forests are adapted to the particular processes characteristic of the region in which they are found. For example, forests in Alaska and the north-central U.S. are adapted to persist through very cold extremes and those forests found in the southwest are particularly well adapted to deal with drought and fire. Climate influences control the disturbance regimes and overall balance within these systems. If climatic patterns are altered, the natural balance within the system can be disrupted resulting in changes in distribution and growing conditions of flora and fauna through the alteration of resources, survivorship and fecundity (Joyce et al. 2001; Seppälä 2007).

The nation's forests provide water to approximately 60 million Americans which accounts for nearly 20 percent of the nation's population in 3400 towns and cities (CCSP 2008). Changes in the distribution, form and intensity of precipitation as a result of a changing climate

will have direct ramifications on those receiving water from National Forests in addition to creating difficulties in the management of watersheds. People and ecosystems in the western United States are heavily dependent on snow melt as a source of water. McNulty (in USFS 2007) reported that reductions in snow pack and earlier snow melts are increasing, thus rendering the region low on water during the summer. This comes at a time with population growth continuing in the west, ground water reserves being used beyond sustainable levels, and an increase in irrigated water usage across the U.S. all resulting a higher demand for water.

Impacts of Climate Change on Forest Ecosystems

The hundreds of scientific studies and the dominant consensus among climate scientists around the world make it clear that our planet is currently going though, and will continue to undergo, rapid climatic shifts as a result of human generated greenhouse gas emissions. The consequences of our actions will have adverse impacts on Earth's natural systems. Consequently, ecosystems that we know and recognize are in danger of significant alteration as many of the processes associated with these systems are driven at least in part by climate. Furthermore, changes in the climate system, in association with the more traditional means, such as habitat degradation and pollution, are creating additional stress on our planet's natural systems putting them in jeopardy of undesirable changes while, at the same time, pushing numerous species to the edge of extinction.

Ecosystem Services

Forests are responsible for playing a natural role in the global cycles of many processes including the circulation of carbon dioxide and water. Human influences are increasing atmospheric components that affect forest processes such as nitrogen oxides, which come from burning fossil fuels and cause acid rain, and ground-level ozone (known as smog) which forms

under the influence of hydrocarbons, nitrogen oxides, and sunlight, which adversely effects forest productivity (NAST 2000).

Forest systems are natural sinks for carbon. Carbon storage within these ecosystems is a function of the biomass of that system (Burley et al. 2007). When the biomass of a forest system is negatively altered, the ability of that system to sequester carbon is altered as well. The current level of deforestation releases about 1.6 Gt (gigatons) of carbon into the atmosphere annually accounting for nearly 25% - 30% of the world's greenhouse gas emissions (Burley et al. 2007; Dresner et al. 2007; Fischlin et al. 2007).

General assumptions regarding the effects of climate change, notably increases in temperature and altered precipitation patterns, are difficult to describe as changes will vary spatially and temporally. The National Association of Science and Technology (NAST 2000) reports that, based on a synthesis of laboratory and field studies, forest productivity is expected to positively correlate with increased levels of atmospheric CO_2, though this will vary regionally (Easterling et al. 2007). Productivity is expected to increase with increases in nitrogen abundance as well, but this is also regional. Generally, experts predict that forest productivity will increase throughout the eastern U.S., where water resources are relatively abundant, and decrease in much of the West, Southeast, and Alaska, where water is scarce and droughts are projected to increase in the coming years (CCRP 2009). As productivity increases a greater demand is put on soil moisture resulting in adverse impacts on most systems (Fischlin et al. 2007). As the climate warms, the soil is likely to decrease its moisture content thus decreasing productivity; and when coupled with the increased threat of severe fire, forests have the potential to turn into carbon sources rather than sinks. The growth or reduction of forests will likely depend heavily on other factors besides temperature including water and nutrient availability as well as human pressures.

Biodiversity

The variation of biodiversity within an ecosystem is based on rates of immigration, emigration, dispersal, fecundity, growth, and adaptations of both plants and animals within that ecosystem. These life characteristics ultimately decide the overall range a species is suited for. Disturbance plays a key role in many of these life characteristics. Humans have already impacted the natural roles that define a system and climate change is already having a noticeable effect on species. The U.S. Climate Change Research Program (CCRP 2009) reports that spring now arrives an average of 10 days to two weeks earlier than it did 20 years ago in the United States; the growing season is lengthening over much of the continental U.S.; and many migratory bird species are arriving earlier.

The analysis of several climate change models encompassing several scenarios indicates that the current distribution for a number of tree species is projected to shift (NAST 2000). The distribution of tree species adapted to cool climates are projected to shift north, while those occupying alpine environments are likely going to shift to higher altitudes, thus eliminating some species because of limitations of how high in altitude they can climb (NAST 2000). Warm climate communities such as oak/hickory and oak/pine in the east and Ponderosa pine are likely to expand in range given that they are well suited for dispersal and are highly adaptable (NAST 2000). Tree species are known to support a range of other organisms; therefore the loss of any tree species can result in an overall loss in biodiversity (Ayers and Lombardero 2000). In addition, genetic differences between individuals or among species may lead to wide variations in survival (Hanson and Weltzin 2000).

Fire

Wildfires are a natural occurrence and are essential to maintaining the integrity of many ecosystems such as the forests of western North America. Fire regimes are directly influenced by climatic variables; hence, changes in climatic conditions can result in changes in the frequency and severity of wildfires. If predictions of future climate scenarios become a reality, an increase in fire intensity and occurrence across the United States could have the most abrupt and significant impact on ecosystems (Flannigan, Stocks and Wotton 2000). Reasons for an increase in wildfires can be attributed to an increasing fire season length, increase in potential size of fires, and an increase in the vulnerability of areas previously unaffected or never affected by fire in the past, fuel load increases due to fire suppression management, and changing vegetation compositions as a result of a changing climate and will all contribute to altered fire regimes (CCSP 2008).

Before European settlement, in areas that experienced fires, high densities of fuel wood and small saplings were eliminated as a result of naturally occurring fires. Currently, forests (primarily the West) are much denser and contain high amounts of fuel wood due to fire suppression (Solomon & Freer-Smith 2007). Suppression of fire creates situations that result in higher intensity and frequency of uncontrollable fires as well as aiding in increased abundance of insects. Further, when fires are suppressed, composition of vegetation may change, resulting in varied responses by new species to stressors such as insect infestations that are more prevalent in the absence of fire.

Fire suppression is greatest on the expanding wildland-urban interface, and currently, of the 5.5 billion dollar budget of the USFS, 42 percent is spent fighting fires, and in order to

support this massive professional firefighting force, the USFS accounts for two-thirds of all firefighting resources in the U.S. (USFS 2007).

Westerling et al. (2006) reports that western forests have a observed longer fire seasons, longer fire durations, and larger fires overall with a significant increase (60 percent) in the western United States as a result of earlier spring snowmelt, and higher spring and summer temperatures. Alaska also has experienced large increases in fire, with the area burned more than doubling in recent decades (CCRP 2009). For forests in the northeastern portion of the country, a combination of prolonged dry periods, as a result of altered precipitation regimes, and warmer temperatures will likely make this area more susceptible to fire. Although climate models conflict on expected precipitation regimes in the South, it is still projected that this region will experience temperature and drought driven increases in fire as well (CCSP 2008). Overall, climate scenarios indicate an increase in fire intensity resulting in a 25-50 percent increase in the area burned within the United States, primarily in the west and southeast (Dale et al. 2001).

Pests and Disease

Insect outbreaks are the number one agent of natural disturbance in North American forests impacting an area approximately 45 times greater than that impacted by fire (Logan, Régnière and Powell 2003; Dale et al. 2001). Assessed with disease, insects cost $1.5 billion in damage per year (CCRP 2009). Insects are key indicators of alterations in forest ecosystems because their ectothermic physiology positively responds to warming influences. These responses result in increased ranges and fecundity. In addition, insects are highly mobile and climatic conditions ultimately determine a species' geographic distribution; if temperatures shift or increase, insects will utilize that changing dynamic and adjust accordingly (Ayres and

Lombardero 2000; Logan et al. 2003). Crozier and Dwyer (2006), report that warmer temperatures have already enhanced the opportunities for insects to spread into areas previously unoccupied. Altered climatic conditions, particularly rising temperatures, increase insect outbreaks in a number of ways. First, higher average winter temperatures more insects to survive the cold season that normally limits their numbers. Second, a longer growing season allows them to develop faster. Third, with warmer conditions, insects are expanding their ranges northward. Finally, drought stress reduces trees' ability to resist insect attack (CCRP 2009).

The mountain pine beetle (*Dendroctonus ponderosae*) has infested lodgepole pine in British Columbia, effecting over 13 million ha. of forest, which amounts to the largest such outbreak in recorded history. Another 600,000 ha. have been infested by pine beetle in Colorado. The Spruce beetle (*Dendroctonus rufipennis*) has affected more than 1 million ha. in Alaska and western Canada (CCRP 2009). Dale et al. (2001) suggests that increased warming will likely increase the diversity of insect related disturbances at higher latitudes and higher elevations. Ultimately, climate change has the potential to shift the current ranges of insects resulting in the possible modification of tree physiology and tree defense (Easterling 2007).

Invasive Species

Invasive species are already a problem in many areas of the United States, and effect forest ecosystems through herbivory, composition alteration, competition with native species, and introduction of disease. Responses by invasive species to changes in climate are difficult to predict for many reasons. First, the exact affects of climate change are not yet fully understood. Secondly, the spread and influence of invasives on native communities will depend on the management tactics and ultimately the philosophy associated with developing strategies to either

cope or eliminate invasives. And third, climate change will likely influence the movement of various native species into favorable habitats never before occupied, and thus creating new communities with unknown impacts on ecosystem services and function.

Building the Case for Forest Ecosystems

Looking at projected losses due to land-use change alone (native habitat loss), habitat reduction in tropical forests and woodland, savanna and warm mixed forest accounts for 80 percent of the species projected to be lost or about 30,000 species (Sala, 2005 in Fischlin et al., 2007).

The world's forests are predominately divided into three subgroups based on region. Boreal forests, such as the forested area extending across Canada, Scandinavia, and Russia; tropical rainforests include forested areas in tropical regions such as Central and South America, Indonesia, Southeast Asia, and Equatorial Africa; and temperate forests such as those found in the United States, northeast Asia, and west-central Europe.

In the United States, approximately 56 percent of all forested land is privately owned whereas the remainder is under federal ownership (American Forest Foundation 2009, USFS 2009). In addition, the majority of private forests are highly fragmented and/or altered as well as utilized for purposes different from those under public ownership. Privately held forests are exploited for predominately utilitarian purposes, which varies from recreational hunting to industrial forestry, making each privately held forest a unique managerial circumstance especially at an ecosystem level as each are managed for very different purposes

National Forests are managed by the USFS and are unique in that they are publicly owned, highly connected (unfragmented) and have mandated management plans. These characteristics make the forests of the NFS ideal to serve as the prototypes from which climate change management policies could be designed, implemented and based off of. It is for this

reason that the managers of the forests within the NFS have been chosen as the focus of this thesis.

Risk

Since the USFS has a direct influence in the management of nearly ten percent of all land area in the United States and approximately 25 percent of all forested land, forest managers are in a key position regarding the conservation and preservation of these systems against a background of climate change. With a presidential administration committed to being a leader in addressing climate change, National Forests have a role in that they can exemplify techniques related to adaptation and mitigation within their management, which, as was shown above, plays a critical role in the Earth's biochemical processes.

Considerable attention has been dedicated to mitigation and adaptation measures that could be utilized to address climatic changes as the problem is most often labeled a "technical" one; despite the vast amount of attention given at the scientific level, little work has been conducted on the social aspects and perceptions climate change (Schliep et al. 2008). Climate change is still perceived to be a controversial issue by much of the public, the media, and politicians as, with only notable exceptions, outside of the scientific community, these groups show little concern about climate change and its consequences (Weber 2006).

Forest managers often struggle with more immediate threats to their forest systems aside from those posed from a changing climate. Deteriorating infrastructure, unmanaged recreation, pests, wildlife, disease, etc. all contribute to the list of stressors forest managers deal with on a daily basis. This forces the allocation of resources to more immediate threats to which the risk associated with these stressors is perceived to be the most pressing (Schilep et al. 2008). It then

follows that the risk perception[2] of USFS Supervisors and Deputy Supervisors (those responsible for the management activities of forests within the National Forest System) plays a key role when deciding on appropriate action, successful communication with stakeholders, politicians, and scientists, and effective decision-making for mitigation and adaptation policies within each National Forest.

Governments, industries and public interest groups have spent huge sums of money conducting risk assessments to address public demands for things such as safer and healthier foods, transportation, medicines, medical procedures, nuclear power plants, etc. The risks associated with the things many of us come in contact with on a daily basis, whether we are aware of it or not, can capture the attention and drive the policy agendas of entire countries and occasionally the world as a whole (Leiserowitz 2003).

In today's society, the term "risk" and "danger" are often synonymous terms, especially among the lay public. In everyday language, "risk tends to be used to refer almost exclusively to a threat, hazard, danger or harm" (Lupton 1999:8). Society now restlessly worries about the risks of unemployment, crime, the economy, unsafe products, pollutants in the air or water, terrorism, gas prices, etc. Within the context of this study, risk perception refers to the perceived likelihood of negative consequences to oneself, society and/or natural systems from one (or more) specific environmental phenomenon; the context of this study is referring specifically to climate change (modified from O'Connor 1999)

Within the past two decades, climate change has come to exemplify the extent of how our risk perceptions guide policy agendas at local, national and international levels. Efforts to define the causes, impacts, risks and potential solutions associated with a changing climate are taking

[2] "Risk" is defined as the potential harm or injury that may arise from some current process or from some future event (in this case- climate change) (Schilep et al., 2008; Renn, 2008)

place across diverse disciplines at local, national and international levels. As a result, a variety of new initiatives and legal frameworks have been created, or are currently in the development process, to research, mitigate, and/or assess the risks associated with climate change at all levels of government. State programs, such as those with greenhouse gas emissions targets (Illinois, New Mexico, California, among others), national programs, such as the current Kerry-Lieberman-Graham Climate Bill, and international agreements, such as the Kyoto Protocol and the Copenhagen Accord are quickly being developed. A January 2009 report issued by the PEW Center breaks down various state initiatives geared toward addressing climate change. Within the United States, there are currently 33 states either actively participating or preparing to participate in regional cap-and-trade initiatives; 40 states have some sort of alternative fuel policy agreements that offer financial incentives for using alternative fuels, gasoline/ethanol blends, alternative-fuel vehicles, and/or low-emission vehicles; and 36 states have completed, or are in the process of revising or developing, comprehensive climate action plans with more than half of the states having set up advisory boards or commissions to develop and/or implement climate action plans that are designed to help decision-makers recognize the most cost-effective opportunities to reduce GHG emissions in ways most suitable for their states (PEW 2009).

It is apparent from the actions outlined above that the risks associated with climate change have motivated the international community to address this threat; yet, despite the consensus among scientists and researchers and the identification of numerous consequences associated with climate change, global greenhouse gas emissions have continued to rise. These trends suggest disconnect among scientists and the general public regarding climate change risks (see following section). But what are the perceptions of those who manage nearly ten percent of our nation's forested area? Clearly, the risk perceptions of these professionals will play a critical

role in the actual on the ground management, management practices, and support for policies designed to mitigate climate change. It is unlikely that these professionals will alter how they do their jobs or support policies addressing climate change until they view climate change as a serious risk themselves.

Risk Perception

Two of the most important factors influencing policy makers are scientists and the general public; therefore, public and expert risk perceptions of climate change will ultimately drive the political response for how climate change is to be addressed. Risk perceptions held by the public and scientists are center in the realm from which policymakers operate. Public opinion can either drive or halt political, economic and/or social action to address particular risks (Leiserowitz 2005). For example, international regulations of greenhouse gasses will greatly depend on the public perception of the risk associated with climate change. Currently, as is described in detail below, Americans view climate change as a risk, but not to the extent that they feel it is necessary to alter their own lifestyles. The lack of pressure on political leaders has resulted in the American holdout on binding regulations to reduce greenhouse gas emissions although scientists warn of serious consequences if action is not taken now. Thus, both the risk perceptions of the general public and of scientists are important components of the policy-making process.

One of the primary ways to measure risk perception among various groups is through surveys or questionnaires. The following is an overview of some of the public opinion polls describing the variation in risk perception associated with climate change over the past two decades.

Climate change didn't become a national public issue until the summer of 1988, which happened to be the hottest year since the middle of the nineteenth century (Leiserowitz 2003). On June 23rd of that year, Dr. James E. Hansen, director of the NASA Goddard Institute of Space Studies testified before the U.S. Senate Energy and Natural Resource Committee in a hearing on global climate change in Washington D.C. on a day where the high temperature set a new record of 101 degrees. In his testimony, Dr. Hansen stated that "the greenhouse effect has been detected and it is changing our climate now" (Hansen 1988).

Over the past two decades since that committee hearing, scientists have been attempting to assess the risk perception associated with climate change using public opinion polls. Public perception of climate change has varied over this time. A Gallup survey conducted in May of 1989 found that 35 percent of Americans indicated they worried "a great deal," 28 percent worried "a fair amount," 18 percent worried "only little," and 12 percent worried "not at all" when asked the question, "How much do you personally worry about the greenhouse effect or global warming?" In 1994, at a time when oil, coal, and other industries that rely heavily on materials that contribute to climate change were lobbying hard to discredit climate change science, a national poll conducted by Cambridge Reports found that only 28 percent of participants stated that "there is a consensus among the great majority of scientist that global warming exists and could do significant damage," whereas 58 percent claimed scientists are divided on the occurrence of global warming and any potential impacts it would have. A 1997 CNN/USA Today poll found that 48 percent of Americans thought that "most scientists believe that global warming is occurring," whereas only 39 percent thought that scientists were still unsure about whether global warming is occurring or not. Ten years later, in 2007, a CNN/Opinion Research Corp. poll found that 56 percent of participants said that the

"phenomenon of global warming has been proven, and can be largely blamed on human endeavors, such as power plants and factories," whereas only 21 percent of those surveyed claimed, "global warming problems are caused either by natural changes or are unproven (CNN, 2007)."

More recently, an October 2009 PEW Research Center in partnership with People and the Press conducted a poll and found that 57 percent of respondents think there is solid evidence that the average temperature on Earth has been getting warmer over the past few decades. In comparison, a poll conducted in April 2008 found that 71 percent of respondents said there was solid evidence of rising global temperatures. In addition, the same poll found that over the same time period there has been a comparable decline in the number of Americans who say global temperatures are rising as a result of human activity, such as burning fossil fuels. Just 36% say that currently, down from 47 percent last year. Further, only 35 percent of respondents see global warming as a very serious problem- down from 44 percent in 2008 (PEW, 2009b).

Furthermore, a March 2009 Gallup poll found that 41 percent of Americans believe the seriousness of global warming is exaggerated in the news; and more Americans think global warming is exaggerated rather than underestimated, 41 percent vs. 28 percent. This is the highest point Gallup has found with relation to "exaggeration" since measurement began in 1997. In addition, compared to a Gallup study conducted in 2008, fewer Americans believe the effects of global warming have begun to occur (53 percent, down from 61). At the same time, a record number, 16 percent, said that the effects of climate change will never occur (Saad, 2009).

Finally, a collaborative study between Yale University and George Mason University found that in late 2009 and early 2010 only 57 percent of Americans agreed when asked if

climate change is happening. This number is down from 71 percent who agreed with the same statement in October of 2008 (Leiserowitz, et al., 2010).

Risk Perception Studies

In general, studies have found that the public's risk perception with regard to climate change can be summed up in the following way: climate change is real and there is a modest to high level of concern about the seriousness of the issue; the general public doesn't understand the underlying causes of climate change; and, although climate change is perceived as a problem individuals do not feel it is necessary to change their lifestyles to address the problem (Schliep, et al. 2008; Leiserowitz 2003).

A handful of general studies investigating the risk perception and policy responses associated with climate change issues have been conducted. While important, and undoubtedly contribute to the growing understanding of climate change risk perception, many of these studies fail to look at the drivers of risk and instead focus on whether or not climate change is viewed as a risk and what policy responses are suitable for addressing the issue. One such study comes from Moser and Tribbia (2006/2007). These researchers looked at attitudes, knowledge and policy preferences of coastal managers with regard to climate change threats. Although no statistical analysis was conducted, Moser and Tribbia concluded through descriptive analysis that coastal managers displayed a high level of knowledge with regard to current impacts and potential impacts of climate change and in turn displayed a heightened risk perception with regard to issues associated with an altered climate (Moser and Tribbia 2006/2007).

Further, Moser and Tribbia investigated specific barriers preventing adequate responses to climate change issues. They concluded that financial barriers were the most prevalent response

elicited by those participating in their study. Other barriers included lack staff resources to address the issue, lack of funding to create management plans, and other, more tangible issues taking priority over the uncertain and seemingly overwhelming task of addressing climate change. In addition, over half of their respondents identified the lack of a legal mandate to address climate change issues as a major barrier to management (Moser and Tribbia 2006/2007).

Few studies have looked at the specific perceptions of individual populations of people outside those with specific political affiliations or across nationalities. One notable exception is the work of Rainer Schliep, Monika Bertzky, Martin Hirschnitz and Susanne Stoll-Kleemann of the Ernst Moritz Arndt University of Greifswald, Germany, who in 2008 conducted a global survey of biosphere reserve managers investigating the risk perception and response of these individuals regarding climate change issues.

Like the focus of the study presented in this thesis, Schliep et al. focused on the individual motivations of natural resource managers (specifically, biosphere reserve managers) and the conditions that dictate those motivations and how those factors relate to climate change management. Thus,

> *"PA managers, are struggling with a variety of challenges and threats besides climate change- inter alia management deficiencies, illegal activities, and external stressors such as pollution and invasive species. They often have to allocate management resources according to which risk is perceived to be the most pressing one."*

In their study, the researchers compared the vulnerability (defined as 'preparedness' in this study) of ecosystems within biosphere reserves with the idea that climate change risk perception will be higher in areas that are perceived as vulnerable to climate change impacts. The findings ran contrary to their hypothesis. In fact, within vulnerable ecosystems, climate change was perceived as the third most pressing threat behind illegal activities and pollution, and was

ranked just higher than invasive alien species. This indicates that more tangible threats to the environment dominate biosphere reserve managers' risk perceptions (Schliep et al. 2008).

Schliep et al. (2008) also found that vulnerability of ecosystems only plays a minor role in the overall risk perception associated with climate change in Biosphere Reserve managers. The researchers concluded that this is primarily attributed to scarce management resources and significant pressures from other more pressing threats to the ecosystem. Thus, the microeconomic climate of the reserve is instrumental in affecting the risk perception associated with climate change.

In addition, within the context of this study, trust and government responsiveness to climate change issues play a critical role in the risk perception of Biosphere Reserve managers. As these managers see an urgency within their countries to address the issue whether it be at the national or sub-national level, and then they feel the urgency themselves.

Finally, Schliep et al. concluded that, "As long as other threats are overwhelmingly present and sites are understaffed and underfunded, there will not be space to address climate change." It is therefore necessary to incorporate strategies that have an 'umbrella' effect on management, whether for climate change or another stressor, be relayed to the managers. Another way to fill this gap is to incorporate these managers in research activities that foster their ability to learn and understand the impacts of climate change on themselves, their communities, and ultimately, the ecosystems they manage.

Leiserowitz (2006) investigated the willingness of Americans to support a variety of national and international policies to mitigate climate change. This research was grounded on the risk perception associated with climate change issues, and found that American have moderate

climate change risk perceptions but perceive the threats of climate change to be geographically distant and will have minimal impact on their own personal lives (Leiserowitz 2006).

Although Leiserowitz (2006) found a moderate risk associated with climate change issues, there was a contradiction identified regarding how the issue should be addressed. On one side, Americans strongly supported policies to reduce carbon dioxide at both the national and international levels, but on the other side, the same group strongly opposed energy and gasoline taxes, both of which have direct implications on greenhouse gasses, and on Americans' bank accounts (Leiserowitz 2006). Thus, this study found that Americans demonstrated high knowledge and moderate concern regarding climate change issues and then in turn supported a variety of government actions to address the issue aside from those associated with fuel and energy taxes.

Leiserowitz concluded that the results of his study suggest that, "Underlying values and worldviews strongly conditions the way many members of the American public currently think about this risk and public policy options to mitigate global climate change." Furthermore, Leiserowitz reasoned that risk perception and policy preferences associated with climate change go beyond knowledge and are influenced by sociopolitical factors as well and that knowledge, trust and other constructs should be incorporated into future studies to give a more complete picture of what drives climate change risk perception (Leiserowitz 2006).

Another notable study was conducted in 1997. Robert O'Connor, Richard Bord and Ann Fisher of Penn State University carried out an in depth study of American risk perceptions, knowledge, and behavioral intentions associated with climate change. One of the primary points of interest in their study was the relationship between knowledge of actual and false causes of climate change and risk perceptions and behavioral intentions. They found that individuals that

correctly associated actual causes of climate change had high risk perceptions and were likely to sacrifice to help reduce the impacts. In addition, those people that identified false causes of climate change were also willing to have a high risk perception but will less likely to sacrifice to prevent potential impacts; thus, they concluded that accurate knowledge of climate change causes and impacts may not be the primary driver of risk perception, though it may be an important area for public support of mitigation efforts (O'Connor et al. 1998; Leiserowitz 2003).

O'Connor et al. (1999) found that knowledge of the causes of climate change is an accurate predictor of behavioral intentions to address climate change which is independent from the level of risk associated with the consequences of climate change. In addition, this study found that risk perceptions and knowledge about climate change increase a willingness to address environmental problems and support behavioral intentions (willingness to take voluntary actions or support government initiatives) to address climate change issues. Thus:

> *Our primary conclusion is that risk perceptions matter in predicting behavioral intentions. Risk perceptions are not a surrogate for general environmental beliefs, but have their own power to account for behavioral intentions...the success of the risk perception variables in accounting for behavioral intentions should encourage greater attention to risk perceptions as independent variables…[past psychometric] work has taught us much about how people conceptualize risks, but rarely looked at the consequences of these perceptions for behavioral intentions or actual behavior (O'Connor 1999: 469-470).*

The research group also constructed multiple regression models that incorporated knowledge, risk perception, general environmental beliefs, and sociodemographic variables to predict voluntary behaviors and support for government initiatives to mitigate global climate change (Leiserowitz 2003, O'Connor 1999). It was determined that each independent variable outlined above retained statistical significance and explanatory power in the full model, indicating that each remained an important predictor of behavioral intentions even in the

presence of the others. This thesis will test many of the parameters outlined above and will contribute to an area seldom looked at within the area of risk perception and environmental management.

CHAPTER 2: METHODOLOGY

Hypotheses and Research Questions

This research was designed to investigate the drivers of risk perception within Forest Supervisors and Deputy Forest Supervisors in addition to answering several questions pertaining directly to USFS response to climate change issues.

This research was designed to answer several general questions:

1. Do USFS employees perceive global climate change as a risk to forests?
2. How likely and how severe do they believe the consequences will be on forest ecosystems?
3. Do USFS employees support inner-agency policies to address climate change and what types of policies are employees most likely to support?
4. What, if anything, could the USFS be doing to more adequately respond to the threats climate change pose to the forests of the National Forest System?

This research also seeks to test the following hypotheses:

1. Higher levels of knowledge pertaining to climate change and higher levels of trust in scientists will increase level of perceived risk associated with climate change.
2. Higher levels of perceived risk associated with climate change will reflect a greater degree of preparedness regarding climate change issues
3. Higher levels of risk associated with the impacts of climate change will reflect a greater satisfaction of climate change policies within the USFS

4. Higher risk perception, knowledge and preparedness associated with the impacts of climate change will reflect a greater degree of policy need with regard to climate change issues within the USFS.

Research Design

In order to evaluate the hypotheses outlined above, a formative evaluation of was chosen for this study. Formative evaluation is a type of evaluation designed with the intent to improve a specific area of interest, which in this case is USFS climate change policy. A web-based survey instrument was utilized to collect both quantitative and qualitative data. The survey administered to current USFS Forest Supervisors and Deputy Forest Supervisors.

PROCEDURE AND RESPONDENTS

Survey Tool

Survey questions consisted of original questions designed by the author and members of his graduate committee as well as questions taken directly from other surveys that were revised to fit the objectives of this study (see Leiserowitz, 2007; ecoAmerica, 2006; and NFO My Survey). Questions were broken into sections designed to give insight into various facets of climate change. The constructs examined were:

- general knowledge of climate change issues;
- trust in scientist and expert opinions about climate change;
- risk perception associated with the potential impacts of climate change;
- preparedness to respond to climate change;
- satisfaction of current USFS policies to address climate change and
- areas of need associated with climate change within USFS policy.

Questions about forest management and possible policy responses to climate change issues were asked and sociodemograpic measures were also solicited and included sex, region of the USFS the respondent works in, and age. See Appendix B for the full survey instrument.

Survey Design

The researcher designed the questionnaire during the spring and summer of 2009. The questionnaire was broken up into different sections, each addressing one of the constructs defined below. The survey included various question types including Likert scales, rankings, choose the best answer, and select as many as apply. These questions provided the bulk of quantitative data. Qualitative data was obtained through a variety of open ended questions. The following constructs were investigated with regard to climate perceptions.

Knowledge

Six questions comprise a 'Knowledge Index' used for statistical analysis. These questions were designed to gain insight into the general knowledge level regarding some of the most generally accepted aspects of climate change science (see Appendix H for full list of questions):

- Questions 1-6: "General Knowledge of Climate Change"- Five Likert scale questions (e.g., Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree) and one question where participants were asked to select the most appropriate answer.

Risk Perception

Risk perception measures encompassed areas including, personal concern for climate change issues and potential impacts, the seriousness of the threat of climate change, as well as the level of concern regarding the potential impacts of climate change on natural systems and

human well-being (see Appendix H for full list of questions included in this index). For statistical analysis, a 'Risk Perception Index' was constructed using six questions of which included the measures listed above:

- Questions 7-11, 14-15, 32-33: "Climate Change Risk Perception" – Six Likert scale questions designed to measure the level of risk perception associated with climate change impacts (used in Risk Perception Index). Four questions where respondents were asked to chose the most appropriate answer from a list of given answers were also included (not utilized in Risk Perception Index).

Trust in Scientists

A 'Trust Index' was designed to determine the level of trust participants have in what scientists say regarding climate change issues (see Appendix H for full list of questions). The 'Trust Index' was comprised of two questions:

- Questions 12 and 13: "Trust in Scientists" – Two Likert scale questions designed to measure the level of trust respondents felt in scientists with relationship to climate change issues.

Forest Management

Questions pertaining to forest management sought to assess the starting point and/or goal from which forest management is based on. These questions have implications for management under an altered climate regime that will be discussed in detail in the Discussion section of this thesis.

- Questions 16-18: "Forest Management"- Three Likert scale questions were designed to gain insight as to how forests are managed after a disturbance and if respondents believe

they can have a significant influence on how forests adapt to various stressors in the environment.

Preparedness

Several variables were measured to determine preparedness associated with climate change issues, including assessing how well current management can respond to natural disturbances and extreme weather events; whether or not current climate change models are being utilized in forest management plans or projects; whether staff are kept up to date on climate change findings. Six questions were utilized to create a 'Preparedness Index' to be used for statistical analysis (see Appendix H for questions):

- Questions 19- 24: "Preparedness"- Six Likert scale questions were designed to examine the preparedness of national forests due to potential changes associated with climate change.

Policy Effectiveness

A specific set of questions aimed at soliciting responses regarding the perceived level of effectiveness of current USFS policies to address climate change was included in the survey. Variables utilized in this section come from areas including, leadership on climate change issues; overall level of satisfaction regarding current policies; whether the USFS has a role in addressing such issues; and where resources would best be utilized by the agency. This section is broken into two distinct parts: Policy Satisfaction and Policy Needs. Indices, consisting of three questions, were utilized for each construct.

Policy satisfaction refers specifically to how satisfied participants are with the role the USFS has taken to address climate change and stresses the progress the USFS has made in the area of policy development (See Appendix H for questions).

- Questions 25, 27-28: "Policy Satisfaction" – Three Likert scale questions were designed to examine the satisfaction of current USFS policies relating to climate change.

Policy needs refers specifically to the needs and concern participants felt regarding climate change and USFS policy (Table 6 and Figure 6) (See Appendix H for questions).

- Questions 26, 30-31: "Policy Needs" – Three Likert scale questions were designed to examine the needs of current USFS policies relating to climate change.

Additional questions were asked about the sociodemographics of the respondent pool.

- Questions: 39-42, 45-47: "Sociodemographics"- These questions assessed the respondents' age, gender, area worked, and willingness to attend climate change seminars, lectures, meetings, etc.

Finally, the remaining questions were designed to yield insight into possible policy responses to deal with climate change.

- Questions 34-38, 43 and 44- "Policy Responses"- These questions were designed to assess possible policy responses to climate change issues through the eyes of the land managers themselves.

Revision Process

Prior to being sent out to the primary study group, Drs. Floress and Dombeck reviewed the questions on a number of occasions and the researcher subsequently made the necessary revisions. Questions were reviewed for clarity and general rewording.

Following the initial revision process, questions were sent out to a pilot study group selected primarily by Dr. Dombeck, and consisted of twelve individuals who represented various niches of the scientific community that the researcher and his advisor believed were able to provide useful insight and suggestions from a variety of different perspectives. Members of this group also included all graduate committee members. The pilot study was distributed June 29, 2009. Members of this group were asked to specifically review for clarity, focus, confusion, and general rewording. Participants were sent an initial e-mail explaining the purpose of the research with a link to the web-based survey embedded within the email. Two days after the initial contact e-mail another email was sent as a reminder. Pilot study participants were given one week to complete the survey. They were also asked to provide feedback about the survey if they wished. This could be done through direct email or via a comment box that was included at the end of the survey. After a few minor revisions based on suggestions made by this group, it was determined that the instrument was ready to be submitted to the focus group.

The final draft was submitted to the Institutional Review Board (IRB) at UW-SP and upon acceptance, the survey was sent to the focus group. The IRB accepted the instrument on May 13, 2009 (Appendix A).

Implementation

On August 9, 2009, a questionnaire soliciting the opinions of 171 USFS Supervisors and Deputy Supervisors was sent out via the survey design software provided by the University of

Wisconsin-Stevens Point, Select Survey. The names and contact information (email addresses) of Supervisors and Deputy Supervisors were obtained via the USFS website (www.fs.fed.us). Of the initial 171 employees identified, six had retired or no longer held the said position and the position had not yet been filled, leaving 165 possible respondents. Survey implementation was carried out via the Dillman Tailored Design Method (2000). This survey method relies on the numerous participant contacts to get the maximum response rate possible. An initial contact e-mail was sent two days prior to all Forest Supervisors and Deputy Forest Supervisors via the e-mail addresses found on the USFS website. The pre-notice made participants to be aware of the survey and to expect it in the coming days. See Appendix C for details. The cover letter described the research in great detail and provided a link to the survey instrument itself (Appendix D). On August 11, 2009 USFS employees received a reminder to participate in the survey (Appendix E). On August 28, a third reminder was sent to USFS employees that contained a link to the survey. See Appendix F for details. And on September 28 a final email reminder/thank you letter was sent to all Supervisors and Deputy Supervisors. See Appendix G for details. Those asked to participate were assured that their participation was voluntary and all responses would be kept anonymous. Survey data were collected over a 9½ week period, from August 09 until October 16, 2009. In total, 90 participants responded yielding a 55% response rate.

Treatment of Data

The results of the survey were analyzed by the researcher using statistical and descriptive techniques. All quantitative analysis was conducted using Statistical Package for Social Sciences (SPSS 18).

Scale Reliability

Cronbach's Alpha was utilized to determine the internal consistency, or interrelatedness of each set of measures used for statistical analysis (knowledge, trust, risk, preparedness, policy satisfaction, and policy needs). The researcher considered a reliability coefficient of .60 or higher to be considered "acceptable" in this circumstance. Normally, an acceptable value of .70 is considered acceptable by researchers, but because this study uses measures not commonly or never before utilized, the researcher accepted a value of .60 or higher (all measures with the exception of two, achieved a Cronbach's Alpha of >.680) (Table 1). Future refinement of the measures will likely increase Cronbach's Alpha.

Table 1. *Cronbach's Alpha for Indices*

Index Name	N of Items	Cronbach's Alpha
Knowledge	5	.744
Trust	2	.836
Risk Perception	6	.692
Preparedness	6	.604
Policy Satisfaction	3	.687
Policy Needs	3	.639

Histograms were checked for normality and multicollinarity diagnostics were run on all measures. All measures fell within acceptable ranges and so the researcher proceeded with the analysis.

Linear regression models were used to assess relationships among the measures tested. Linear regression models are used to predict how one or more variables respond to another. This is useful in forecasting how people might respond to a certain situation if one or more variables are known.

Qualitative data also were collected through the use of open-ended questions. These data were analyzed through the method of content analysis. Content analysis was coded by the

researcher for each open-ended response. The responses were examined by the researcher and concepts were chosen from the response using individual words or phrases. Next, the responses were analyzed to examine the frequencies that arose from specific concepts. Finally, the concepts with similar themes were grouped into larger categories and the frequency of each concept was combined within that larger category. In an attempt to make the analysis as valid and reliable as possible, the researcher created a set of codes related to specific concepts that were used throughout the coding process in order to remain consistent. These data were not intended to reflect theories of phenomena; rather, the data were only interpreted based on the content alone. These frequencies are presented in bar graphs that are included in the Results section.

CHAPTER 3: RESULTS

Overview

Of the 165 Forest Supervisors and Deputy Forest Supervisors with valid email addresses, 90 USFS employees responded to the survey, yielding a 55 percent response rate. The goal of this chapter is to evaluate those responses. The results from the regression analysis are displayed first with the frequencies of individual questions following.

Drivers of Risk Perception

Linear regressions were used to test the correlation between the measures used and to test they hypotheses, which were:

1. Higher levels of knowledge pertaining to climate change and higher levels of trust in scientists will increase level of perceived risk associated with climate change.
2. Higher levels of perceived risk associated with climate change will reflect a greater degree of preparedness regarding climate change issues
3. Higher levels of risk associated with the impacts of climate change will reflect a greater satisfaction of climate change policies within the USFS
4. Higher risk perception, knowledge and preparedness associated with the impacts of climate change will reflect a greater degree of policy need with regard to climate change issues within the USFS.

Model 1. Knowledge, Trust and Risk Perception

Knowledge about climate change and trust in scientists about climate change issues were tested against risk perception associated with climate change impacts. Linear regression models

indicated that there is significance between knowledge and trust with regard to risk perception at the >.001 level. Beta weights associated with the independent variables of knowledge and trust were .298 and .542 respectively indicating a very strong correlation between trust and risk perception. The R-square value indicated that knowledge and trust accounted for nearly 63 percent of the variation in the model suggesting that both knowledge and trust play major roles in the level of risk perception associated with climate change issues. See Table 2.

Model 2. Risk Perception and Preparedness

Risk perception of climate change was tested against preparedness associated with the impacts of climate change on forest systems. Linear regression models indicated that there is no significance between risk perception and preparedness as indicated by a p-value of .534. Beta weights were represented a -.066 association between risk perception and preparedness and less than 1 percent of the variation in the model can be accurately attributed to the influence of risk perception on preparedness. See Table 2.

Model 3. Risk perception and Policy Satisfaction

Risk perception about climate change was tested against satisfaction of policies associated with climate change impacts. Linear regression models indicated that there is no significance between risk perception and policy satisfaction as indicated by a p-value of .437. Beta weights suggest only a -.083 influence of risk perception on policy satisfaction with association to climate change. An R-square value of .007 suggests a very high amount of variance to be explained by other, unknown factors. See Table 2.

Model 4. Risk Perception, Knowledge, Preparedness and Policy Needs

Risk perception and knowledge about climate change in addition to preparedness with regard to climate change issues was tested against policy needs associated with climate change impacts. Linear regression models indicated that there is significance between risk perception, knowledge, preparedness and policy needs as indicated by a p-value of < .010. This indicates that the model is accurate at the 95 percent confidence interval. Beta weights shed additional insight on this model and indicate that knowledge about climate change is the biggest driver of policy needs with a beta weight of .218. Preparedness was also influential yielding a beta weight of -.203 whereas risk perception was the least influential at .055. An R-square value of .123 suggests that 12 percent of the variation in the model can be explained though the independent variables described above. See Table 2.

Table 2. *Regression Analysis for Models Tested*

Model	Predictor(s)			Dependent	P-value	R^2
1	Knowledge		Trust	Risk Perception	<.000	.626
	Beta: .298		Beta: .542			
2	Risk Perception			Preparedness	.534	.004
	Beta: -.066					
3	Risk Perception			Policy Satisfaction	.437	.007
	Beta: -.083					
4	Risk Perception	Knowledge	Preparedness	Policy Needs	.010	.123
	Beta: .055	Beta: .218	Beta: -.203			

Climate Change Risk Perception

Do U.S. USFS employees perceive global climate change as a risk to forests? If so, how likely and how severe do they believe the consequences will be on these systems? To answer these questions, the questionnaire described above included a series of risk perception questions including, personal concern for climate change issues and potential impacts, the seriousness of

the threat of climate change, as well as the level of concern regarding the potential impacts of climate change on natural systems and human well-being.

A clear majority of Forest Supervisors and Deputy Forest Supervisors, 84 percent, indicated a clear holistic concern with regard to the threat of climate change. Holistic concern was measured though agreement with the question of, "I believe that climate change is a very serious problem." Only three percent of participants disagreed with this statement. See Table 3. Because risk perception encompasses more than holistic levels of concern and includes things such as the of the likelihood and severity of various consequences on health and job security (measured in this case though threats to natural systems), more specific questions were asked relating to risk perception of climate change.

In general, Forest Supervisors view climate change as a substantial risk to forest ecosystems. Respondents were asked whether or not they were concerned about the severity of natural disasters in the near future. Fifty-eight percent of respondents indicated that they are concerned that in ten years natural disasters will be more severe than they are currently; 12 percent disagreed with this statement and nearly one third of respondents (30 percent) were neutral. Participants were asked how they felt about climate change issues in relation to other pertinent issues such as healthcare, terrorism, and the economy. Fifty-three percent of respondents indicated that we should not be more worried about the economy, healthcare, or terrorist threats over environmental problems such as climate change. Seventy-five percent of respondents indicated they believe that the consequences of climate change will affect themselves and their families in their lifetimes. Only four percent of respondents disagreed with this statement (Table 3).

Two questions asked specifically about the level of risk perception regarding climate change in association with environmental issues. Eighty-five percent of respondents indicated they were worried about the impacts climate change could have on natural systems versus only five percent who disagreed. In addition, 83 percent of respondents indicated they believe that climate change is already having adverse impacts on natural systems (Table 3).

Table 3. *Forest Supervisor Risk Perception*

Question:	**Strongly Disagree (1)**	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly Agree (5)**	**Mean (n=90)**
a. I believe climate change is a very serious problem.	1	2	11	41	35	4.19
b. I am concerned that ten years from now natural disasters will be more severe than they are now.	0	11	27	34	18	3.66
c. We should be more worried about the economy, health care, and terrorist threats than about environmental problems such as climate change.	8	40	31	8	3	2.53
d. The consequences of climate change will affect myself and my family in my lifetime.	1	3	19	50	17	3.88
e. I am worried about the impacts climate change could have on natural systems.	1	4	8	47	30	4.12
h. I believe climate change is already having adverse impacts on natural systems.	1	4	10	53	22	4.01

In addition, respondents were asked how concerned they were with the threat of climate change on individual forest systems. Respondents indicated they were most concerned with the threat of climate change on boreal forests as a whole. U.S. National Forests and regional forest systems within the U.S. were ranked of least concern of the choices (Table 4).

Table 4. *Threat of Climate Change on Selected Forest Systems*						
Level of Concern:	Most 1	2	3	4	Least 5	Mean (n)
U.S. National Forests	2	5	15	37	30	3.99 (89)
Regional Forest Systems (eg. Pacific Northwest)	3	6	15	30	35	3.99 (89)
Temperate forests as a whole	16	36	28	6	3	2.37 (89)
Tropical rainforests as a whole	27	19	17	11	14	2.61 (88)
Boreal forests as a whole	41	23	14	5	6	2.01 (89)

In addition, respondents were asked to rank a number of issues with regard to how large of a threat (1-11, one being most threatening, 11 being least) they pose to U.S. National Forests. Participants identified invasive species (3.1), pests (3.7) and climate change (4.3) as the three biggest threats facing U.S. National Forests (Table 5). Deteriorating infrastructure (7.4), water pollution (7.6) and illegal logging (10.6) were ranked least threatening (Table 5).

Table 5. *Level of Concern Associated with Various Threats to National Forests (1 indicates most threatening)*	
Invasive Species	3.1
Pests	3.7
Climate Change	4.3
Wildfire	4.6
Unmanaged Recreation	5.3
Urban Agricultural Development	5.4
Disease	5.7
Air Pollution	7.2
Deteriorating Infrastructure	7.4
Water Pollution	7.6
Illegal Logging	10.6
n=90	

Thirty-two percent of respondents indicated that they believe the most significant consequence of climate change to human well-being is droughts and water shortages. Twenty-one percent believed more severe natural disturbances are the most significant consequences.

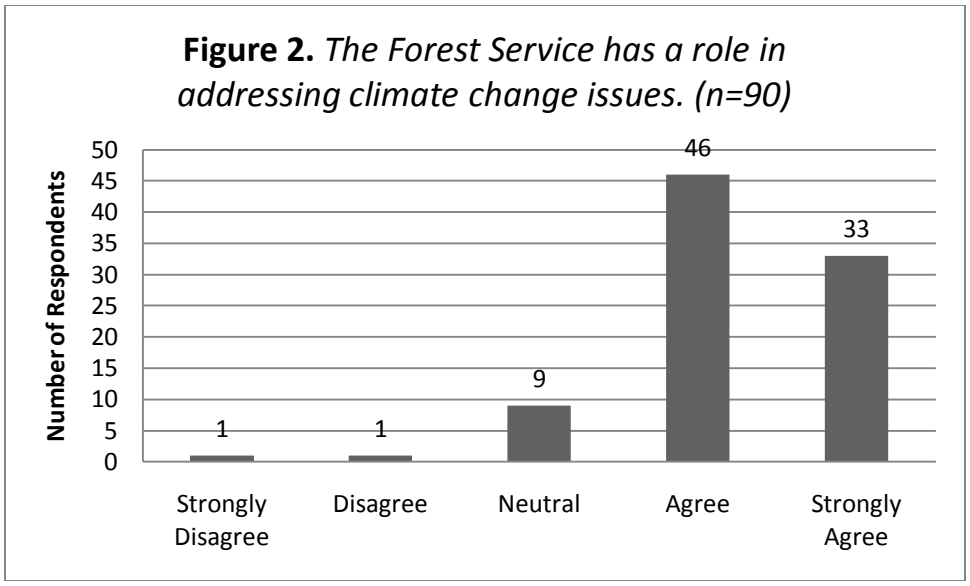
These were followed by sea level rise (17 percent) human health implications (13 percent), more extreme weather events (ten percent), and species loss (seven percent). See Table 6.

Table 6. *Most Significant Consequence of Climate Change*	
Droughts and Water Shortages	29
More Severe Natural Disturbances	19
Sea Level Rise	15
Human Health Implications	12
More Extreme Weather	9
Species Loss	6
Acid Rain	0
n=90	

Climate Change Policy Preferences

Do USFS employees support inner-agency policies to address climate change and what types of policies are employees most likely to support? To answer this question, the climate change questionnaire included a series of questions designed to measure USFS policy preferences and needs.

Before specific questions were asked, participants were asked if they first believe that the USFS has a role in addressing climate change issues. Eighty-eight percent of respondents agree and think the USFS has a role in addressing climate change issues. Only two percent disagree with this statement (Figure 2).



A series of questions were asked questions pertaining to satisfaction of climate change policies within the USFS. Thirty-five percent of respondents indicated that the USFS is not doing enough to address climate change issues, whereas nearly half (49 percent) of respondents responded neutral and only 15 percent agreed (Table 7). Participants were fairly evenly split when asked if they were satisfied with the progress the USFS is taking toward climate change issues (Table 7). Finally, 62 percent believe that the USFS has taken steps to bring climate change to the forefront of its policy agenda. Only 11 percent disagreed with this statement (Table 7).

Table 7. *Policy Satisfaction and Climate Change*					
Question:	Number of Respondents				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The USFS is doing enough to address climate change issues. (n=90)	2	30	44	11	3
I am satisfied with the progress the USFS is taking toward climate change issues. (n=90)	2	26	33	28	1
The USFS has taken steps to bring climate change to the forefront in its policy agenda. (n=90)	2	8	24	47	9

Next, a series of questions were asked pertaining to policy needs of the USFS with relationship to climate change. Forty-eight percent of respondents indicated they believe the USFS should increase spending on research and development projects related to climate change. Nearly one-third responded neutral and 18 disagreed (Table 8). When asked if they are concerned that the USFS isn't doing enough about climate change, 43 percent of respondents disagreed and 25 percent agreed (Table 8). Finally, 60 percent of respondents indicated that the USFS has the leadership in place to address climate change issues. Only 13 percent of respondents indicated that leadership is lacking (Table 8).

Table 8. *Questions Pertaining to Policy Needs of the USFS with Regard to Climate Change*					
Question:	Number of Respondents				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The USFS should increase spending on research and development projects relating to climate change issues. (n=90)	0	16	31	36	7
I am concerned that the USFS is not doing enough about climate change. (n=90)	6	32	29	19	4
The USFS is lacking the leadership needed to address climate change issues. (n=90)	12	42	24	9	3

Barriers and Policy Strategies to Address Climate Change

What, if anything, could the USFS be doing to more adequately respond to the threats climate change pose to the forests of the U.S. National Forest System? A series of questions were asked relevant to policy strategies and recommendations with relationship to addressing climate change issues within the USFS. First, USFS employees were asked to select the most favorable responses should climate change have an effect on U.S. forests. The most favorable strategies to address climate change within the USFS were to incorporate climate change issues into all Forest Management Plans (22 percent), Reconsider post-disturbance restoration policies (21 percent) and to develop seed banks to keep a genetic library of species (21 percent). The least favorable strategies were to not take any action (one percent), manually move species from one location to another (two percent) and plant non-native species that may be better suited to thrive under predicted conditions (three percent). See Table 9 for full results.

Table 9. *Assuming Climate Change is going to have an Effect on U.S. Forests, the USFS should (check all that apply):*

	Number of Respondents (Percentage of Total)
Incorporate climate change issues into all forest management plans	72 (22%)
Develop seed banks to keep a genetic library of species	69 (21%)
Reconsider post-disturbance restoration policies	68 (21%)
Incorporate climate change issues into job training sessions	52 (16%)
Incorporate climate change issues into job training sessions	52 (16%)
Develop corridors to help the migration of species to more suitable habitats	43 (13%)
Plant non-native species that may be better suited to thrive under predicted conditions	10 (3%)
Manually move species from one location to another	7 (2%)
Not take any action; the current structure of the FS will address any issues that come along	4 (1%)

USFS employees were asked who within the USFS is in the best position to lead a climate change initiative. Thirty-nine percent of respondents indicated the Chief is in the best position. Researchers/scientists were also noted as an entity that should lead the initiative (Table 10). An option designated as 'other' was available where respondents could identify entities other than the ones listed. Eleven participants chose the 'other' option; these responses were compiled for their frequencies and displayed in Table 10.

Table 10. *Who Should Lead the Climate Change Initiative?*

Response:	Number of Responses:
Chief	35
Researchers/Scientists	28
Deputy Forest Supervisors	12
Other:	11
➢ All levels and branches of the USFS	6
➢ Team of management officials and researchers/scientists	4
➢ Natural Resource Professionals	1
Ecologists	3

USFS employees were asked about leadership within the USFS with relationship to climate change issues. Respondents indicated that the most important step the USFS should take in order to be a leader in addressing climate change issues would be to integrate with other federal and nonfederal agencies (50 percent) and the least effective step would be to have a charismatic leader that will bring climate change to the forefront of the USFS policy agenda (Table 11). Participants were also given an 'other' option where they had the opportunity to write in responses. Nine participants responded 'other.' These results are displayed in Table 11.

Table 11. *To be a leader in climate change issues, the USFS should…*	
Response:	Number of Responses:
Integrate with other (federal and nonfederal) agencies	44
Alter management plans to incorporate climate change issues	11
Increase spending in research and development to make more precise climate models and predictions	11
Other:	9
➢ Manage for resiliency	2
➢ Validate research findings	2
➢ Develop and commit to a specific message	2
➢ Establish a connection between research, agency understanding, and actual forest management	1
➢ Education of employees and the public	1
➢ Dissemination of research findings	1
➢ Better connection between land managers and the public	1
Hire employees knowledgeable about climate change issues	5
Have a charismatic leader that will bring climate change to the forefront of USFS policy	8

Two final questions were asked to participants with regard to addressing climate change. The first asked, "What are the key barriers preventing the USFS from addressing this issue [climate change]?" This was an open ended response only. Eighty-four individuals contributed. Frequencies ranged from one to 12 responses. Notable responses with the highest frequencies were "funding" (n=12), "priorities" (n=11), and "public/political support (litigation)" (n=11). The results are displayed in Table 12 below.

Table 12. *List of the key barriers preventing the USFS from addressing climate change issues*

Barrier:	Frequency
Funding	12
Priorities	11
Public/Political Support (Litigation)	11
Knowledge	10
Lack of Management Support	8
No Clear Strategy	7
No Clear Definition of FS role	7
Scope	6
Uncertainty	6
Policy Frameworks	6
Lack of Global and National Commitment	6
FS Culture	5
Trust in Managers	5
Not Perceived as a Threat	4
Lack of Partnerships	4
Public education	3
Complexity	3
Time	2
Agenda	2
Lack of Qualified Personnel	2
Leadership	2
Resources	2
Lack of FS Wide Climate Change Policy	2
Monitoring	1
Insufficient Resources	1
Appropriation of Funds	1
Denial	1
Insufficient Analysis/Modeling Techniques	1
Agency Actions Inadequate	1
Coordination	1
Emphasis on Short Term Goals	1
Communication	1
Outdated Management Systems	1

The second open ended question asked, “In your opinion, assuming change in climate are going to occur as projected by scientists, what, if any, resources does the USFS need to adequately address this issue?” Eighty individuals responded to this question. Notable responses

with the highest frequencies were “funding” (n=15), “partnerships” (n=13), and “management support (from researchers to land managers) (n=13). Table 13 displays the results.

Table 13. *List of resources needed by the USFS to adequately address climate change*

Need:	Frequency:
Funding	15
Partnerships	13
Management Support (researchers to managers)	13
Knowledge	11
Research	10
Clear Strategy	9
Public/Political Support	9
Personnel	8
Reallocation of Funds	4
Education of Public	4
Incorporate into Management Policies	4
Update Legal Frameworks	4
Clear Message	4
Reduce FS Carbon Footprint	3
Communication	3
Leadership	3
Promote Resiliency	3
Sound Science	3
Legal Authority to Address Issue	3
Personnel Training	2
Better Climate Models	2
Time	2
Demonstration Projects	2
Global Leadership	2
Prioritization	2
Plan for Future not for Past	2
"Sense of Urgency"	1
Freedom to Manage	1
Monitoring	1
Emergency Response Plans	1
Patience	1
Organizational Capacity	1
Institutionalization of Climate Change	1

Consideration on Response Return and Possible Bias

Of the 171 initial surveys sent out, six came back inactive. It was determined that those who held these positions had either retired or had no longer held the said position. Of the remaining 165, 90 people filled out the survey yielding a 55 percent response rate. This response rate is relatively high when compared to similar studies (46.1 percent response rate by Moser and Tribbia 2006/2007 and 55.4 and 55.9 percent response rate for Leiserowitz 2003). It is this researcher's assumption that these 90 people accurately represent the views of the entire population as a whole. Concern with regard to bias associated with willingness to express opinions about climate change issues has been brought to the attention of the researcher. Because of the very apparent honesty contained within a number of open ended responses, it appears that this survey wasn't avoided on grounds of unwillingness to participate due to personal beliefs but rather time constraints. It cannot be completely ruled out that people didn't respond because they felt sensitive to the subject, as this is the case with any study. The survey was distributed in the late summer. For many National Forests across the country, especially those in the west, this is the busiest time of the year. Forest managers are often in the field dealing with recreationists as well as on the ground management. This is also a prevalent time for fire in the western U.S. and it was brought to the researcher's attention that there were a number of fires occurring when the survey was distributed. Therefore, it is this researcher's conclusion that the majority of those who didn't participate did not have the time to do so.

DISCUSSION: CHAPTER 4

Summary

In the summer of 2009, a survey was conducted to solicit the opinions of USFS Forest Supervisors and Deputy Forest Supervisors with regard to risk perception and policy preferences associated with the impacts of climate change on forest systems. Through responses given by 90 Forest Supervisors and Deputy Forest Supervisors insight was gained in these areas. This study reflects what specifically drives risk perception and how that risk perception is related to policy preferences related to climate change issues within the NFS. This study also investigated how the USFS can best respond to the impacts associated with climate change through opinions gathered by respondents.

Scientists from all disciplines of environmental science warn that global climate change is a very serious risk with the potential to have devastating consequences on both human society and natural systems. The global community is responsible for reducing greenhouse gas emissions attributed to a changing climate at all levels of local, national and international government. Addressing the issues will not only require individual action to reduce our carbon footprint but will also require political leaders to create and implement legislation that legally mandates entities to reduce their greenhouse gas emissions. The USFS is the largest forest management entity in the world, and will play a key role in managing forest systems under a changing climate. The management of the NFS rests on the hands of only a few individuals relative to the size of the area managed. Therefore, it is imperative to take the opinions, concerns and recommendations of these individuals into consideration when developing climate change mitigation strategies because these are ultimately the people who will decide the management protocol for approximately one third of the nation's forested landscape.

Drivers of Climate Change Risk Perception

This research found that a number of variables influence the risk perception of climate change issues held by Forest Supervisors and Deputy Forest Supervisors. Knowledge about climate change issues was a major predictor with regard to predicting overall climate change risk perception and policy needs of the USFS. Regression analysis concluded that as knowledge increased both risk perception and policy needs associated with climate change issues increase. This is consistent with the findings of O'Connor et al. (1996). In their study, O'Connor et al. concluded that, "Knowledge about global warming is a powerful predictor of behavioral intentions, independent from believing that climate change will happen and have bad consequences." Furthermore, the findings presented here are also consistent with those presented by Moser and Tribble (2006/2007). They found that coastal managers' knowledge of climate change impacts were consistent with the judgment of experts in the field (Moser and Tribble 2006/2007). This study also indicated a very high risk perception by the field of respondents associated with climate related impacts on coastal systems with only three percent of participants indicating that they are not personally concerned about global warming (Moser and Tribble 2006/2007). The link between knowledge and risk can best be summed up as follows though the work of Schliep et al. (2008): "climate change is perceived as more dangerous a threat, the more knowledge and information is available."

Risk Perception and Preparedness

This study found that there was no significant correlation between climate change risk perception and preparedness to address climate change threats. This researcher proposes two reasons for these findings. First, although viewed as a risk by forest managers, they are unsure of

how to be prepared for the uncertain impacts climate change could have on natural systems and have thus not incorporated climate change into management protocol. This study asked questions pertaining to preparedness with regard to climate change management. When asked if there are plans in place to respond to extreme weather events or natural disturbances, respondents were almost evenly divided between disagreeing with the statement, remaining neutral or agreeing. Similarly, a large portion of managers (62 percent) indicated that they do not use climate models that predict future climatic conditions when developing forest management projects or restoration activities, and finally, only 17 percent of managers indicated that climate change is referenced as something that needs to be taken into consideration within their Forest Management Plans. This is consistent with findings by Moser and Tribbia (2006/2007) who found that although coastal managers have relatively high levels of concern with regard to climate change, they do not incorporate climate change into their planning or decision making. The researchers concluded that this is primarily due to a lack of information presented to them in an understandable and applicable language. Therefore, it is evident that in order to be prepared for the impacts of climate change, managers must first understand what it is they can do to be better prepared for potential impacts.

Secondly, although risk perception with regard to climate change is relatively high, other more pertinent, tangible threats are facing U.S. National Forests; thus, managers are not actively preparing for the largely unknown consequences of a changing climate. Priority issues were cited as the second largest barrier preventing the USFS from responding to climate change. The lack of a correlation between a high risk perception and preparedness can then be attributed to different understandings of what preparedness actually is with regard to what threats to forests are prioritized and managed for. These findings are consistent with findings by other researchers.

Schliep et al. (2008) found though a survey of World Biosphere Reserve managers that although climate change is seen as high risk to vulnerable ecosystems, other issues take priority over management. Tribbia and Moser (2008) also attest priority issues as a key barrier in preventing active management of climate change issues:

> *"Against a backdrop of already pressing management challenges, coastal managers have very specific information needs, most of which are not about future problems but about the current conditions, and many of which are already not entirely met. Lack of resources, staff, and time present major hurdles for them to even get informed about how global warming may affect the problems they deal with on a daily basis."*

The findings cited above strongly suggest that climate change is viewed as a risk by environmental managers, though other issues take priority. These other issues/environmental threats inhibit the understanding of climate change issues and preparedness as to how to address such issues from a management perspective.

Risk Perception and Climate Change Policy

Within this study, risk perception was not found to be an accurate predictor of policy satisfaction with regard to climate change. This may be attributed to the uncertainty surrounding how to manage the uncertain or potential impacts of an altered climate regime. When managers were asked if they were satisfied with the progress the USFS has taken toward climate change issues, the responses were evenly split between disagree, neutral and agree. Further, nearly 50 respondents out of the 90 that answered the question indicated the USFS is doing enough to address climate change. If managers are largely uncertain or split as to how to address climate change, there should be no observed trend between risk perception and policy satisfaction. It is postulated here that because land managers are largely unsure of how to deal with climate

change issues, they cannot gauge whether they are satisfied or not with current (or non-existent) climate change policies.

The lack of correlation between risk perception and policy satisfaction can be attributed to the correlation between knowledge, risk perception and preparedness and climate change policy needs. The apparent level of knowledge and lack (or uncertainty) of preparedness with regard to climate change reflect a greater need for policies to address the issue. As was outlined above with regard to the drivers of risk perception, the findings of this study suggest that a greater knowledge base about climate change results in a greater risk associated with the impacts of climate change which then leads to a push for policies to address the issue. This is consistent with the findings of Moser and Tribble (2006/2007) who found that coastal managers cited a lack of a legal mandate addressing climate change a major hurdle in addressing it within a specific department.

Conclusions

Policies cannot be effective unless there is support from constituents for those policies. In an era of increasing awareness about the human influence on Earth's climatic system, agencies around the world are feeling the need to piece together policies to address the threats of climate change. The USFS is in a key position to lead the climate change initiative from a land management perspective. However, history suggests that the USFS is an entrenched bureaucracy and change within this agency occurs very slowly. In order to get the USFS up to speed with regard climate change issues, this researcher thought it best to address the socio-factors that drive the adoption of a climate change policy within the agency.

This research also set out to answer the question of if USFS employees support inter-agency policies to address climate change and what types of policies are employees most likely to support?

The responses given by participants give valuable insight into how policy formulation occurs within a land management agency. The responses paint a picture with regard to how climate change is viewed within the USFS. The following is a summary of the major findings in this research with regard to climate change policy:

- When asked if they believe climate change is a very serious problem, 84 percent of respondents agreed while only three percent disagreed.
- Eighty-one percent of respondents agreed that the global consensus among scientists is that climate change is occurring while only four percent of respondents disagreed.
- Eighty-five percent of respondents indicated they were worried about the impacts climate change could have on natural systems versus only five percent who disagreed. In addition, 83 percent of respondents indicated they believe that climate change is already having adverse impacts on natural systems.
- When asked to rank a number of issues with regard to the threat they pose on U.S. National Forests, participants identified invasive species, pests and climate change (in that order) as the top three threats facing U.S. National Forests.
- Seventy-one percent of respondents indicated that current management practices would not to be able to address environmental changes if changes in climate were to occur as projected. Only six percent of respondents agreed that current management practices could deal with potential alterations.

- Sixty-nine percent of respondents indicated that Forest Management Plans don't reference climate change and only seventeen percent indicate that they identify climate change as something that needs to be taken into consideration when developing forest management plans.
- Eighty-eight percent of respondents think the USFS has a role in addressing climate change issues. Only two percent disagree with this statement.

There is a disparity between the level of concern for climate change issues and sense of urgency to address those issues. Although over 80 percent of respondents indicated that they are worried about the impacts of climate change on natural systems and that they feel impacts are already being realized, and that 88 percent of respondents think that the USFS has a role in addressing climate change issues, nearly half (49 percent) of respondents indicated 'neutral' and only 35 percent disagreed when asked if the USFS is doing enough to address climate change issues. In addition, when asked if respondents were concerned that the USFS isn't doing enough about climate change, 43 percent of respondents disagreed (indicating that the USFS *is* doing enough) and only 25 percent agreed that the USFS is not doing enough to address climate change issues.

Furthermore, participants were fairly evenly split when asked if they were satisfied with the progress the USFS is taking toward climate change issues with nearly a third of respondents falling into each agreement category (disagree, neutral, and agree).

Finally, despite the fact that 88 percent of respondents think the USFS has a role in addressing climate change issues and 85 percent of respondents indicated they were worried about the impacts climate change could have on natural systems, 62 percent believe that the USFS has taken steps to bring climate change to the forefront of its policy agenda. Compare this

to 71 percent of respondents that indicated current management practices would not to be able to address environmental changes if changes in climate were to occur as projected.

Participants were fairly evenly split when asked if they were satisfied with the progress the USFS is taking toward climate change issues with nearly a third of respondents in every category (disagree, neutral and agree). Although nearly a third of respondents are satisfied with the progress the USFS is making with regard to climate change issues, 38 percent believe current policies to address climate change are not adequate, 42 percent believe policies are somewhat adequate, 18 percent believe policies are adequate and only two percent believe policies are very adequate. Thus, although nearly a third of respondents think progress has been made with regard to climate change issues, the level of adequacy of those issues appears to be very low.

Although it appears that forest managers support intra-agency policies to address climate change, there seems as though there is a lack of urgency to address climate change issues within the USFS. Although respondents indicated they are concerned with the impacts of climate change on natural systems and that the USFS has a role in addressing such issues, the progress with regard to the development of climate change policies and the adequacy of those policies appears to be low, indicating a lack of attention, or urgency, associated with the issue. In addition, as indicated though the results presented in this study, there is an obvious uncertainty as to how exactly to address the issue.

Through questions presented in the survey, it is evident that certain policies are favored more heavily than others. The incorporation of climate change issues into Forest Management Plans, the reconsideration of post-disturbance restoration policies, the establishment of long term seed banks, and integration with other federal and non-federal ecosystem management agencies were heavily favored by forest managers. These findings are consistent with those strategies put

forth by experts in the climate change mitigation and adaptation fields (See management recommendations by CCSP 2008, Millar 2007, Noss 2001, Smith and Lenhart 1996).

Recommendations for Policy Formulation

The ultimate goal of this research is to provide recommendations to the USFS to more effectively create and gain support for a clear, cohesive and holistic policy for responding to climate change. Because climate change is an issue unlike many of the others threatening the integrity of U.S. National Forests, it is important to set the stage and illustrate the evolution of where land management in the United States has been and where it needs to go.

In the early days, the USFS nothing short of a well oiled machine when it came to the management of public lands. There was no project the USFS couldn't accomplish, especially following World War II if commercially valuable timber was the prize. The traditional view of United States forests paralleled that of a modern day corn or bean field. These systems were not viewed as intricate parts of the ecosystem; rather, these systems were viewed as fields that demanded the most sophisticated engineering skills and technological mastery to extract the billions of board feet coming from these systems every year (Dombeck et al. 2003).

In response to a lawsuit filed by the West Virginia chapter of the Izaak Walton League of America against the USFS for clear-cutting practices in the Monongahela National Forest in West Virginia due to concerns over the impacts of clear-cutting on wildlife. The Walton League argued that in utilizing clear-cutting practices, the USFS was subsequently violating the Organic Act of 1897 which allowed for the sale of only dead, mature or "large growth" trees (Dombeck et al. 2003). Because the court ruled in favor of The Izaak Walton League leading to a fear of a timber crash, Congress passed legislation provisioning the Organic Act which allowed for a number of different timber harvesting methods including clear-cutting. This legislation became

known as the National Forest Management Act of 1976. NFMA required the USFS to develop management plans for each national forest that would be updated every ten or 15 years, and also required the USFS to engage the public in land management activities. In 1982, under the advising of several scientists, the NFMA was finalized and included the provision that the agency would, "maintain well-distributed, viable populations of all native vertebrates in national forests and grasslands" (Dombeck et al. 2003).

NFMA did not slow the amount of timber being produced in the United States. Political issues and interagency culture still drove the harvest of timber in the United States from a utilitarian perspective. Many agency leaders during the 70s and 80s came from a traditional engineering and timber harvest background and failed to understand the importance of ecosystem management. It wasn't until the formulation of the Interagency Scientific Committee that shifted the focus of Northern Spotted Owl management from protecting nesting sites to protecting landscapes and eliminating timber harvest in habitat conservation areas until suitable silvicultural practices could be established that would ensure spotted owl existence in a managed landscape. The 1990 listing of the spotted owl as 'threatened' by the U.S. Fish and Wildlife Service sealed the fate for the necessary evolution from a utilitarian approach to an ecosystem wide approach to forest management.

The evolution of the USFS from an agency driven by utilitarianism to an agency mandated to mange from an ecosystem-wide approach does not come without its difficulties. Traditionally the USFS was responsible for extracting timber in the most efficient way possible. This required the expertise of engineers and technical advisors who could view forests as essentially a field ready to be harvested. The mandate to transition to an ecosystem approach to management comes with the requirement to alter the skill sets used to manage systems. Now,

instead of finding the most efficient way to harvest, the USFS is required to take into consideration the opinions of biologists, soil scientists, climatologists, and professionals from other disciplines to determine how to adequately manage the system not only for timber but for the ecosystem services forests provide as well. The difficulties of managing from an ecosystem approach not only derive from the numerous players now participating in management, but the uncertainties and differing opinions regarding the underlying workings of these ecosystems and how they should be managed, whether based on past, known conditions, or future, uncertain conditions. Ultimately, different skill sets are required when managing from an ecosystem approach as opposed to a utilitarian approach. Managers must now evolve to the system and abide by what the system dictates rather than manipulating the system to coincide with our own desires of what it should look like; thus, in order to effectively address the threat of climate change on U.S. National Forests, a number of reforms must occur (Dombeck et al. 2003).

Administrative Recommendations

One of the most prevalent responses found throughout the open ended questions was a need for a clear strategy or message from the USFS as well as communicating the role the USFS has with regard to addressing climate change. The USFS recognizes itself as a leader in climate change research. The USFS's own Global Climate Change Research webpage (http://www.fs.fed.us/research/climate/) states that, "Research on the possible impacts of climate change on forests in the US and the development of adaptation and mitigation strategies has been carried out at the USFS for the last 20 years." Yet despite this statement, climate change generally held a backseat to other more pertinent threats facing forests until 2005. This is due primarily to the lack of acknowledgement of the issue by the Bush Administration. It wasn't until the USFS's centennial celebration that the need to address climate change was made clear by

those in attendance but it wasn't until 2007 that attention was really given to the issue of climate change within the USFS at the highest level. Chief Gail Kimbell sent a strong message regarding climate change issues within the USFS,

> *"History will judge the leaders of our age by how well we respond to climate change… I believe that climate change is the conservation challenge of the 21st century and that trees, forests, and forest ecosystems are part of the answer. Future generations will judge our generation by how well we all respond" (Kimbell n.d.).*

The Obama Administration brought a heightened concern over climate change to the USFS. In Seattle, Washington on August 14, 2009, Agriculture Secretary Vilsack announced his new direction and vision of the USFS. Secretary Vilsack put considerable emphasis on climate change, "There is no doubt that we are facing a health crisis in our forests. Climate change places them under increasing stress that exacerbates the threats of fire, disease, and insects." Furthermore, Secretary Vilsack charged Chief Tidwell with developing a new forest planning rule that will allow the USFS to improve its existing authorities and to take advantage of new tools and emerging markets in order to restore forests so that essential ecosystem services are protected and forests are more resilient to climate change (Vilsack 2009).

At the onset of this research, it appeared as though a clear message regarding how the USFS was responding to climate change was not a matter of question. A clear statement regarding the USFS's position on climate change is presented through a list of goals outlined in Strategic Framework (2009) and through various statements presented by former Chiefs Bosworth and Kimbell, current Agricultural Secretary Vilsack and Chief Tidwell. After receiving a number of responses suggesting land managers had no notion of the goals outlined by the USFS to address climate change or even the overall message, it appears there is a communication issue within the USFS with regard to keeping employees up to date on initiatives

and policy formulation. An effort needs to be made internally within the USFS for more effective communication between employees of all sectors in order to clearly articulate the message of the USFS with regard to climate change issues.

Next, it would be beneficial for the USFS to create a science-based "climate change task forces" at the national level as well as within each region (or eco-region). Currently, no such task force exists and climate change research is carried out within the various branches of the USFS without collaboration with other branches. These task forces would be responsible for developing regional strategies that coincide with a national strategy to address and minimize the potential impacts of climate change on National Forests. Such strategies will require extensive cooperation and understanding amongst policy makers, climate change scientists, and forest managers in addition to members of various outside agencies including the USGS, NGOs, and academic institutions about impacts, threats, management options, and current research. Collaboration among the various agencies with regard to climate change issues will be critical in the success of any climate change policy. The lack of collaboration and partnerships between federal agencies, NGOs and academic institutions as well as a lack of communication from within the USFS itself ranked second when asked what resources the USFS needs to address climate change issues. For instance, respondents indicated,

> *"More emphasis and resources are needed in Research and Development and more interaction and exchange needs to take place among academia, research branches and field managers and staff"*

> *"Join other federal agencies in developing an international response that can be applied at the national forest level"*

As suggested in the Climate Change Science Program (2008) document, "*Adaptation options for climate-sensitive ecosystems and resources*," one of the first actions taken by the task force should be to run a science-based assessment of all forest management plans. This

assessment would be designed to gather information about the current level of preparedness and adaptive capacity of forests as well as identifying areas in need of greater attention in addition to identifying areas of improvement within current forest management plans that relate directly to climate change issues. The assessment would have many practical implications and should focus on current management direction and on the ground management practices. It will also be useful in the prioritization of species management and process management initiatives and goals. An assessment of management priorities within the USFS was identified as the second greatest barrier preventing the USFS from addressing climate change. For example, respondents stated:

> *"Too many priorities. We respond to crisis in most cases and are not respected for our professional knowledge."*
>
> *"…the agency is so busy trying to maintain and deliver the traditional multiple use services, climate change initiatives can be viewed as a low priority add-on that with no real direction, we can lose a lot of time on."*

A science-based assessment would identify areas within all national forest management plans that are ill-suited for dealing with potential climatic changes. The task forces would then identify specific areas where changes are needed within forest plans or project plans, and would also aid in helping managers decide the best course of action.

Information about climate change issues, impacts, and tools to address such issues should be disseminated across all levels of management. A handbook or general manual providing general information about climate change, possible impacts, and management options to address such impacts should to be provided to forest managers. The gaps in the understanding of risks, impacts, and potential managerial responses to climate change between scientists, policy makers, and managers are vast and *must* be filled in order for progress to occur. Managers need to be able to understand what threats their forests face and how to address those threats. Policy makers need to be able to set realistic and workable policies, and scientists need to keep all groups up to

date on the latest findings and research and inform managers on how to apply scientific findings directly to on the ground management. Only after the potential threats and impacts are understood by forest managers, can they begin to manage for any potential changes in the system. A lack of management support from researchers and managers ranked fifth in the list of key barriers preventing the USFS from responding to climate change issues and was identified as the third most important resource managers need in order to adequately address climate change issues. Further, issues associated with general knowledge about specific climate change impacts and what to do about those impacts was ranked fourth in barriers preventing the USFS from addressing climate change and resources needed to respond to climate change issues.

> *"The key barrier is to have our Research Scientists step out and counsel managers on what options we have for project level work."*
>
> *"A closer relationship between NFS and R&D would help in science based decision-making."*
>
> *"A greater understanding (perhaps from Research & Development, integrated with NFS), defining the problem at the Forest and project level, and knowing how to consider and disclose effects of our proposed actions.*
>
> *"To start with, we need to increase our manager's knowledge about the most relevant and likely effects for which we could take action to make a difference."*
>
> *"The agency lacks knowledge regarding climate change and the potential effects on natural resource system."*

Resilience of Forest Ecosystems

Although adaptation measures will be spatially specific, a consensus about certain aspects of adaptive management can be applied broadly to sustain healthy forests under a changing climate. A shift in focus from managing for what we know to managing for change and desired future function of an ecosystem aligned with future conditions will likely need to occur (CCSP 2008, Noss 2001). The concept of triage may need to be explored when addressing species

management due to changes in range size, population sizes, abundances, as well as the risks of extirpation and extinction due to climate change (CCSP 2008). Finally, the most obvious would be to reduce current stressors on the environment. The impacts of climate change will be enhanced by the current stressors on the land making management more difficult (Millar 2007).

Resistance is most often referred to as the capacity of a system to remain in relative equilibrium in the face of disturbance or stress. Resilience is how well a system recovers after a disturbance. Some studies have suggested that the biodiversity of a system is positively related to increased tolerance to disturbances resulting in greater system stability (e.g. Tilman 1999). The more species available to fill the ecological roles of other species impacted by a disturbance allows that function to persist in the system. Enhancing resistance and resilience should focus on the diversity of functional groups as well as the diversity of species associated with those groups encourages ecological resistance (Noss 2001).

Few open ended responses indicated the need to address resiliency:

> *"We need to focus on the mission of managing forests and grasslands in a state that keeps them healthy and thus resilient. Then they will be in better condition to withstand changes positive or negative."*

Although promoting resistance and resilience are important steps in addressing the climate change issue, these methods alone will likely not be able to solve the problem. When taken in association with policies consistent with adaptive management will we be better suited to cope with the challenges of managing under a changing climate. Restoring (if need be) ecosystem function in the form of hydroloigical processes and overall forest health are key components to managing for forest resiliency (CCSP 2008) and has been made a priority area by Secretary Vilsack (2009). Adaptation strategies will be determined through what is currently understood about the impacts of climate change, what has been learned through the many years

of Resource Planning Act (RPA) assessments, and what climate models can predict about future climate conditions. Combining the knowledge gained through the RPA assessments with the forest management plan assessment suggested above will provide managers with a solid foundation from which to identify and prioritize issues within individual management areas.

Putting it into Perspective- Resistance and Resilience

An applicable example specific to the evolution of where the USFS needs to go with regard to climate change management can be drawn from fire management and the associated risk perception of fire over the past century. "A century ago wildfire was considered the number one enemy of the forest, a dangerous force that had to be "snuffed out cold" (Dombeck et al. 2003, pg. 127)." The general risk associated with wildfire is very high and was born out of the catastrophic fires the occurred over the West and Midwest in the late 1800s and early 1900s. The risk associated with fire was so great that by the 1930s the USFS had developed the most effective firefighting force in the world (Dombeck et al. 2003) and is arguably still one of the greatest devoting nearly half of its annual budget (currently 5.5 billion dollars) and a third of its employees to fighting fires. Though despite efforts to control wildfire, the total acres burned have increased since the mid-1980s. It wasn't until 1995 that policy has recognized and embraced the role of fire as an essential ecological function within national systems (Stephens and Ruth 2005). The realization that actively managing for fire might be much more effective than attempting to suppress fire and runs parallel to how a climate change management policy within the USFS could look.

The heightened risk associated with allowing a seemingly destructive process such as fire occur naturally is evident and understood as it potentially poses a threat to human well being an short term losses to ecosystems in a variety of ways. Managing for climate change is much the

same way. Managing for resistance, or managing for the status quo, will likely only have a positive outcome in the long run if utilized under specific circumstances such as those dealing with endangered or threatened species or for forest systems that are likely to exhibit low sensitivity to climatic changes (CCCSP 2008). Like fire, encouraging resistance to change will likely only exasperate the effects of climate change once the impacts become more and more evident and cost more in the long run. As species invade other areas and change their behavior to respond to altered climatic conditions, it will likely prove more difficult and costly to maintain systems especially in the presence of such things as increased drought, insect outbreaks and wildfire. Climate change should then be embraced and rather than resisting natural processes, ecosystems should be encouraged to be resilient to change so that they might be better equipped to adapt to changes in the environment. Promoting ecosystem function may be the most effective way to address changes in climate. Maintaining key ecosystem function, such as hydrological processes and natural disturbance regimes, while promoting composition and structure will likely be the most appropriate way to respond to climate change.

Manage for Ecosystem Function

The vast majority of management agencies in the United States (federal, state and private) manage ecosystems based on the concept of managing according to the historical range of natural variability for that system (CCSP 2008). The fundamental philosophy behind this concept revolves around restoring an altered or disturbed landscape to a condition that existed before pre-European settlement or to another arbitrary point in history. The conditions present within the time period chosen are viewed by land managers as a set of reference conditions from which land management should be based- commonly assumed to be a ‘pristine,’ or the definition of what a ‘natural-state’ should look like. After taking the possible implications of climate

change into consideration, it can be argued that this approach to managing ecosystems may need to be revised and viewed from a different perspective if it is to be an effective tool in the future.

In this study, the researcher asked three questions specifically about forest management. Those questions were as follows:

1. Environmental managers have the ability to facilitate adaptation to changes in the environment through various management practices.
2. Current restoration goals for forest management are based primarily on pre-settlement conditions.
3. After a disturbance such as a wildfire or flood, we restore things back to pre-disturbance conditions the best we can.

Fifty-seven percent of respondents agreed that environmental managers have the ability to facilitate adaptation to changes in the environment through on the ground management activities; only 14 percent disagreed with this statement. Forty percent of respondents indicated that current restoration goals for forest management are based primarily on pre-settlement conditions; 26 percent of respondents disagreed with this statement, and 33 percent of respondents were neutral. Finally, 39 percent of respondents indicated that after a natural disturbance, the system is restored back to pre-disturbance conditions in the best way possible; whereas, 29 percent disagreed with this statement.

These findings suggest that USFS managers are still managing based on the historical range of variability and striving for that "pristine" state. Forty percent of respondents (over one-third of all National Forests- the equivalent to over 64 million acres of forest) indicated that management goals are based on pre-settlement conditions; whereas, 39 percent indicated that after a disturbance forest management attempts to restore the system back to pre-disturbance

conditions, or likely, pre-settlement conditions assuming that's what day-to-day management is based from.

In principle, the rationale for the use of the historic range of variability in management activities can be easily understood; restore the system to a condition reminiscent of pre-European influence. This is done under the assumption that by restoring and maintaining a system to pre-settlement conditions, the result yields the best chances of maintaining ecosystem function. This management protocol manages for what existed under past conditions but does not take into account the potential for future conditions. Scientists concur that the current and future rate at which the climate is projected to change will be faster than most historic changes, and unlike anything observed within the timeline of what most managers consider within the historical range. In addition, human influence, such as habitat fragmentation and degradation, will have a compounding effect when considered in concert with climatic changes. Therefore it seems that managing based solely on the historical range of variability of an ecosystem is problematic in a changing climate.

Only a few respondents expressed their concern for this issue in the open ended responses but those responses were some of the most well articulated,

> *"We are operating on a paradigm of restoration to a past ideal with objectives to stay within a desired range for key environmental parameters. The ideal is often what the world might have been like pre-contact. We live in a world of constant change and adaptation. We need resources to predict where we will be in 50 or 100 years based on expected change rather model habitat based on our ability to remake the land as it was 200 or 400 years ago."*

> *"Our fire, fuels, timber and range management efforts could all support climate change better if our thinking were adjusted toward the next forests and grasslands rather than the last ones."*

The threats to National Forests from climate change are severe, and the threats are likely to occur rapidly as changes become more apparent. Rather than expecting systems to return to a

previous state in time, the system must be looked at from the perspective of what can the area sustain in the future. As a result, we must revisit the basis from which ecosystems are managed (CCSP 2008, Millar et al., 2007, Noss 2001).

Address the Socio-Political Facets of Climate Change

Addressing the threats to U.S. Forests in a changing climate will require an approach that considers all elements of the ecosystem, including the human element. Social commitment is essential for environmental policies to be successful (Likens and Franklin 2009) and was listed third in barriers preventing the USFS from addressing climate change and seventh in resources needed by the USFS to address climate change. U.S. National Forests have the potential to exemplify mitigation and adaptation strategies used to address the threats of climate change. Management of the NFS rests largely in the hands of supervisors and deputy supervisors overseeing these areas in addition to the various stakeholders that have some interest in the management direction of these natural areas. As a result, it seems obvious that the sense in which these forest managers view climate change will have a direct influence on the management techniques employed and whether these techniques take into consideration changes in climate outside the known historical range. Thus, it seems that the socio-political factors influencing the management of our National Forests may play a very important role in how forest managers view the threat of a changing climate when compared to other, more immediate threats such as wildfire, invasive species, disease, deteriorating infrastructure, budget constraints, etc.

It is important that the social aspects surrounding the perceptions of climate change be understood so that gaps in knowledge can be dissolved and progress can be made in the areas of adaptation and mitigation. Further, an understanding of the social aspects with relation to climate change will make collaboration among scientists, policy makers, and forest managers much

easier as the barriers preventing understanding among the various groups can be taken into consideration and dealt with separately.

> *"Public support for non-traditional approaches to managing forest may be a difficult sell for the majority of the public."*

> *"Until we have the social engagement, all agencies re going to have a difficult time implementing appropriate climate change management strategies."*

Address Funding Issues

Funding was the number one issue in both resources preventing the USFS from addressing climate change and barriers preventing the USFS from responding to climate change. Funding issues within the agency are prevalent which coincides with what was found by Moser and Tribbia (2006/2007) in their study of coastal managers policy preferences for climate change management. In that study, nearly 80 percent of managers cited money constraints as the number one barrier to addressing climate change. Over half of the USFS budget is allocated to fire suppression and this concern was expressed in the open ended responses:

> *"We currently don't have the capacity within our organization to plan (NEPA) and implement (specialists) restoration work out on the ground. We've lost specialists and expertise to retirements and have not been able to replace positions because of ~50 percent of budget going to fire suppression."*

It was expressed that the reallocation of funds from ineffective or too numerous projects into other areas may be more appropriate than restructuring the entire USFS budget. Many respondents expressed the distain for the number of initiatives and projects currently underway within the USFS and that a reassessment of these projects for their applicability might be warranted and benefited from.

National Policies

Although this section has focused on recommendations for dealing with climate change by the USFS, it will take national and international policies, together with cooperation from the private sector, to alleviate the impacts of climate change on all fronts. Responses from participants expressed concern for the lack of national and international agreements to reduce world dependence on fossil fuels as well as distain for the current presidential and congressional administrations for not setting clear goals and creating workable policies with regard to climate change issues.

National policies relating not only to greenhouse gas reduction need to be revisited, but as respondents suggest, much of our natural resource management frameworks are outdated and in need of being revisited if we are to deal with current and future natural resource challenges.

> *"Current environmental laws are built around a maintaining a static environmental condition, ie ESA or viability- what does that look like in the face of changing environmental conditions/landscapes?"*

> *"Our planning and procedural laws and regulations are from days gone by (1960s, 1970s, 1980s, etc.) and are not workable for today's and tomorrow's issues and scientific/social questions. NEPA, APA and all regs. that influence and control planning procedures need to be revamped."*

Moser and Tribbia (2006/2007) also found a strong emphasis placed on the need for legal mandates to respond to the climate change issue (Tribbia and Moser 2008). At the national and international levels, the problems associated with climate change are not as much a scientific issue as they are a leadership issue. The current administration has an historic opportunity to respond to the challenge of climate change and institute policies to protect our nation's forests and other natural resources for future generations. Congress needs to act and pass legislation that reduces annual emissions of greenhouse gasses and invests in research directed toward managing environmental changes that are anticipated to occur. The need for immediate action is critical.

Overall the results of this study indicate that the need for more effective communication within the USFS needs to take place if the agency wishes to adequately address the issue of climate change within the NFS. In order for the largest forest management department in the world to be a leader on climate change issues, an emphasis needs to be put on communication within all levels of the Forest Service with regard to the platform of the agency on the issue. There also needs to be dedicated collaboration effort between research scientists and forest managers that results in the application of scientific findings to on the ground management activities. Only after the platform and goals of the Forest Service with regard to climate change are understood at all levels, will the agency be able to work to fulfill its mission of sustaining forests and grasslands for present and future generations under a changing climate.

Summary of Recommendations

1. Effectively communicate a clear, concise mission with regard to the USFS's position on climate change to all levels of forest management
2. Increase the dissemination of knowledge and communication among the National Forest System and areas of Research and Development
3. Promote partnerships within branches of the USFS and among other federal, state, and private organizations
4. Lead by example- reduce the agencies greenhouse gas emissions
5. Develop short-term, medium term and long term-goals with relationship to monitoring progress and greenhouse gas reductions
6. Educate the public on climate change issues and management responses
7. Work with climate scientists to develop a set of management goals that can be incorporated into all Forest Management Plans
8. Manage forest ecosystems for function, composition, and structure
9. Increase resilience of forest systems
10. Address the socio-political factors preventing effective climate change adaptation, mitigation, and policy measures.

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APPENDIX A

Institutional Review Board Proposal and Approval

University of Wisconsin-Stevens Point
Institutional Review Board for the Protection of Human Subjects

Protocol for Original Submissions

A complete protocol must be submitted to the IRB for approval prior to the initiation of any investigations involving human subjects or human materials, including studies in the behavioral and social sciences.

For all research protocols, please submit the following:

- **1 printed copy with Faculty Mentor and Department Chair signatures** of (1) the completed protocol; (2) project abstract; and (3) samples of informed consent forms to the IRB chairperson. PROTOCOLS LACKING ANY ONE OF THESE THREE ELEMENTS WILL NOT BE APPROVED.
- **A second copy of this page, with signatures.** Printed materials should be submitted to: IRB/Grants Office, 204 Old Main.
- **Electronic copies of all submission materials (multiple files are acceptable)** emailed as attachments to Jason R. Davis, IRB chair: jdavis@uwsp.edu

PLEASE TYPE

Project Title: Evaluating Perceptions of _____

Principal Investigator: Nick Blay _____

Department: Human Dimensions of Natural Resources- CNR Rank: Graduate Student _____

Campus Mailing Address: Nick Blay- TNR _____

Telephone: 515 447 7797 E-mail address: nblay595@uwsp.edu _____

Faculty Sponsor (if required): Mike Dombeck _____
(Faculty sponsor required if investigator is below rank of instructor.)

Expected Starting Date: May 20th, 2009 Expected Completion Date: July 31st 2009 _____

Are you applying for funding of this research? Yes ____ No X____

If yes, what agency? _____

Please indicate the categories of subjects to be included in this project. Please check all that apply.

X Normal adult volunteers ____ Minors (under 18 years of age)
____ Incarcerated individuals ____ Mentally Disabled
____ Pregnant women ____ Other _____ (specify)

(**Faculty Member**) I have completed the "Human Subjects Protection Training" (available at http://www.uwsp.edu/special/irb/start.htm) and agree to accept responsibility for conducting or directing this research in accordance with the guidelines.

_____

(Signature of Faculty Member responsible for research)

(**Department Chair or equivalent**) I have reviewed this research proposal and, to the best of my knowledge,

believe that it meets the ethical standards of the discipline.

_____

(Signature of Department Chair or equivalent)

******************************** Do not write below this line – for IRB use only ********************************

IRB approval_____ Date_____

(Signature of IRB Chair)

Approval for this research expires one year from the above date.
If research is not completed by this date, a request for continuation must be filed and approved before continuing. **Revised form: January 2001**

Your research protocol titled "Evaluating Perceptions of and Attitudes of U.S. USFS Employees About Climate Change" has been approved by the IRB, and you are free to start your research effective this date.

A signed copy of your research protocol will be sent via campus mail to you for your files.

Best wishes for a successful research project. - Libby

Libby Raymond

Catalog Editor/University Services Associate

Academic Affairs Office

lraymond@uwsp.edu

715-346-3880

Proposal Abstract

Write a brief description of the purpose of the proposed research project. (100-200 words)

Forests provide significant social, economic and environmental goods and services to people around the world. These systems serve functions critical for human well-being, of which include: water storage, flood control, erosion control, water purification, renewable energy sources, timber products, nutrient cycling, carbon sequestration, and biodiversity habitat. Anthropogenic induced climate change has come to the forefront as a significant threat to ecosystem function, biodiversity, and ultimately human welfare. Climate change is now recognized as *unequivocal* by the global scientific community, and has thus stimulated political action on a number of local, national, and international levels. This study is concerned with the response to predicted climate change impacts on forest ecosystems by the United States USFS. This research will investigate the attitudes of USFS employees regarding climate change. A questionnaire will be administered to various USFS employees to obtain information regarding causes of climate change, knowledge about, and perceived impacts of climate change on forest ecosystems. In addition, ideas about how to incorporate climate change related strategies into USFS policy will be solicited from participants. The data will be synthesized and a statement of recommendations will be submitted to the USFS upon the completion of this project.

Please complete the following questions for all research.

1. Describe the characteristics of the subjects, including gender, age ranges, ethnic background, health/treatment status and approximate number.

166 U.S. USFS employees will make up the population of this study. Age ranges vary but all participants will be over the age of 18. The study population will be of mixed gender and ethnic background.

2. Indicate how and where your subjects will be obtained. Describe the method you will use to contact subjects.

The names and contact information for the participants was obtained through the USDA USFS website (www.fs.fed.us). Participants will be contact via email.

3. What are you going to ask your subjects to do (be explicit) and where will your interaction with the subjects take place?

Participants will be asked to fill out a questionnaire that will take on average 20 minutes of their time. There will be no direct interaction with the participants. All interaction will take place through email, or if there are any questions, over the phone. All subjects will give consent to participate prior to doing so.

For specific examples of questions asked, please see attached survey.

4. Will deception be used in gathering data? Yes ~~No~~ X

If yes, describe and justify.

5. Are there any risks to subjects? Yes ___No___ X _____
If yes, describe the risks (consider physical, psychological, social, economic, and legal risks) and include this description on the informed consent form.

6. What safeguards will be provided for subjects in case of harm or distress? (Examples of safeguards include having a counselor/therapist on call, an emergency plan in place for seeking medical assistance, assuring editorial rights to data prior to publication or release where appropriate.)

Risks to subjects are seen to be no greater than any other everyday activity, thus no safeguards are necessary.

7. What are the benefits of participation/involvement in this research to subjects? (Examples include obtaining knowledge of discipline, experiencing research in a discipline, obtaining course credit, getting paid, or contributing to general welfare/knowledge.) Be sure to include this description on the informed consent form.

There will be no direct benefits of participating in this research. However, USFS employees concerned with climate change issues may be encouraged by research focused around the topic.

8. Will this research involve conducting surveys or interviews? Yes X~~No~~ _____
If yes, please attach copies of all instruments or include a list of interview questions.

9. If electronic equipment is used with subjects, it is the investigator's responsibility to determine that it is safe, either by virtue of his or her own experience or through consultation with qualified technical personnel. The investigator is further responsible for carrying out continuing safety checks, as appropriate, during the course of the research. If electronic equipment is used, have appropriate measures been taken to ensure safety? Yes X No
_____ _____

The survey program that will be used in this study will be Select Survey which is utilized by the University for its own surveying needs.

10. During this research, what precautions will be taken to protect the identify of subjects and the confidentiality of the data?

Subjects will be assigned a random number to correspond with their answers. The data will be stored on a locked computer accessible to only those directly involved with the research.

11. Where will the data be kept throughout the course of the study? What provisions will be taken to keep it confidential or safe?

The data will be stored on a password protected computer accessible to only those directly involved with the research.

12. Describe the intended use of the data by yourself and others.

The data will be used to gain an understanding of how important climate change issues are to land managers so policy makers have a sense of where to begin when trying to incorporate such policies into law.

13. Will the results of the study be published or presented in a public or professional setting?
    Yes ___X___ No _____
    If yes, what precautions will be taken to protect the identity of your participants? **State whether or not subjects will be identifiable directly or through identifying information linked to the subjects.**

Subjects will not be identifiable. Data will be reported in aggregate form.

14. State how and where you will store the data upon completion of your study as well as who will have access to it? What will be done with audio/video data upon completion of the study?

Only principal investigators will have access to the data. The data will be stored on a password protected computer.

PARTICIPANT INFORMATION FORM

Purpose of the Research

Nick Blay, Master's student in the Natural Resources Department at the University of Wisconsin-Stevens Point, working under the supervision of Dr. Michael Dombeck, would appreciate your participation in a research study designed obtain information about climate change issues from the perspective of environmental managers. This consent form was developed for your protection—to make sure that you are aware of the purpose of this project, how the project may affect you, and what is being done to ensure your confidentiality.

Procedures Used and Duration of Study

While this information could be obtained by interviewing you, I feel that the survey is the quickest and easiest method for obtaining this information. The study will be conducted from June 2009 to August 2009. Surveys will average about 20 minutes and you will be asked to complete no more than one survey.

Risks to the Individual

I anticipate no risk to you as a result of your participation in this study other than the inconvenience of the time to complete the survey.

Benefits to the Individual

There will be no direct benefits to individual participants.

Confidentiality

The information that you give us in the questionnaire will be recorded in anonymous form. You will not be required to submit information that could be used to identify you. All data collected through our survey program of choice, Select Survey, is housed on a secure SQL server. Upon completion, all survey data will be stored in a password protected computer for the duration of the project, and will not be available to anyone not directly involved in this study. The project's research records may be inspected by the University of Wisconsin-Stevens Point Institutional Review Board or its designees to ensure that participants' rights are being protected.

Voluntary Nature of Participation

If you would like to withdraw from the study at any time you may do so without penalty.

Once the study is completed, we would be glad to give you the results. In the meantime, if you have any questions, please ask or contact:

Nick Blay
College of Natural Resources
University of Wisconsin-Stevens Point
800 Reserve Street
Stevens Point, WI 54481 (515) 447-7797
nblay595@uwsp.edu

If you have any complaints about your treatment as participant in this study, please contact:

Institutional Review Board for the Protection of Human Subjects
Department of Business & Economics
University of Wisconsin-Stevens Point
Stevens Point, WI 54481
(715) 346-4598

Your completion and submission of the survey to the researchers represents your consent to serve as a subject in this research.

APPENDIX B

Survey Instrument- Print Screen Versions

Climate Change Survey

Page 2 of 17

General Climate Change Questions

1. Please indicate the extent to which you agree with the following statements, with **1= strongly disagree and 5=strongly agree.**

	1	2	3	4	5
1. Current climatic changes are happening outside the natural cycle	○	○	○	○	○
2. Human activity is the primary cause of current changes in earth's climate and long-term weather patterns.	○	○	○	○	○
3. Deforestation alters the natural balance among atmospheric gases.	○	○	○	○	○
4. The global consensus among scientists is that climate change is occurring.	○	○	○	○	○
5. Human activities contribute to climate change but are not the primary cause.	○	○	○	○	○

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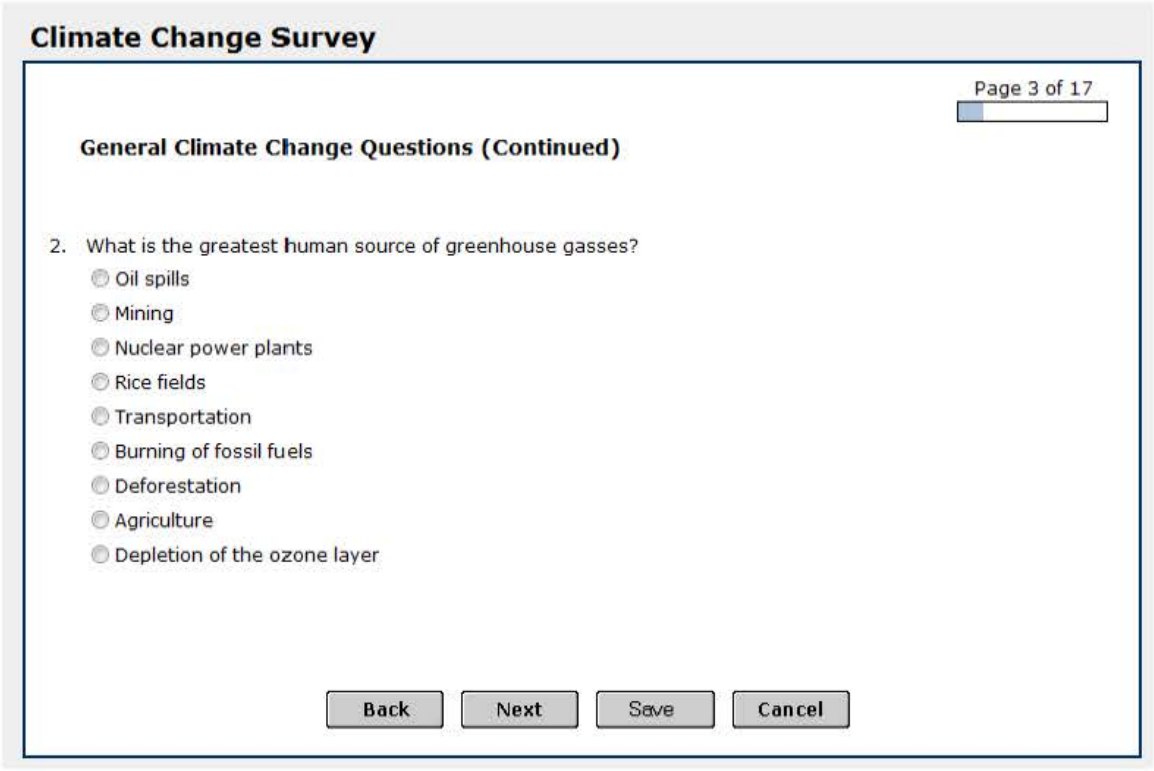
Climate Change Survey
Page 3 of 17
General Climate Change Questions (Continued)
2. What is the greatest human source of greenhouse gasses?
Oil spills
Mining
Nuclear power plants
Rice fields
Transportation
Burning of fossil fuels
Deforestation
Agriculture
Depletion of the ozone layer
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Climate Change Survey

Concerns about Climate Change

3. Please indicate the extent to which you agree with the following statements, with **1= strongly disagree and 5=strongly agree.**

	1	2	3	4	5
1. I believe climate change is a very serious problem.	○	○	○	○	○
2. I am concerned that ten years from now natural disasters will be more severe than they are now.	○	○	○	○	○
3. We should be more worried about the economy, health care, and terrorist threats than about environmental problems such as climate change.	○	○	○	○	○
4. The consequences of climate change will affect myself and my family in my lifetime.	○	○	○	○	○
5. I am worried about the impacts climate change could have on natural systems.	○	○	○	○	○
6. I believe much of what scientists have to say with regard to climate change.	○	○	○	○	○
7. When scientists say humans are very likely responsible for climate change, I believe them.	○	○	○	○	○
8. I believe climate change is already having adverse impacts on natural systems.	○	○	○	○	○

Climate Change Survey

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Concerns about Climate Change (Continued)

4. Please rank the following (1-5) in terms of how concerned you are about the threat of climate change on that system with 1 being most concerned and 5 being least.
Rank the items below, using numeric values starting with 1.

U.S. National Forests	
Regional Forest Systems (eg. the Pacific Northwest)	
Temperate forests as a whole	
Tropical rainforests as a whole	
Boreal forests as a whole	

Climate Change Survey

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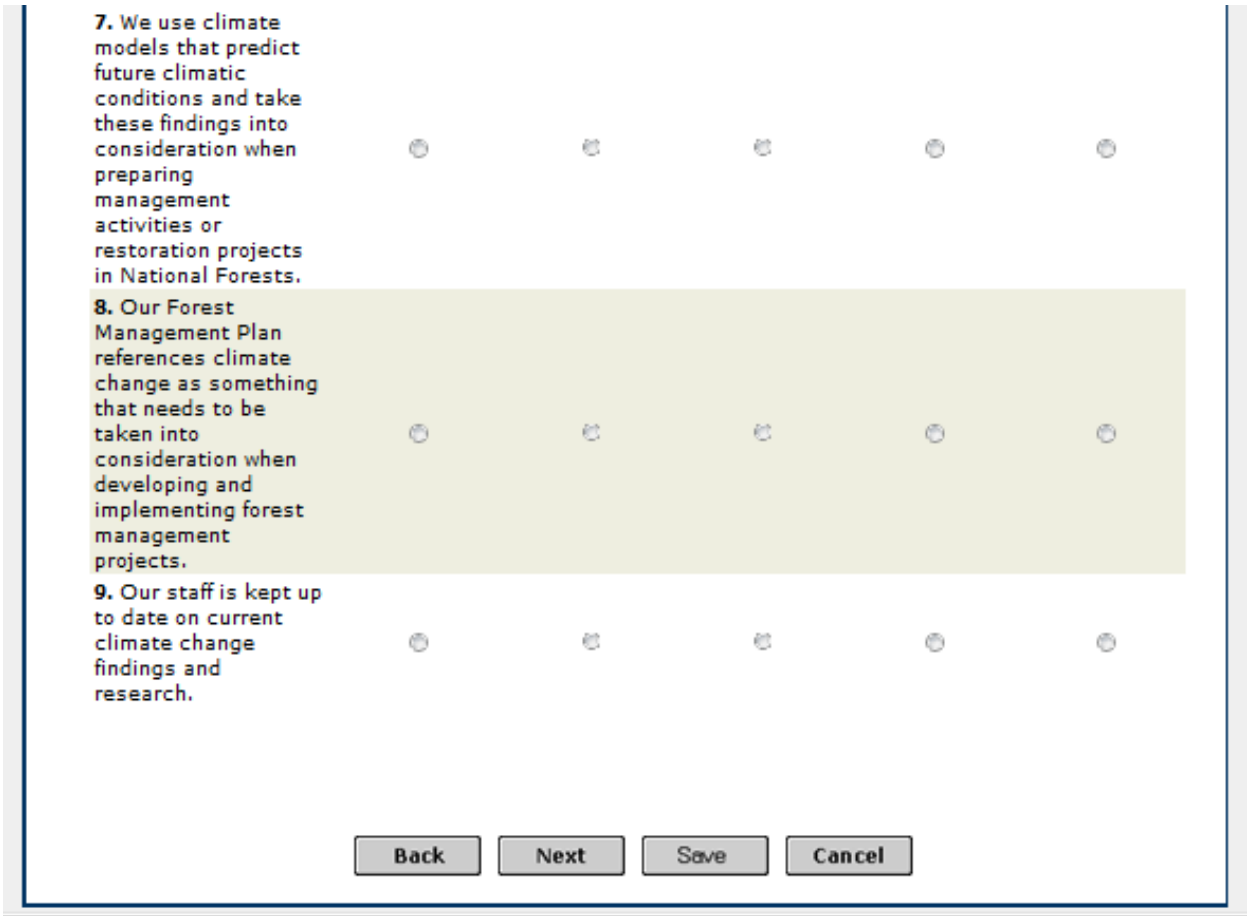
National Forests and Climate Change

5. Please indicate the extent to which you agree with the following statements, with **1= strongly disagree and 5=strongly agree.**

	1	2	3	4	5
1. Environmental managers have the ability to facilitate adaptation to changes in the environment through various management practices.	○	○	○	○	○
2. Current restoration goals for forest management are based primarily on pre-settlement conditions.	○	○	○	○	○
3. After a disturbance such as a wildfire or flood, we restore things back to pre-disturbance conditions the best we can.	○	○	○	○	○
4. National Forests maintain long term seed banks or send local seed to places that do.	○	○	○	○	○
5. If changes in climate were to occur as projected, current management practices would be able to deal with such changes.	○	○	○	○	○
6. We have plans in place to respond to extreme weather events (such as hurricanes, tornados, or severe ice storms) and natural disturbances (such as severe wildfire, disease, or insect outbreaks).	○	○	○	○	○



7. We use climate models that predict future climatic conditions and take these findings into consideration when preparing management activities or restoration projects in National Forests.					
8. Our Forest Management Plan references climate change as something that needs to be taken into consideration when developing and implementing forest management projects.					
9. Our staff is kept up to date on current climate change findings and research.					

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Climate Change Survey

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National Forests and Climate Change (Continued)

6. Please indicate the extent to which you agree with the following statements, with **1= strongly disagree and 5=strongly agree.**

	1	2	3	4	5
1. The Forest Service is doing enough to address climate change issues.	○	○	○	○	○
2. The Forest Service should increase spending on research and development projects relating to climate change issues.	○	○	○	○	○
3. I am satisfied with the progress the Forest Service is taking toward climate change issues.	○	○	○	○	○
4. The Forest Service has taken steps to bring climate change to the forefront in its policy agenda.	○	○	○	○	○
5. The Forest Service has a role in addressing climate change issues.	○	○	○	○	○
6. I am concerned that the Forest Service is not doing enough about climate change.	○	○	○	○	○
7. The Forest Service is lacking the leadership needed to address climate change issues.	○	○	○	○	○

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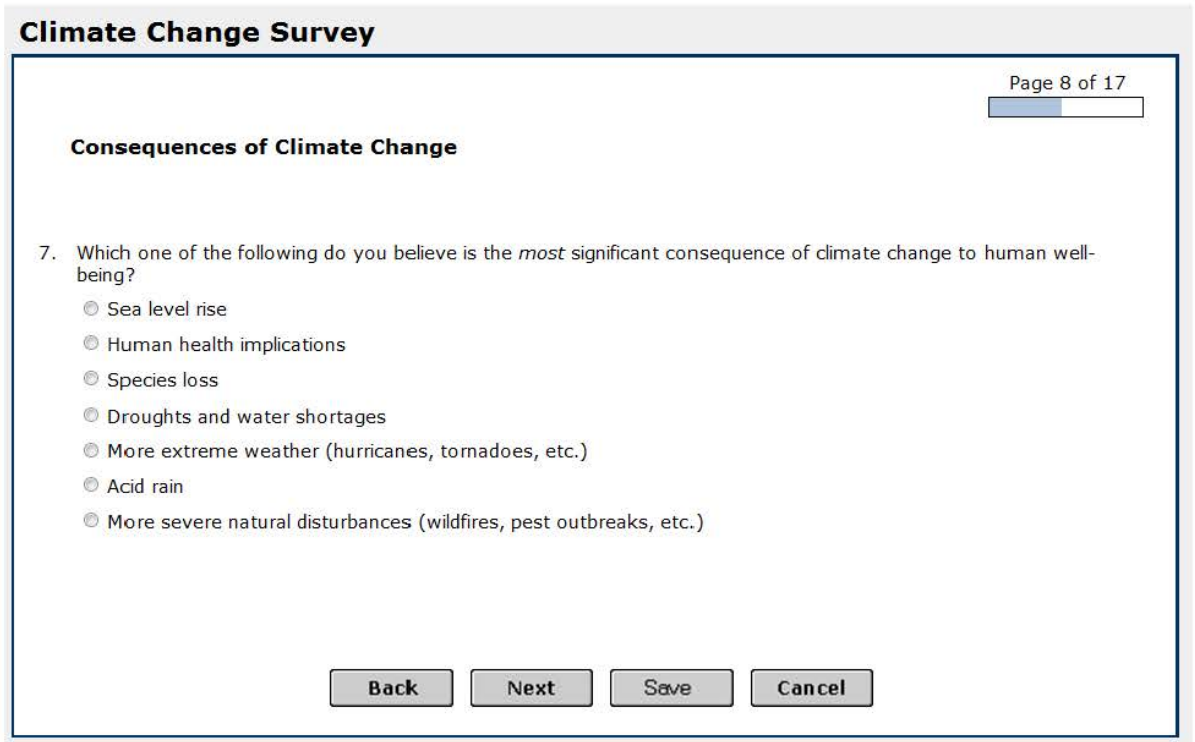

Climate Change Survey

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Consequences of Climate Change

7. Which one of the following do you believe is the *most* significant consequence of climate change to human well-being?

- Sea level rise
- Human health implications
- Species loss
- Droughts and water shortages
- More extreme weather (hurricanes, tornadoes, etc.)
- Acid rain
- More severe natural disturbances (wildfires, pest outbreaks, etc.)

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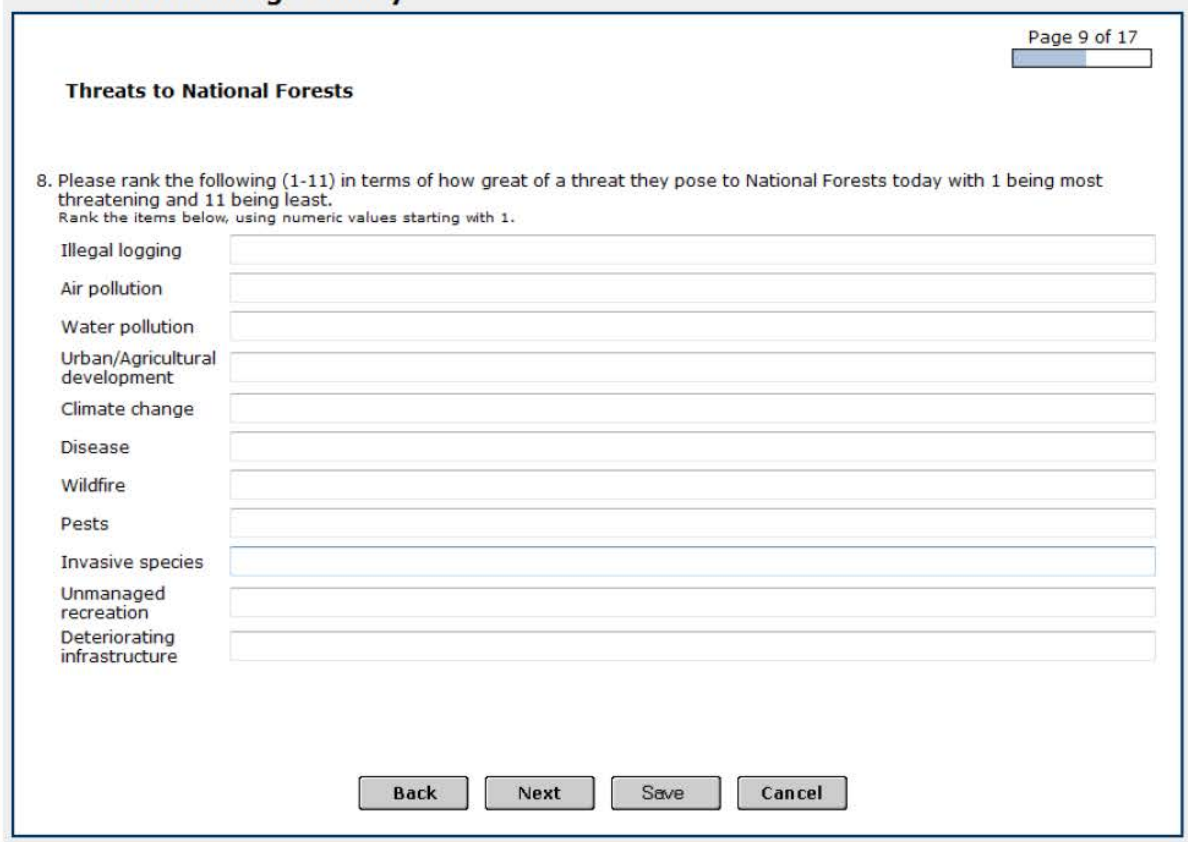

Climate Change Survey

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Threats to National Forests

8. Please rank the following (1-11) in terms of how great of a threat they pose to National Forests today with 1 being most threatening and 11 being least.
Rank the items below, using numeric values starting with 1.

Illegal logging	
Air pollution	
Water pollution	
Urban/Agricultural development	
Climate change	
Disease	
Wildfire	
Pests	
Invasive species	
Unmanaged recreation	
Deteriorating infrastructure	

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Climate Change Survey

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National Forest Service Progress

9. How much *progress* in terms of policies implemented, enforcement, attention, etc. do you think the Forest Service has made in the following areas:

	None	Little progress	Some progress	Substantial progress	NA
Policies to mitigate climate change	☐	☐	☐	☐	☐
Policies to protect the ozone layer	☐	☐	☐	☐	☐
Policies to reduce acid rain	☐	☐	☐	☐	☐
Policies to control air pollution	☐	☐	☐	☐	☐
Policies to conserve/protect forests	☐	☐	☐	☐	☐
Policies to protect biodiversity	☐	☐	☐	☐	☐
Policies to conserve water resources	☐	☐	☐	☐	☐

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Climate Change Survey

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National Forest Service Adequacy

10. In your opinion, how *adequate* are the following Forest Service policies?

	Not adequate	Somewhat adequate	Adequate	Very adequate	NA
Policies to mitigate climate change	☐	☐	☐	☐	☐
Policies to protect the ozone layer	☐	☐	☐	☐	☐
Policies to reduce acid rain	☐	☐	☐	☐	☐
Policies to control air pollution	☐	☐	☐	☐	☐
Policies to conserve/protect forests	☐	☐	☐	☐	☐
Policies to protect biodiversity	☐	☐	☐	☐	☐
Policies to conserve water resources	☐	☐	☐	☐	☐

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Climate Change Survey

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Climate Change Policy Options

11. Assuming climate change is going to have an effect on U.S. forests, the Forest Service should (check all that apply):
    - ☐ Develop corridors to help the migration of species to more suitable habitats
    - ☐ Manually move species from one location to another
    - ☐ Develop seed banks to keep a genetic library of species
    - ☐ Reconsider post-disturbance restoration policies
    - ☐ Plant non-native species that may be better suited to thrive under predicted conditions
    - ☐ Not take any action; the current structure of the FS will address any issues that come along
    - ☐ Incorporate climate change issues into all forest management plans
    - ☐ Incorporate climate change issues into job training sessions

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Climate Change Survey

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Leadership

12. In your opinion, who within the Forest Service is in the best position to lead the climate change initiative?
    - ○ Chief
    - ○ Researchers/Scientists
    - ○ Ecologists
    - ○ (Deputy) Forest Supervisors
    - ○ Other, please specify

13. In order to be a leader on addressing climate change issues, the *most important* step the Forest Service should take would be to:
    - ○ Integrate with other (federal and nonfederal) agencies
    - ○ Alter management plans to incorporate climate change issues
    - ○ Increase spending in research and development to make more precise climate models and predictions
    - ○ Hire employees knowledgeable about climate change issues
    - ○ Have a charismatic leader that will bring climate change to the forefront of Forest Service policy
    - ○ Other, please specify

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Climate Change Survey

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Climate Change Education

14. Have you done any of the following:

	Yes	No
I have attended a lecture, meeting, seminar, or workshop on climate change	○	○
I have been exposed to climate change information in my workplace	○	○
I would be willing to attend a lecture, meeting, seminar, or workshop on climate change	○	○

15. How often do you discuss climate change with your family or friends?

- ○ never
- ○ rarely
- ○ sometimes
- ○ often

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Climate Change Survey

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What do you think?

16. In your opinion, assuming changes in climate are going to occur as projected by scientists, what, if any, are the key barriers preventing the Forest Service from addressing this issue?

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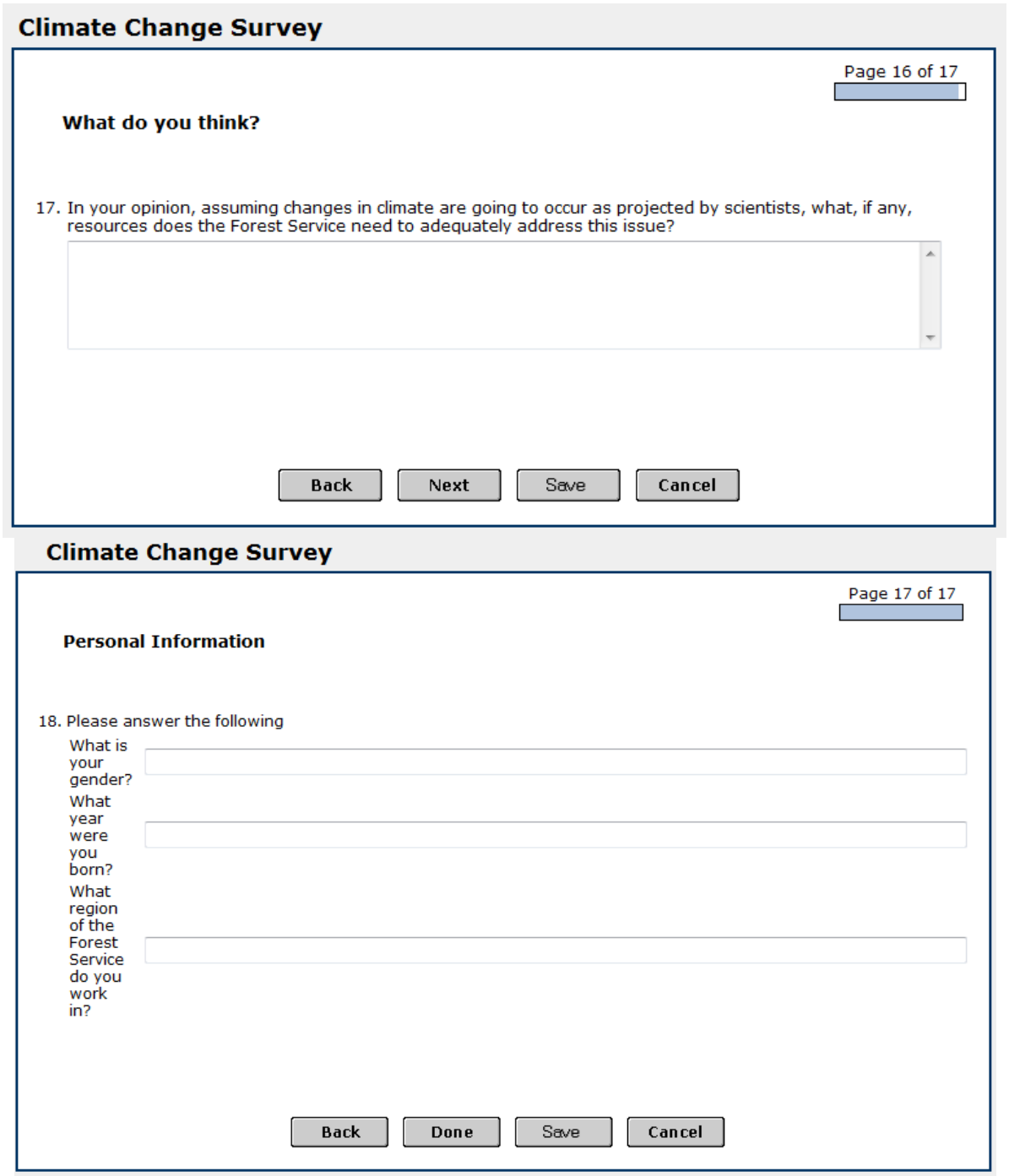

Climate Change Survey

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What do you think?

17. In your opinion, assuming changes in climate are going to occur as projected by scientists, what, if any, resources does the Forest Service need to adequately address this issue?

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Climate Change Survey

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Personal Information

18. Please answer the following

What is your gender?

What year were you born?

What region of the Forest Service do you work in?

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APPENDIX C

Prenotice Letter

09 August 2009

Title

Dear

A few days from now you will receive, via email, a link requesting you to fill out a brief questionnaire for my Master's thesis being conducted at the University of Wisconsin- Stevens Point under the supervision of Dr. Mike Dombeck.

My research is interested in the perceptions of environmental managers, such as yourself, about issues relating to climate change.

Your responses will remain completely anonymous and your name will not be used in any report or presentation. I will personally be conducting the analysis and will keep the collected data secure.

I am writing you in advance because past studies have indicated that participants like to know ahead of time that they will be contacted. Your voluntary participation in this survey is extremely important as the data collected will serve as the centerpiece of my Master's thesis. It will also be extremely useful in the development of land management policies related to climate change issues.

Thank you in advance for taking the time to assist me with this research.

Sincerely,
Nick Blay

Nicholas Blay
Graduate Assistant
UWSP- College of Natural Resources,
800 Reserve Street
Stevens Point, WI 54481
515 447 7797

P.S. If you have any questions about the nature of this study, please do not hesitate to contact me at 515.447.7797 or via email at nblay595@uwsp.edu.

APPENDIX D

Initial Contact/Cover Letter

11 August 2009

Title

Dear _____,

My name is Nick Blay. I am writing to ask your participation in a study for my Master's thesis being conducted at the University of Wisconsin- Stevens Point under supervising professor, Dr. Michael Dombeck. My research is interested in the perceptions of environmental managers, such as yourself, about issues relating to climate change.

Climate change has come to the forefront in concerns regarding how to manage natural systems. Many state and federal entities, including the USFS, are exploring the idea of incorporating climate change issues into land management policy. My research gives you, the land manager, a chance to express your views on the subject. Professionals, such as yourself, have an important role in any climate change policy as you are the individuals responsible for carrying out and implementing any land management policy created with regard to climate change. This is your opportunity to voice your opinion.

I am writing to ask for your participation by filling out the attached survey. The survey is brief and will take only 15 to 20 minutes of your time. To access the survey, please click on the link below or copy and paste the address into your browser. Your responses will remain completely anonymous and your name will not be used in any report or presentation. I will personally be conducting the analysis and will keep the collected data secure.

Thank you for taking the time to assist me with this research. Your voluntary participation in this survey is very important as the data collected will serve as the centerpiece of my Master's thesis.

Here is the link to the survey: http://survey.uwsp.edu/TakeSurvey.aspx?SurveyID=883H882

I would greatly appreciate it if you could have your responses to me by **AUGUST 21st**.

Thank you in advance for taking the time to assist me with this research.

Sincerely,

Nick Blay

Nicholas Blay
Graduate Assistant
UWSP- College of Natural Resources,
800 Reserve Street
Stevens Point, WI 54481
515 447 7797

P.S. If you have any questions about the nature of this study, please do not hesitate to contact me at 515.447.7797 or via email at nblay595@uwsp.edu

APPENDIX E

Follow-up Letter

28 August 2009

Title

Dear _____,

Two weeks ago, you may have received a survey link in an email similar to this one. If you have already completed the survey, apologize for this email and thank you very much! If you have not completed the survey or in case this survey was lost, accidently deleted, or if you have misplaced it, I have enclosed a new one. Please consider taking the time to complete this short questionnaire. It will only take a minute of your time but will provide a wealth of valuable data for my Master's thesis.

I am writing to ask your participation in a study for my Master's thesis being conducted at the University of Wisconsin- Stevens Point under supervising professor, Dr. Michael Dombeck. My research is interested in the perceptions of environmental managers, such as yourself, about issues relating to climate change.

Climate change has come to the forefront in concerns regarding how to manage natural systems. Many state and federal entities, including the USFS, are exploring the idea of incorporating climate change issues into land management policy. My research gives you, the land manager, a chance to express your views on the subject. Professionals, such as yourself, have an important role in any climate change policy as you are the individuals responsible for carrying out and implementing any land management policy created with regard to climate change. This is your opportunity to voice your opinion.

I am writing to ask for your participation by filling out the attached survey. The survey is brief and will take only 15 to 20 minutes of your time. To access the survey, please click on the link below or copy and paste the address into your browser. Your responses will remain completely anonymous and your name will not be used in any report or presentation. I will personally be conducting the analysis and will keep the collected data secure.

Thank you for taking the time to assist me with this research. Your voluntary participation in this survey is very important as the data collected will serve as the centerpiece of my Master's thesis.

Here is the link to the survey: http://survey.uwsp.edu/TakeSurvey.aspx?SurveyID=883H882

I would greatly appreciate it if you could have the survey completed by **SEPTEMBER 4th.**

Thank you in advance for taking the time to assist me with this research.

Sincerely,

Nick Blay

Nicholas Blay
Graduate Assistant
UWSP- College of Natural Resources,
800 Reserve Street

Stevens Point, WI 54481
515 447 7797

APPENDIX F

Third-Contact Letter

15 September 2009
Title
Dear _____,

During the last month and a half I have sent you several mailings about an important research study I am conducting for my Master's thesis at the University of Wisconsin- Stevens Point under supervising professor, Dr. Michael Dombeck.

My research is interested in the perceptions of environmental managers, such as yourself, about issues relating to climate change.

The study is drawing to a close, and this is one of the final contacts that will be made. I apologize if you have already participated in my study but because completion of the survey is anonymous, I cannot track who has and who has not finished the survey; therefore I apologize for the repeated emails to those who have participated. If you have not completed the survey or in case this survey was lost, accidently deleted, or if you have misplaced it, I have enclosed a new one. Please consider taking the time to complete this short questionnaire. It will only take a minute of your time but will provide a wealth of valuable data for my Master's thesis. Again, if you have completed the survey, disregard this email and, again, thank you very much.

I am sending this additional contact because it is my concern that people who have not responded may have different opinions about the topics within the study than those who have. Hearing the opinions of everyone in this small sample helps assure that the survey results are as accurate as possible.

I am again writing to ask for your participation by filling out the attached survey. The survey is brief and will take only 15 to 20 minutes of your time. To access the survey, please click on the link below or copy and paste the address into your browser. I want to stress that your responses will remain completely anonymous and your name will not be used in any report or presentation. I will personally be conducting the analysis and will keep the collected data secure.

Thank you for taking the time to assist me with this research. Your voluntary participation in this survey is very important as the data collected will serve as the centerpiece of my Master's thesis.
Here is the link to the survey: http://survey.uwsp.edu/TakeSurvey.aspx?SurveyID=943H8m2
I would greatly appreciate it if you could have the survey completed by **9:00 CST TUESDAY SEPTEMBER 22nd.**

Thank you in advance for taking the time to assist me with this research.

Sincerely,

Nick Blay
Nicholas Blay
Graduate Assistant
UWSP- College of Natural Resources,
800 Reserve Street
Stevens Point, WI 54481
515 447 7797

P.S. If you have any questions about the nature of this study, please do not hesitate to contact me at 715.310.7834 or via email at nblay595@uwsp.edu

APPENDIX G

Final Contact/Thank You Letter

28 September 2009

Over the past several weeks I have asked for your participation in a survey to obtain data for my Master's thesis being conducted at the University of Wisconsin- Stevens Point under advising professor, Mike Dombeck.

If you have already completed the questionnaire, please accept my sincere thanks and disregard this email. Because of the nature of the survey, in that it is completely anonymous, I cannot track who has and who has not participated; therefore, if you have participated I apologize for the additional emails. If you have not participated, and wish to, you can still do so until **Friday October, 2nd at 9:00pm CST**.

To access the survey, click on the following link or paste it into your browser: http://survey.uwsp.edu/TakeSurvey.aspx?SurveyID=ml3H8p2.

If you are unable to complete the survey via the internet, feel free to drop me an email at nblay595@uwsp.edu or give me a call at 715.310.7834 and we can work out another way for you to complete the survey.

Again, thank you for your participation.

Sincerely,
Nick Blay
Nicholas Blay
Graduate Assistant
UWSP- College of Natural Resources,
800 Reserve Street
Stevens Point, WI 54481
515 447 7797

P.S. If you have any questions about the nature of this study, please do not hesitate to contact me at 715.310.7834 or via email at nblay595@uwsp.edu

APPENDIX H

Variable Indices and Associated Questions

Index	Question(s)
Knowledge	Current climatic changes are happening outside the natural cycle
	Human activity is the primary cause of current changes in earth's climate and long-term weather patterns.
	Deforestation alters the natural balance among atmospheric gases
	The global consensus among scientists is that climate change is occurring.
	Human activities contribute to climate change but are not the primary cause.
Trust	I believe much of what scientists have to say with regard to climate change.
	When scientists say humans are very likely responsible for climate change, I believe them
Risk Perception	I believe climate change is a very serious problem
	I am concerned that ten years from now natural disasters will be more severe than they are now
	We should be more worried about the economy, health care, and terrorist threats than about environmental problems such as climate change
	The consequences of climate change will affect myself and my family in my lifetime
	I am worried about the impacts climate change could have on natural systems
	I believe climate change is already having adverse impacts on natural systems
Preparedness	National Forests maintain long term seed banks or send local seed to places that do
	If changes in climate were to occur as projected, current management practices would be able to deal with such changes
	We have plans in place to respond to extreme weather events (such as hurricanes, tornados, or severe ice storms) and natural disturbances (such as severe wildfire, disease, or insect outbreaks).
	We use climate models that predict future climatic conditions and take these findings into consideration when preparing management activities or restoration projects in National Forests
	Our Forest Management Plan references climate change as something that needs to be taken into consideration when developing and implementing forest management projects
	Our staff is kept up to date on current climate change findings and research
Policy Satisfaction	The USFS is doing enough to address climate change issues
	I am satisfied with the progress the USFS is taking toward climate change issues
	The USFS has taken steps to bring climate change to the forefront in its policy agenda
Policy Needs	The USFS should increase spending on research and development projects relating to climate change issues
	I am concerned that the USFS is not doing enough about climate change
	The USFS is lacking the leadership needed to address climate change issues

APPENDIX I

IPCC Treatments of Uncertainty (derived in full from IPCC, 2007)

Treatment of Uncertainty

The IPCC uncertainty guidance note1 defines a framework for the treatment of uncertainties across all WGs and in this Synthesis Report. This framework is broad because the WGs assess material from different disciplines and cover a diversity of approaches to the treatment of uncertainty drawn from the literature. The nature of data, indicators and analyses used in the natural sciences is generally different from that used in assessing technology development or the social sciences. WG I focuses on the former, WG III on the latter, and WG II covers aspects of both. Three different approaches are used to describe uncertainties each with a distinct form of language. Choices among and within these three approaches depend on both the nature of the information available and the authors' expert judgment of the correctness and completeness of current scientific understanding. Where uncertainty is assessed qualitatively, it is characterized by providing a relative sense of the amount and quality of evidence (that is, information from theory, observations or models indicating whether a belief or proposition is true or valid) and the degree of agreement (that is, the level of concurrence in the literature on a particular finding). This approach is used by WG III through a series of self-explanatory terms such as: high agreement, much evidence; high agreement, medium evidence; medium agreement, medium evidence; etc. Where uncertainty is assessed more quantitatively using expert judgment of the correctness of underlying data, models or analyses, then the following scale of confidence levels is used to express the assessed chance of a finding being correct: very high confidence at least 9 out of 10; high confidence about 8 out of 10; medium confidence about 5 out of 10; low confidence about 2 out of 10; and very low confidence less than 1 out of 10. Where uncertainty in specific outcomes is assessed using expert judgment and statistical analysis of a body of evidence (e.g. observations or model results), then the following likelihood ranges are used to express the assessed probability of occurrence: virtually certain >99%; extremely likely >95%; very likely >90%; likely >66%; more likely than not > 50%; about as likely as not 33% to 66%; unlikely <33%; very unlikely <10%; extremely unlikely <5%; exceptionally unlikely <1%. WG II has used a combination of confidence and likelihood assessments and WG I has predominantly used likelihood assessments. This Synthesis Report follows the uncertainty assessment of the underlying WGs. Where synthesized findings are based on information from more than one WG, the description of uncertainty used is consistent with that for the components drawn from the respective WG reports. Unless otherwise stated, numerical ranges given in square brackets in this report indicate 90% uncertainty intervals (i.e. there is an estimated 5% likelihood that the value could be above the range given in square brackets and 5% likelihood that the value could be below that range). Uncertainty intervals are not necessarily symmetric around the best estimate.