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Policy makers in the United States (US), following recommendations made by the international scientific community, have drafted national emissions reduction legislation in hopes of minimizing the harmful effects of global climate change. Included in this legislation is a national cap-and-trade system with provisions for carbon offsets. Specific provisions for forest carbon offsets include reduced emissions from deforestation and degradation (REDD) as well as other forestry-related offsets both domestically and internationally. Given that the majority of forestland in the US is privately owned and little extant work examines this population in relation to forest carbon offsets, the goal of the current research was to employ survey methodology to measure the intentions of US forestland owners (non-industrial and industrial) to participate in emerging carbon offset markets. Applying the Theory of Planned Behavior (TPB) (Ajzen 1991) as a theoretical framework, the current research examined the effects of attitudes, subjective norms, and perceived behavioral control on intentions to participate in carbon sequestration and trading. In addition, the TPB model developed for non-industrial owners was extended to

measure effects of innovativeness, environmental orientation, knowledge of carbon offsets, and perceived risk. The TPB model developed for industrial owners was extended to measure effects of perceptions regarding the likelihood of national cap-and-trade legislation implementation, legislation effectiveness, the legitimacy of domestic forest carbon offsets, economic short-termism, and organization (company) size.

Overall, few private forestland owners were currently managing forestland for carbon offsets (non-industrial 5%; industrial 18%). For non-industrial owners, core constructs within the TPB acted as hypothesized by Ajzen (1991). The extended model suggested that more innovative owners and owners with more biocentric environmental orientations tended to hold more positive attitudes regarding carbon sequestration and trading. Perceived risk and knowledge were significant factors, but found to be less influential. However, knowledge positively influenced attitudes while negatively influencing behavioral intentions, thus, indicating that knowledgeable forestland owners, although holding positive attitudes regarding carbon sequestration and trading, were less likely to implement the practice.

A reduced TPB model was effective when applied to industrial owners. Attitudes had a strong effect on intentions regarding carbon sequestration and trading. Attitudes were influenced by perceptions regarding the implementation of cap-and-trade legislation, as well as the legitimacy of domestic forest carbon as a viable climate change mitigation tool. Qualitative data support these findings and suggests that industrial owners were adopting a passive approach to carbon offset opportunities until a suitable regulatory

framework emerges and carbon prices create sufficient return on investment. Results suggest attitudes regarding carbon sequestration and trading are significantly less positive at the organizational level than attitudes held by individual managers responsible for the carbon sequestration activities.

Findings from this study identify key requirements for carbon market participation by non-industrial and industrial private forestland owners. Non-industrial owners require education and guidance regarding carbon offset opportunities. Industrial owners require a stable and healthy carbon offset market with well defined regulations and sufficient carbon values to justify the cost of alternative forest management practices.

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Intentions of US Forestland Owners to Participate in Emerging Carbon Markets: A Behavioral Modeling Approach

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Derek W. Thompson

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I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Derek W. Thompson, Author

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INTENTIONS OF US FORESTLAND OWNERS TO PARTICIPATE IN EMERGING CARBON MARKETS: A BEHAVIORAL MODELING APPROACH

CHAPTER 1 - GENERAL INTRODUCTION

In the 1820s, Joseph Fourier first hypothesized that "greenhouse gasses" trap heat radiated from the Earth's surface after it has absorbed energy from the sun (Fleming 1999). His discovery sparked nearly two centuries of research and escalating debate regarding causes, effects and mitigation strategies related to climatic change. In 1989, the Intergovernmental Panel on Climate Change (IPCC), consisting of leading climate experts from the scientific community, was created by the United Nations with the task of providing the world with a clear scientific view regarding the status of global climatic change. Since its inception, the IPCC has issued four reports addressing the state of knowledge, social and economic impacts, and possible response strategies (IPCC 2007).

In 1997, the Kyoto Protocol, an international agreement linked to the United Nations Framework Convention on Climate Change, aimed to set binding targets for thirty-seven industrialized countries for reducing greenhouse gas emissions. The protocol called for a 5% reduction in emissions below 1990 levels over a five year period from 2008-2012. All developed countries and economies in transition have ratified the Kyoto Protocol, with the exception of the United States (US). Countries must meet their targets through national measures, however, the protocol also allows for emissions trading, the Clean

Development Mechanism (CDM), and Joint Implementation (JI) strategies. CDM projects are initiated by ratifying countries and carried out in developing countries. Projects may include biofuel conversion, methane recovery, and hydroelectric power. JI projects are similar to CDM projects with the distinction that the partnering country is another developed (industrialized) country (UNFCCC 2010).

As per the terms of the Land Use, Land Use Change and Forestry (LULUCF) stipulation of the Kyoto protocol, forestry projects established under the CDM or JI are limited to afforestation and reforestation on land that was not previously forested in 1990 and are capped at 1% of base year emissions. In 2008, less than 1% of CDM credits were derived from approved forestry under LULUCF methodologies. This is, in part, due to the complexities of permanence, leakage, measurement and monitoring related to these projects. UN-led climate negotiations have considered the inclusion of reduced emissions from deforestation and degradation (REDD) in developing countries in addition to LULUCF projects, but a decision has not yet been made (UNFCCC 2010).

Emerging emissions reduction legislation in the US aims to utilize a cap and trade emissions reduction system, similar to the European Union Emission Trading Scheme (EU-ETS) which was established in 2005. While the EU-ETS adheres to the regulations outlined within the Kyoto Protocol, the two proposed pieces of US legislation are likely to adhere to self-established targets and allow for offsets approved by the US government. The American Clean Energy and Security Act (ACESA) passed the House

in 2009 but is awaiting approval in the Senate. The bill allows for up to two billion tons of carbon offsets per year from domestic and international offset projects and allows for REDD projects (WRI 2009). A more recently drafted bill, The American Power Act, sets similar targets but places somewhat more emphasis on REDD and other forestry-related projects (e.g. forest products) (Vidaurrazaga 2010).

In the absence of a nationally legislated carbon emissions system in the US, forest carbon offset buyers and suppliers can operate within regional regulatory markets and national voluntary markets. These markets vary in the type of forest offsets accepted and the requirements required in terms of permanence, additionality and leakage. Although the market is underdeveloped and change is eminent, there currently exists a market for forest carbon offsets, and in the event that a nationally legislated framework emerges, these market opportunities are expected to grow.

Ideally, public policy is formed with all pertinent information available to the policy-maker. In the case of emissions reduction legislation, however, policy-makers have drafted substantial opportunities for domestic forestry offsets without having a complete understanding of the attitudes and intentions held by US forestland owners regarding these opportunities. Given that 63% of the forestland in the US is privately owned (Butler and Leatherberry 2004) and little extant academic study exists on the matter, it is likely that policy-makers drafted forest offset provisions without understanding the

attitudes and intentions of forestland owners that control over half of the US forest resource.

The present research uses behavioral models to explain the intentions of both industrial and non-industrial forestland owners regarding the management of forestland for carbon sequestration and trading. The proposed theoretical framework, based on the Theory of Planned Behavior (Ajzen 1991), aims to use psychographic, demographic and land characteristic measures to predict intentions of these forestland owners to manage forestland for carbon sequestration and trading. As outlined in subsequent chapters, this study addresses an important knowledge gap which provides a framework for meaningful academic inquiry and offers practical insights useful to policy-makers, carbon marketers and investors. Overall research objectives include the following:

1. Use behavioral theory to predict the intentions of non-industrial forestland owners to manage their forestland for carbon sequestration and trading (Chapter 3)

2. Determine land characteristic, land use planning, and demographic variables that significantly influence attitudes held by non-industrial forestland owners regarding carbon sequestration and trading (Chapter 4).

3. Use behavioral and organizational theory to predict intentions of large industrial forestland owners to manage forestland for carbon sequestration and trading.

LITERATURE CITED

Ajzen, I. 1991. The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50, 179-211.

Butler, B.J., and Leatherberry, E.C. 2004. America's family forest owners. Journal of Forestry, October/November, 4-14.

Fleming, J.R. 1999. Joseph Fourier, the 'greenhouse effect', and the quest for a universal theory of terrestrial temperatures. Endeavour, 23(2): 72-75.

IPCC. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In Pachauri, R.K.& Reisinger, A. (Eds.) Geneva, Switzerland.

United Nations Framework Convention on Climate Change (UNFCCC). 2010. The Kyoto Mechanism. Retrieved from http://www.unfccc.int

Vidaurrazaga, J. 2010. Trees fare well in latest US climate bill. Ecosystem Marketplace. Retrieved from http://www.ecosystemmarketplace.com

World Resources Institute (WRI). 2009. The American Clean Energy and Security Act: Key elements and next steps. Retrieved from http://www.wri.org

CHAPTER 2 - THEORETICAL BACKGROUND

Politicians, industrial representatives, and the media, particularly in the US, frequently suggest that climate change science is highly debated and uncertain. This uncertainty is commonly used as an argument against the adoption of stringent measures aimed at reducing greenhouse gas emissions (Oreskes 2004). Even high ranking officials in the US Environmental Protection Agency (EPA), while commenting on a report outlining the risks of climate change, have suggested a lack of consensus on the science and conclusions on climate change (Revkin and Seelye 2003). Corporations, the revenues of which would almost certainly be adversely affected by emissions controls, have also voiced their concerns over substantial disagreement regarding the science of climate change (van den Hove et al. 2002).

Despite presumptions of debate within the scientific community regarding climate change, scientific consensus is expressed within the reporting of the Intergovernmental Panel on Climate Change (IPCC). Created in 1988 by the United Nations and the World Meteorological Organization, the IPCC's mandate is to evaluate the current science of climate change, primarily based on peer-reviewed literature, for the purpose of informed policy formation (IPCC 2000). A recent IPCC report states, "Human activities … are modifying the concentration of atmospheric constituents … that absorb or scatter radiant energy. Most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations" (IPCC 2007). The IPCC is not alone in its

assertions. The National Academy of Science, the American Meteorological Society, the American Geophysical Union, and the American Association of the Advancement of Science have all issued statements in support of evidence suggesting that humans are indeed responsible for climate change (Oreskes 2004).

Claims of disagreement within the scientific community by political, corporate and media entities have been addressed by two separate reviews of the scientific literature related to climate change. An analysis of 928 abstracts published from 1993 to 2003 (Oreskes 2004) found none of the studies to reject the consensus that the majority of the warming in the past 50 years was caused by humans. A similar review of 539 abstracts published from 2004 to 2007 (Schulte 2008) did not reveal an absolute consensus, identifying 31 papers explicitly or implicitly rejecting the consensus. However, the vast majority of abstracts reviewed were in agreement with the position of the IPCC.

FORESTS AND CARBON SEQUESTRATION

Tropical, temperate and boreal forests cover approximately 30% of the Earth's land surface (~42 million km^2). These forestlands are capable of sequestering over 33% of the anthropocentric carbon emissions from fossil fuel and land use change (2.6 billion tons per year) (Bonan 2008). Four key strategies for the mitigation of carbon emissions through forestry-related activities are available: 1. increases in forestland through reforestation, 2. reduced emissions from deforestation and degradation (REDD),

3. increases in carbon sequestration of existing forests, and 4. the use of forest products in place of petroleum-based or unsustainable products (Canadell and Raupach 2008).

CARBON MARKETS AND FOREST OFFSETS

Globally, both voluntary and regulatory emissions trading initiatives and frameworks, typically emphasizing carbon emissions, have emerged to provide market-based systems to manage emissions. Although not all global frameworks recognize forest-based carbon as a tradable unit, demand for forest carbon is expected to continue to grow strongly, particularly as existing and proposed emissions frameworks recognize forestry offsets (Olander and Murray 2007; Olander et al. 2009). The United States (US), both large in area and high in per capita emissions, has perhaps the greatest capacity for extensive forest carbon offset generation in the developed world. The development of initiatives associated with reduced emissions from deforestation and forest degradation (i.e. REDD) in developing countries will further increase the focus on forests and develop the opportunity for using forests as a greenhouse gas (GHG) mitigation option (Mollicone et al., 2008). US consumption trends, environmental policy, and capacity for mitigation activities using forests will continue to have an interdependent relationship with global forests (Brooks 1993; USDA Forest Service 2003).

Extensive efforts have been invested in developing the appropriate institutional and regulatory systems to allow efficient operation of market-based frameworks

incorporating forest carbon offsets. Portela et al., (2008) highlighted critical conditions for such markets to function successfully:

- *Property rights* – to allow the privatization of the resource so that an exchange can be made between the supplier of the good or service and those who demand it;
- *Legal framework* – to establish who is responsible and liable for different aspects of market transactions;
- *Regulatory framework* – to define the conditions under which the framework will operate;
- *Monitoring and enforcement* – to ensure that sellers adhere to the rules and conditions of transactions.

The combination of these conditions and the related idiosyncrasies that they demand illustrates the complicated nature of regulating, monitoring and enforcing the rules upon which forest carbon sequestration practices need to be managed to ensure they are an effective and appropriate mitigation tool.

Although the broad conditions (e.g. those listed by Portela) of forest carbon markets may be relatively clear, there is variance in the ways in which different emissions frameworks specifically manage and regulate the use of forest carbon offsets. While the greatest difference may be between developing and developed countries, there are also many differences between frameworks in developed countries. Identifying knowledge gaps that may impact the successful growth and implementation of forest carbon markets can be used to develop a framework for understanding and studying forest carbon offsets. Improving the understanding of forest carbon offsets allows informed decisions to be

made about climate change mitigation potential as well as the economic, social and environmental benefits that forest carbon sinks may be able to deliver (Kraxner et al. 2009).

Development of markets for forest carbon offsets is the result of many years of work by the actors and institutions holding stakes in carbon markets. These actors and institutions include scientists, intergovernmental agencies, non-government organizations (NGOs), national governments and the business community. Figure 1 illustrates a generalized process by which forest carbon offsets have come to be recognized in emissions frameworks.

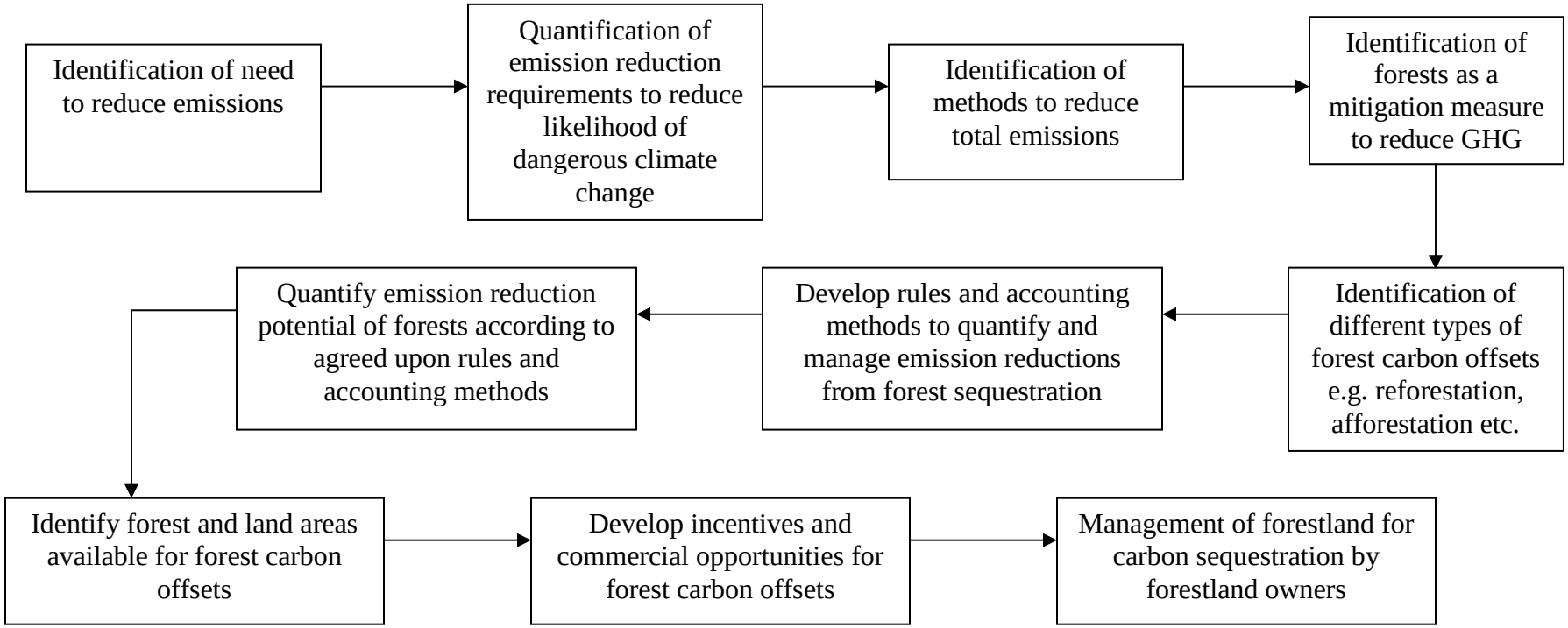


Figure 1. Stages of forest carbon offset development (Bull and Thompson 2010)

Markets for Forest Carbon Offsets

As illustrated in Figure 1, it is necessary to develop frameworks that set the boundaries and rules for abatement capacity if forest carbon sequestration is going to contribute and be accountable for GHG removal. Such frameworks are the mechanism by which markets can recognize carbon units derived from forest carbon offset projects and allow them to be traded on an equitable basis with other units recognized within the frameworks. Emissions trading frameworks typically incorporate one or more of four different types of forest carbon offset projects. General definitions for these are provided in Table 1; however, it is noted that definitions are often altered to suit the needs of different frameworks. These definitions are adapted from the Report of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (UNFCCC 2006). Emissions frameworks can recognize all or a combination of the following project types:

Table 1. Definitions of forest carbon offset projects

Term	Definition
Afforestation:	Direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources.
Reforestation:	Direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period (of the Kyoto Protocol), reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989.
Avoided Deforestation:	Avoidance of direct human-induced conversion of forested land to non-forested land
Improved Forest Management:	System of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biodiversity), economic and social functions of the forest in a sustainable manner.

FOREST CARBON OFFSET POTENTIAL IN THE UNITED STATES

In 2005, approximately 14% of US GHG emissions were offset by terrestrial sequestration. The vast majority of these offsets arose from carbon sequestered by forests (US EPA 2007). The vastness of US forested lands allows even small increases in carbon sequestration per hectare to achieve substantial sequestration nationwide. The US currently holds 504 million acres of unprotected forestland with the potential to uptake 43.2 tC/acre/year (Kimble et al., 2003). The conversion of marginal cropland also provides an opportunity for the establishment of carbon sequestering forests. Currently,

in the US, over 69 million acres of marginal cropland is suitable for this type of conversion (Lal et al., 1998) and has the potential to sequester 48.6 mtC/year (Parks and Hardie 1995). Comis et al. (2001) suggest that US farmlands and rangelands could potentially sequester 13% of the country's carbon emissions.

Regulatory Frameworks in the United States

Regulatory frameworks in the US have been slow to develop at the national level. As of August 5, 2009, the American Clean Energy and Security Act passed the House and had entered the second reading in the Senate (OpenCongress 2010). The legislation proposes a cap-and-trade emissions reduction program. An emissions cap of 17% below 2005 levels by 2020 and an 83% reduction by 2050 has been projected at this time (WRI 2009). The legislation would also set a 20% renewable energy standard by 2020 (Burnham 2009) and allow up to two billion tons of offsets per year which may jointly be met by domestic and international activities. The domestic offsets would mainly come from forestry and agricultural projects (WRI 2009). A subsequent bill, the American Power Act, was drafted in May 2010. The bill sets similar targets as the American Clean Energy and Security Act, but places more emphasis on REDD and identifies specific forestry-related projects eligible for offsets (e.g. forest products) (Vidaurrazaga 2010).

At a regional level, regulatory frameworks have emerged through inter-state agreements to reduce carbon emissions, especially from large industrial emitters. The Regional

Greenhouse Gas Initiative (RGGI) regulates eastern states while the Western Climate Initiative (WCI) is an agreement between seven US states and four Canadian provinces.

The Regional Greenhouse Gas Initiative (RGGI) is the first regulatory cap-and-trade program in the US and targets CO_2 emissions from power plants on a regional level. Ten northeast and mid-Atlantic states have joined RGGI, which became effective on January 1, 2009. The aim of the program is to lower emissions 10% below 2009 levels either by reducing actual emissions or purchasing offsets available through quarterly auctions (RGGI 2009a). Offsets other than auction purchases are limited to 3.3% of a company's total annual allowance purchases. Currently, the only acceptable forestry offset is afforestation (RGGI 2009b). To date, no forestry offsets have been registered with RGGI because rules for such offsets are still in development.

The Western Climate Initiative (WCI), initiated in February 2007, was created to identify, evaluate and implement collective and cooperative ways to reduce regional greenhouse gas emissions by establishing a market-based, cap-and-trade system (WCI 2008). To date, seven states and four Canadian provinces have ratified the initiative, while six states, two Canadian provinces, and six Mexican states have agreed to observe. The WCI recommends a reduction in greenhouse gas emissions of 15% below 2005 levels by 2020. These reductions, unlike RGGI, would target 90% of the region's emissions including utilities, industry, transportation, and residential/commercial fuel use

(WCI 2009). The program is currently in the design phase with an anticipated implementation year of 2012. The program allows for the purchase of emission offsets limited to 10% of the reported reductions. Acceptable forestry offsets include afforestation, reforestation, forest management, forest preservation/conservation, and forest products (WCI 2008). Forestry projects will not be registered until protocols are finalized by WCI committees.

VOLUNTARY FRAMEWORKS IN THE UNITED STATES

Various voluntary carbon trading frameworks, varying in scope and size, have emerged in the US and allow individuals, groups, government agencies and corporations to report emissions and/or purchase offsets in a market-like environment. The following frameworks represent the most influential voluntary frameworks either operating or under development.

The Voluntary Carbon Standard (VCS) was developed in 2005 by The Climate Group, the International Emissions Trading Association, and the World Economic Forum with the objective of standardizing and providing transparency and credibility to the offset market. The VCS creates tradable voluntary offset credits, known as Voluntary Carbon Units (VCU). Currently, the VCS allows forest offsets related to afforestation, reforestation and revegetation (ARR), improved forest management (e.g. reduced impact logging, forest protection, extended rotation ages, and conversion from low to high-

productivity forests), and reduced emissions from deforestation and degradation (REDD) (VCS 2008). At time of publication, no forestry projects had been registered in the VCS registry system. Guidelines for forestry projects were only incorporated into the registry system in early 2009 (Seager 2009).

The California Climate Action Registry (CCAR), formed in 2001 by the state of California, provides a voluntary greenhouse gas registry to foster early actions to reduce greenhouse gas emissions by organizations. The registry now includes over 300 of the world's largest corporations, universities, cities/counties, government agencies, and environmental agencies. The registry allows members to measure, monitor and publicly report emissions (CCAR 2007). The Climate Action Reserve, the national offset program of CCAR, currently recognizes forestry projects related to conservation-based forest management, reforestation, and conservation easement projects. Once projects are quantified and verified, carbon credits can be issued and traded over time in a transparent, publicly-accessible system. These carbon credits, known as Climate Reserve Tonnes (CRT), typically attract high prices due to rigorous verification and monitoring standards. CRT's can be traded in the voluntary market or transferred into the Voluntary Carbon Standard's unit of measure, the Voluntary Carbon Unit (VCU) (CCAR 2007).

The Climate Registry, a sister organization of CCAR, is a nonprofit collaboration among North American states, provinces, territories and Native Sovereign Nations that aims to

set consistent and transparent standards to quantify and publicly report greenhouse gas emissions within a single registry. The registry supports both voluntary and mandatory reporting programs. The registry may allow offsets that have been purchased or traded (Climate Registry 2009). The registry incorporates forestry activities as outlined by CCAR.

The Chicago Climate Exchange (CCX) is the world's first and North America's largest voluntary and legally binding carbon trading system. The CCX began in 2000 with a grant from the Joyce Foundation to Northwestern University to provide technical support as researchers examined the feasibility of a greenhouse gas cap-and-trade market in the US. The CCX officially launched in 2003 and attracted some of the largest corporations in the country and now has over 300 members worldwide. In 2005, the CCX launched the European Climate Exchange (ECX) which has become a dominant exchange operating within the European Union Emissions Trading Scheme (EUETS).

The CCX also developed the Chicago Climate Futures Exchange (CCFE), a futures exchange that provides standardized and cleared futures and options contracts on emission allowances and other environmental products (CCX 2009a). The CCX currently accepts forestry offset projects related to afforestation, managed forestry, wood products, REDD, and urban tree planting. Approved forestry offset projects must have some sort of forest sustainability certification (e.g. FSC, SFI, etc.). As of March 2009,

8,860,500 MTCO2e of forestry offsets have been registered with the CCX. This represents 14% of all offsets registered with the CCX (CCX 2009b).

The DOE 1605 (b) Voluntary Reporting Program was developed as part of the Energy Policy Act of 1992 and provides a method of voluntary reporting of emissions by corporations, government agencies, non-profits, and households. Currently, the framework recognizes reporting of carbon stock increases occurring on managed forests as well as reforested, restored, and permanently protected land (DOE 2009). In 2005, 590 forest carbon sequestration projects were registered using various forestry measures including afforestation, reforestation, urban forestry, forest preservation, and modified forest management. These projects accounted for 27% of the projects reported in 2005 and represented 7.9 MTCO2e (EIA 2006).

Other Frameworks

Currently, independent working groups and committees are working to develop standards for forest carbon offsets that could potentially provide confidence and transferability to a highly variable sector. The Forest Climate Working Group, organized by the American Forest Foundation, was established in 2007 to develop consensus regarding the role of forests in climate change. Representing conservation, industry, wildlife, carbon finance, forestry and forest owner interests, the group has developed specific recommendations for climate change policy makers (AFF 2009). The Forest Carbon Standards Committee

aims to create a uniform set of North American standards that would enable forestland owners to participate in emerging carbon trading schemes. The Society of American Foresters, the Forest Products Association of Canada, the Canadian Institute of Forestry, and the American Forest and Paper Association have joined together in hopes of initiating an ANSI-accredited standard. This process began in 2008 with the creation of a technical committee to guide the development of these standards (FCS 2009).

IDENTIFYING KNOWLEDGE GAPS IN THE FOREST CARBON OFFSET MARKET

Like any new product, the development of forest carbon offsets requires research and development prior to implementation. As markets for forest carbon offsets have developed, extensive investigation has been undertaken to understand the elements of the forest carbon offset market. For example, there have been numerous studies describing forest carbon offset opportunities currently available within the various frameworks and relevant markets (Clean Air-Cool Planet 2006; Ribon and Scott 2007; Tuerk et al. 2008; Hamilton et al. 2008). Other reports have tracked the carbon market holistically (Capoor and Ambrosi 2008), while others describe the demand requirements from potential buyers of forest carbon offsets (Till 2009). These market-based reports, however, are all derived from the demand side of the forest carbon offset market. There appears to be little work providing insights into the intentions to develop forest carbon offsets from a forestland owner or a supply side perspective (Kraxner et al. 2009). Reflecting on the pathway of

forest carbon offset development (Figure 1), Table 2 identifies the information currently available at each step of the development of the forest carbon offset market.

Table 2. Knowledge gaps related to the development of forest carbon offsets

Information requirement	Information available?	Example publication/s
Identification of need to reduce emissions	✓	IPCC (2007)
Quantification of emission reduction requirements to reduce likelihood of dangerous climate change	✓	Stern (2007) Garnaut (2008) Eilperin (2009)
Identification of methods to reduce total emissions	✓	McKinsey & Company (2009) Capoor and Ambrosi (2008) Markey (2009)
Identification of forests as a mitigation measure to reduce GHG emissions	✓	Ribon and Scott (2007); Eliasch (2008) Streck et al., (2008)
Identification of different types of forest carbon offsets (e.g. reforestation, afforestation, etc)	✓	UNFCCC (2006) Stavins and Richards (2005) Hoyer (2009); US EPA (2008)
Develop rules and accounting methods to quantify and manage emission reductions from forest sequestration	✓	CCAR (2009); CCX (2009); DOE (2009); RGGI (2009); VCS (2008); WCI (2008); US EPA (2008)
Quantify emission reduction potential of forests according to agreed upon rules and accounting methods	✓	DOE (2007)
Identify forests and land areas available for forest carbon offset development	✓	Gunasekera et al (2007) Benitez and Obersteiner (2004) Zomer et al. (2007)
Develop incentives and commercial opportunities for forest carbon offset development	✓	Stavins and Richards, 2005; Amacher, et al. (2009) Information provided by carbon offsetting organisations: e.g. http://www.afar.net.au/ Shabman et al. (2002); US FIP (2002)
Intentions of forestland owners to develop forest carbon offsets	x	

The obvious gap identified in Table 2 is the lack of information pertaining to the development of forest carbon offsets by forestland owners. Work does exist at the local level that covers aspects such as forestland owner attitudes toward woodland regeneration (Maraseni and Dargusch 2008) and farm forestry incorporating environmental benefits (Alig 2003; Herbohn et al. 2005). Although some work may incorporate carbon within a broader set of values, there is little evidence of specific and consistent work that provides information on forest owner attitudes and intentions regarding forest carbon offset development. This understanding is critical in order to understand the realistic potential of forests to contribute to GHG removal and to optimize their contribution. A complete understanding of forest carbon offsets will also ensure that effective policy incentives are developed and implemented. If forest carbon offset projects are to become a mainstream opportunity for forestland owners and a large scale and viable means to reduce emissions for emitters, the opportunity must fulfill the requirements of both the suppliers (forestland owners) and buyers (emitters) of forest carbon offsets (Bull and Thompson 2010). Accordingly, meta-analyses have called for the integration of forestland owner behavior in large-scale policy models related to climate change mitigation practices (Amacher et al. 2003).

Forest Carbon Offsets and the Role of the Innovation System

Innovation systems describe the set of players and institutions that contribute to the development and diffusion of innovations – in this case forest carbon offsets. The work completed by Kubeczco et al. (2006) and Rametsteiner and Weiss (2006) on innovation systems in the forest sector appears to be the relevant link to understand the different actors participating and influencing the development of forest carbon offset projects. The success of these projects will be dependent upon the performance and interaction of those players and institutions present in the forest carbon offset innovation system (Cairns and Lasserre 2004).

In any innovation system, there are many actors and institutions working both individually and in collaboration, to develop a variety of innovative responses to incorporate forest carbon offsets as a climate change mitigation option. Noting the interconnectedness of these actors and institutions, they can be broadly classified as follows:

- Society;
- Intergovernmental processes;
- National and state governments;
- Companies;
- Business community;
- Non-Government Organizations (NGOs); and
- Forest owners

Using the broad concept of the innovation system, Figure 2 demonstrates the components of the forest carbon offset innovation system and the relationships between each component. As recognized by Edquist (2001), this, like other descriptions of innovation systems, is necessarily a simplification. The institutions of the forest carbon offset innovation system are described below:

- *Society*: At the global, regional and local levels, society exerts pressure for the development of responses to the threat of climate change. This pressure is informed and, at least in part, developed by NGOs while the business community responds by creating and responding to their demands with innovative and often financially beneficial solutions;

- *Intergovernmental organizations and processes* such as the United Nations Intergovernmental Panel on Climate Change are designed to be both reactive and proactive in the development of treaties and agreements such as the Kyoto Protocol to create international agreements for implemented change;

- *National governments* can choose whether they wish to be signatories to the outcomes of Intergovernmental Processes. In doing so, they are often reacting to the pressure exerted by their national society including NGOs and the business community;

- *Companies* are the specific entities of the business community present at the national level that develop markets for forest carbon offsets. Their ability to do so is, at least in part, dependent on the policies and legislation developed by the Government. Two examples of companies that have realized such opportunities

are CO_2 Australia headquartered in Australia and CantorCO2 headquartered in the US;

- *The business community* is made of companies, both at the national and global level, as well as associated industry lobbies. Like NGOs, they work across the system, both influencing and responding to the outcomes of the other actors within the system;

- *NGOs* influence the entire system through information and promotion of the importance of climate change and the need for societal change; and

- *Forestland owners* are those who make the decisions regarding the planting or managing of forest carbon offsets. They are influenced by the opportunity presented to them by the company.

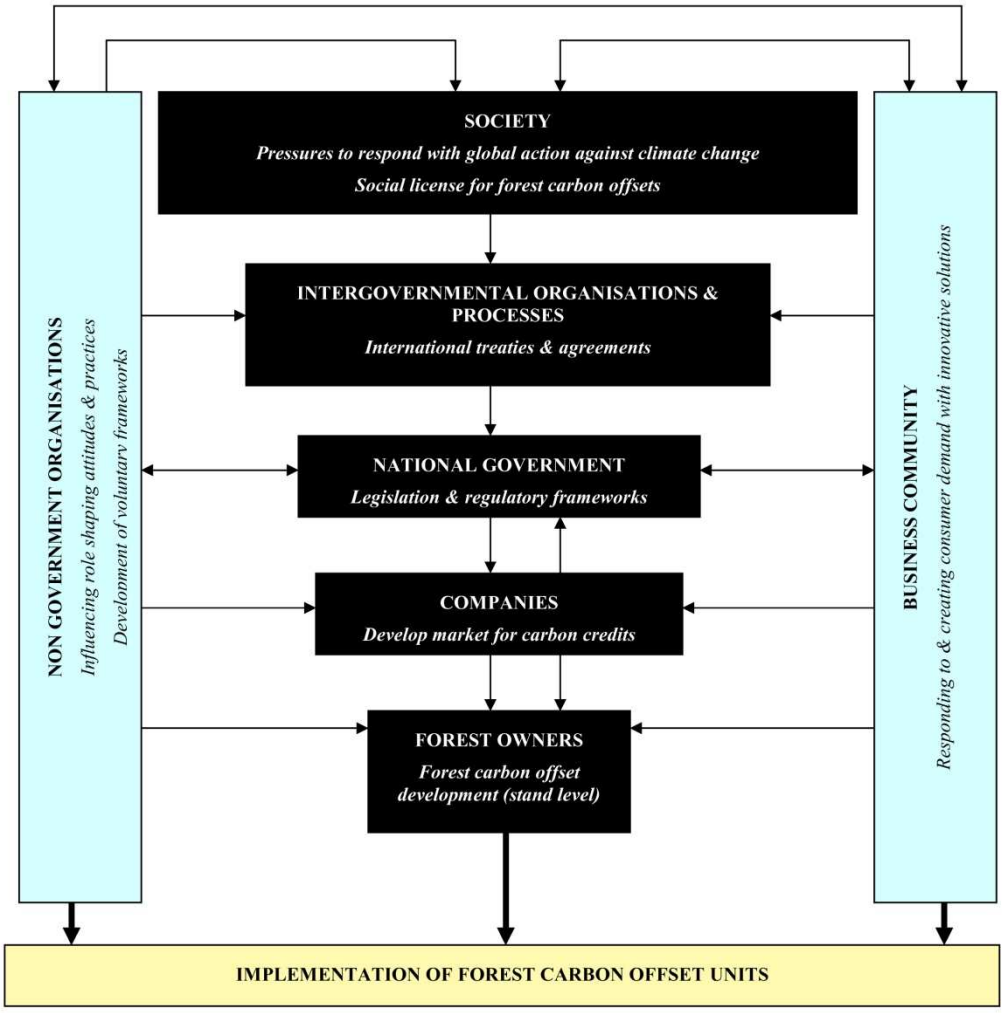


Figure 2. Forest carbon offset innovation system (Bull and Thompson 2010).

As both Figure 1 and Figure 2 illustrate, forest owners are an integral component to ensure the successful development of forest carbon offsets. As Table 2 and this review have demonstrated, there is currently a lack of information to understand forest owners' intentions to develop forest carbon offsets. For this knowledge to be acquired, a robust method of investigation is needed (Bull and Thompson 2010).

PRIVATE FORESTLAND OWNERS

Forests cover approximately 620 million acres of land within the US, of which 393 million acres (63%) are privately owned (Butler and Leatherberry 2004). The remaining forestland is divided amongst federal, state and municipal governments (i.e. public). Private forestland holdings can be divided into two categories: industrial and non-industrial (Figure 3).

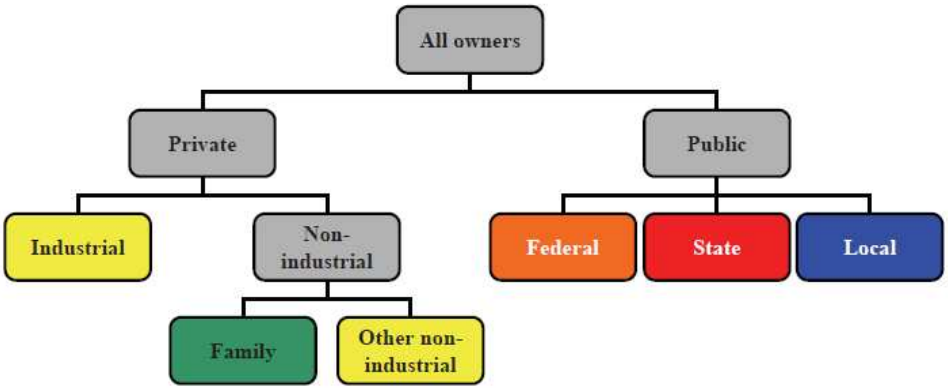


Figure 3. Categories of forest ownership in the United States.

Industrial forestland owners may include entities such as forest product companies, real estate trusts, and timber management organizations, while non-industrial forestland owners include individuals, families or organizations with non-industrial management activities attached to their forestland holdings.

Family forests, which can be described as lands owned by individuals, married couples, family estates and trusts, or other groups who are not incorporated or a registered legal entity, represent nearly 40% of the forested acres in the US. These lands must be at least

one acre and 10% stocked (Butler and Leatherberry 2004). Family forest owners are often unaware of the multitude of income opportunities these lands may offer. A 2003 survey suggests that of the nearly 10.3 million family forest owners in the US, only 3% have written management plans for their lands and only 16% have sought management advice within the past five years (Butler and Leatherberry 2004). Common reasons for ownership were the enjoyment of beauty/scenery, protection of biodiversity, maintenance of an acreage as part of a farm or home site, enhancement of privacy, and passing of land onto heirs. Investment and timber production were less frequently cited reasons, but were identified by 48% and 30% of respondents, respectively. Studies conducted in the US suggest that there are also regional differences in forestland owner decision-making (Greene and Blatner 1986; Romm et al. 1987).

THE SIGNIFICANCE OF NON-INDUSTRIAL PRIVATE FORESTLAND OWNERS

Private forestland owners will likely be key players in any climate change mitigation strategy involving increased carbon sequestration on forested land (Alig 2003). In fact, nearly two-thirds of carbon stored in US forests is located on private lands which have the capacity for further storage (Birdsey et al. 2000). The response of forestland owners to this capacity will depend, partially, on motivations of these owners and responses to market and government incentives (Alig 2003). The objectives of these owners and subsequent decisions are crucial to future timber supply. The behavior of private

forestland owners is also markedly different than the forest industry due to the multi-objective nature of NIPF ownership (Amacher et al. 2003). As first noted by Dennis (1989), NIPF owners may not always respond to prices in the same way the forest industry does and this may create challenges in predicting forestland owner behavior.

Forestland Owner Investment in Forest Carbon Offsets

Although there is currently little information available regarding NIPF owner intentions to develop forest carbon offsets, it is possible to make some predictions on how they might respond to the opportunity. The development of forest carbon offsets by forest owners presents a diversification opportunity and an emerging area of the forest product market. As an emerging product, it is reasonable to expect that, assuming there are appropriate benefits for the forest owner, developing forest carbon offsets will increase over time before reaching a plateau when the majority of the opportunity has been realized. It is, thus, expected that the rate of forest carbon offset development will broadly follow the traditional adoption curve (Figure 4) (Bull and Thompson 2010).

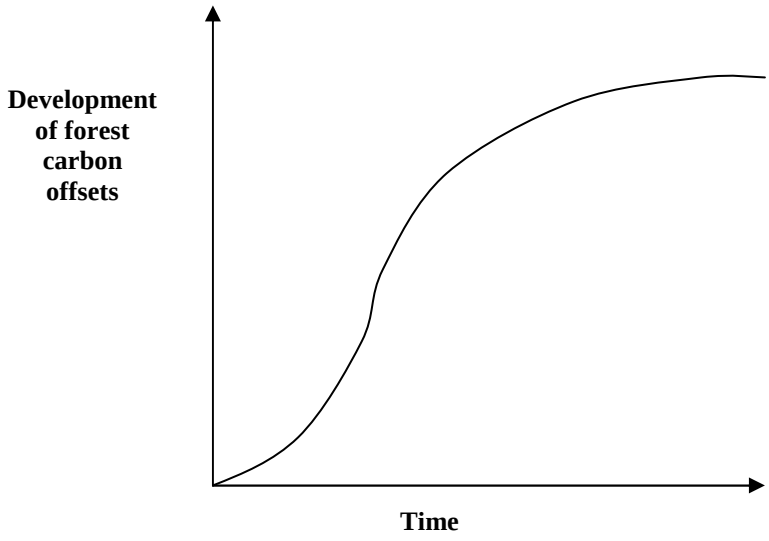


Figure 4**.** Anticipated adoption curve of forest carbon offset development.

It is logical to conclude that the more stringent the requirements by government to lower emissions, the higher the likely demand and price for forest carbon credits. However, the impact that different rules and governance measures may have on forestland owner development of carbon offsets is more difficult to predict. While it is expected that different monitoring and governance requirements may impact the so called 'quality' of the carbon unit and consequently the price paid for it, it is also relevant to question the impact that different requirements may have on forestland owner development of forest carbon offsets (Bull and Thompson 2010).

An oversupply scenario occurred in the early stages of the European Union Emissions Trading Scheme (EU-ETS) resulting in large price fluctuations (King 2008). It is, thus, somewhat at the policy developers' discretion to appropriately set the benchmark (or in

the case of a cap and trade system, the cap) so that demand for units matches the supply. Such experiences verify the need for a robust understanding of the potential supply of credits including those from forest carbon offsets.

LARGE INDUSTRIAL FORESTLAND OWNERS

Beginning in the 1980s, many large forest products companies began to either sell-off all or part of their forestland holdings, or restructure their forestland ownership. These vertically integrated forest products companies often transferred the rights to forestland holdings over to individual investors represented by Timber Investment Management Organizations (TIMOs). TIMOs buy, sell, and manage forestland on behalf of investors such as pension funds, insurance companies and foundations. In the case of restructuring, forestland is typically held by Real Estate Investment Trusts (REITs). REITs are entities that buy, sell, and manage real estate related assets on behalf of private investors. A key distinction between TIMOs and REITs is that REITs actually own the forestland while, in the case of TIMOs, the individual investors own the forestland. Between 1985 and 2005, investment in forestland by TIMOs and REITs grew from one $1 billion to more than $25 billion ($15 billion invested by TIMOs and $10 billion by publicly traded REITs) (Fernholz et al. 2007). Concurrently, forestland ownership by large, vertically integrated forest products companies decreased from 58 million acres to 21 million acres, with most of this reduction in forestland sold or transferred to TIMO/REITs (Fernholz et al. 2007; Hickman 2007). As of 2007, TIMOs and REITs controlled nearly 5% of the forestland

(land predominantly covered by trees) and 7% of the timberland (forestland that can produce 1.5m3/hectare/year of commercial wood) in the US (Fernholz et al. 2007). Between 1980 and 2007, the number of TIMOs grew from two to twenty-five, of which seven are also investing outside of North America (Neilson 2007).

There are several motives which spurred the wide-spread sell-off of forestlands by forest products companies. First, the period saw weak financial performance by forest products companies. The average returns for the Forestry and Paper Group were nearly half the average for the S&P 500 and Dow Jones Industrial. The sale of timber holdings was thought to be the best means by which forest products companies could increase returns in both the short and long term (Fernholz et al. 2007; Hickman 2007).

The sell-off, or transfer, of forestlands was also congruent with accounting procedures which aimed to minimize taxation. Forest products companies with forestlands were required to recognize any appreciation in the value of their forestland assets when computing their return on investment. Forest companies found it more profitable to either divest their forestlands or transfer them to a separate entity (Fernholz et al. 2007). REITs are typically exempt from paying federal corporate income taxes on net income distributed to stockholders. This eliminates the “double taxations” experienced by many forest products companies with land holdings (Brody et al. 2009).

The previous two points have been amplified by steadily increasing forestland values, due in part to the sprawl noticed throughout the country. Higher forestland values equate with higher values of the primary asset held by forest products companies. Forestlands in close proximity to urban areas and with good access, water frontage, aesthetic values, and recreation opportunities were especially prized. Liquidation of forestland, however, required a reassessment of the perceived raw material needs of forest products companies (Germain et al. 2007). In the past, it was believed that ownership of forestlands was necessary to ensure a reliable supply of reasonably priced raw materials. However, more recently, forest products companies have found that they can rely on open-market sources of timber, both domestic and international. During the last 20 years, the forest products sector has noticed increasing competition from low cost suppliers in other countries. This contributed to significant consolidation within the sector, often leaving significant debt in the wake of such consolidations. The sale of forestlands was often viewed as a low-risk strategy to remove this debt (Hickman 2007).

Distribution of TIMO and REIT development has been somewhat uneven in the US. For example, 7 million acres of Maine's forestland has been divested by forest products companies since 1998 (NRCM 2009). Similarly, the Midwest has seen over 5 million acres of forestland sold or transferred to TIMOs and REITs since 1992 (Timberland Report 2006). Overall, market analysts have found investment in timberlands to be financially attractive, reporting five-year returns of 10.6% and three-year returns of 14%

(MarketWatch 2007). It should be noted, however, that these figures are pre-recession and it is likely that returns have declined since publication.

This pattern of investment in timberland not only occurs within the US, but also Canada, South America, New Zealand and other regions of the world. Some market researchers suggest that the purchase of timberlands in the US has leveled and investors will shift focus towards international opportunities (TimberLink 2006). Countries in Europe and Asia appear to have the highest growth potential for international REITs, as countries such as Britain, Germany, Japan, France, Singapore, Hong Kong, and South Korea have either passed or are in the process of passing REIT legislation (Fernholz et al. 2007). As the value of forestland rises, it is expected that investment outside of the US will continue to increase. The US Congress recently passed the Timber Revitalization and Economic Enhancement Act which aims to provide temporary tax benefits to the timber industry, including TIMOs and REITs.

FORESTLAND OWNER PERCEPTIONS OF CARBON SEQUESTRATION AND TRADING

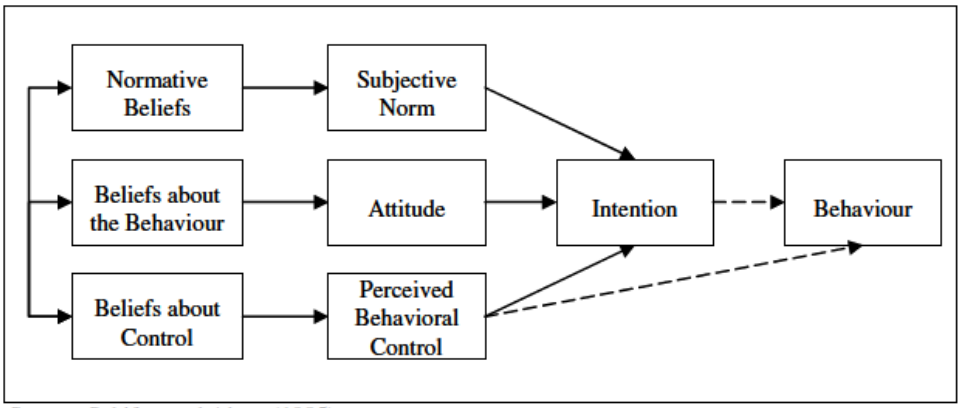
Overall, few studies exist which empirically measure forestland owner perceptions regarding carbon sequestration and trading. Several empirical studies have found that non-timber management goals have become incorporated in overall land management objectives by NIPF owners (eg. Conway et al. 2002; Pattanayak et al. 2002; Hodges and Cuddage 1990). It is also quite common to observe forestland owners showing interest

in attaining income from both timber production and non-timber forest amenities (Newman and Wear 1993; Conway et al. 2002; Pattanayak et al. 2002).

Surveys of southern US range and forestland owners showed disapproval of publicly funded programs promoting afforestation in order to sequester atmospheric carbon (Olenick et al. 2005). However, those with more supportive attitudes about climate change mitigation tended to be more willing to participate. Whether the programs were voluntary or mandatory influenced the landowners' overall willingness to participate. Short term performance contracts (5-10 years) were more favorable than longer-term conservation easements. Overall, respondents agreed that private lands can effectively contribute to the climate change mitigation effort (Olenick et al. 2005). Landowners responded least favorably to voluntarily participating in publicly funded incentive programs to accelerate carbon sequestration as compared to other ecosystem services (Olenick et al. 2005). As expected, surveys of NIPF owners show that the incentive payments needed to forego harvesting were higher for owners with primarily timber objectives for their land, as opposed to both timber and non-timber objectives (Kline et al. 2000). As NIPF owners are typically interested in attaining at least some level of benefit from their land, incentives are often required to persuade owners to manage their forests holistically rather than for maximum timber value (NRCS 1996; Johnson et al. 1997; US Department of State 1997; Springston 1998).

THE THEORY OF PLANNED BEHAVIOR

To examine and better understand intentions of forest owners to participate in carbon sequestration, behavioral models, such as the Theory of Planned Behavior (TPB), can be applied. The TPB (Ajzen 1991) is as an extension of the Theory of Reasoned Action (TRA) developed by Fishbein and Ajzen (1975). The TRA suggests that a given behavior is dependent upon the intention to perform the behavior, where intentions are dependent upon attitudes towards the behavior and subjective norms (or social pressures). The TPB extended the TRA by including a *perceived behavioral control* construct which also acts as an antecedent to behavioral intentions (Figure 5). Defined as an individual's perception regarding the ease or difficulty associated with performance of the behavior, perceived behavioral control can be compared to a similar construct known as self-efficacy, or the belief that one is capable of performing in a certain manner to achieve certain goals (Bandura 1977).



Source: Schifter and Ajzen (1985)

Figure 5. The Theory of Planned Behavior

The TPB has been used in a variety of applications such as health (Godin and Kok 1996), leisure (Ajzen and Driver 1992), wildlife and recreation (Martin and McCurdy 2009), recycling (Valle et al. 2005) and forest management decisions regarding reforestation (Karppinen, 2005). Although the model is most commonly used in health related studies, a meta-analysis conducted by Armitage and Conner (2001) demonstrated support for the use of the TPB in a multitude of research fields.

Since the inception of the TPB, there has been a growing recognition of the value of integrative models which uniquely combine the TPB with constructs from other theoretical frameworks (Baranowski 1993; Fishbein 2000; Nigg et al. 2002; Fishbein and Cappella 2006; Schmiege et al. 2009). These integrations not only test the reliability of single theories, but continually nurture theory development by extending and improving existing theories. These models do not merely explain a greater amount of variance in outcome by adding more predictors of behavior present. Rather certain combinations of constructs within the integration might contribute to a greater amount of variance explained by the model (Weinstein and Rothman 2005).

THE THEORY OF PLANNED BEHAVIOR AND FOREST CARBON OFFSET DEVELOPMENT

Although the TPB is most commonly applied to health and consumerism related studies, the model has previously been applied to forest management activities. The TRA (the

TPB's predecessor), has been applied to several natural resource-related studies since its development (e.g. Bright et al. 1993; Cordano and Frieze 2000; Vogt et al. 2005). In the realm of forest management, Young and Reichenbach (1987) found the TRA to adequately predict intentions to harvest timber and generate wood products and discovered strong relationships between attitude and subjective norms, and intentions. Karppinen (2005) applied the TPB to forest owner decision making related to reforestation methods and found a significant effect of each antecedent to behavioral intentions to allow natural regeneration rather than alternative regeneration (e.g. planting). Karppinen also extended the model to include past experience, a new construct also found to influence all other constructs in the model. Pouta and Rekola (2001) applied the TPB to willingness to pay (WTP) research related to forest management in Finland resulting in another successful application of the model. Turner et al. (1977) suggest that behavioral intentions of forestland owners remained constant over time in 65% of those surveyed, and those that altered their intentions did so to a very minimal extent.

The Theory of Planned Behavior Constructs and Forest Carbon Offsets

Here, the classic constructs within the TPB are defined as found in Ajzen (1991). Operationalization of these constructs is outlined in later chapters. It is hypothesized that, within the context of the present research, the original constructs will behave as predicted by the TPB (Figure 5).

Behavioral Intentions

Behavioral intentions indicate one's willingness and preparedness to perform a given behavior and are assumed to be a direct antecedent of actual behavior. For example, in the context of carbon sequestration and trading, the behavior is the sequestration and trading of forest carbon and intentions are the willingness and preparedness to perform such practices.

Attitudes

An antecedent of behavioral intentions, *attitude* toward a behavior indicates one's evaluation (positive or negative) of one's self-performance of the given behavior. Attitude (A), as expressed in the equation below, is determined by a series of salient beliefs (b_i) regarding the behavior, each combined multiplicatively with a subjective evaluation (e_i) of the belief's attribute (*n* denotes the total number of salient beliefs). For example, a salient belief statement regarding forest carbon sequestration and trading might be "carbon sequestration and trading on my forestland aids in the mitigation of climate change" and a corresponding subjective evaluation statement might be "how important is the mitigation of climate change through forest carbon sequestration?"

$$A = \sum_{i=1}^{n} (b_i e_i)$$

Subjective Norms

An individual's *subjective norm* refers to his/her perceived social normative pressures which may influence (positively or negatively) the intention to perform a given behavior. As shown in the equation below, subjective norms (SN) are developed from normative beliefs (nb_i) regarding the behavior, each combined multiplicatively with a measure of the motivation to comply (mc_i) for each normative belief (*n* denotes the total number of normative beliefs). In the context of carbon sequestration, a normative belief statement might be "adjacent forestland owners believe I should participate in forest carbon sequestration and trading" and a motivation to comply statement might be "how important are the opinions of adjacent forestland owners?"

$$SN = \sum_{i=1}^{n} (nb_i mc_i)$$

Perceived Behavioral Control

The single construct that differentiates the TPB from the TRA, *perceived behavioral control*, refers to the perceived ease or difficulty one experiences regarding the performance of a particular behavior. As illustrated in the equation below, perceived behavioral control (PBC) is created based on control beliefs (cb_i) which express one's beliefs about the presence of factors that may assist or hinder performance of a behavior. These beliefs are combined multiplicatively with the perceived power (pp_i) of the control belief under consideration (*n* denotes the total number of control beliefs). A control

belief statement might be “I have the necessary financial resources to manage my forestland for carbon sequestration” and a perceived power statement might be “in the context of forest carbon sequestration, how important is having the necessary financial resources?”

$$PBC = \sum_{i=1}^{n} (cb_i pp_i)$$

LITERATURE CITED

Ajzen, I. 1991. The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50, 179-211.

Ajzen, I., Driver, B.L., 1992. Application of the theory of planned behavior to leisure choice. Journal of Leisure Research, 24(3), 207-224.

Alig, R.J. 2003. US landowner behavior, land use and land cover changes, and climate change mitigation. Silva Fennica, 37(4), 511-527.

Amacher, G.S., Conway, M.C., Sullivan, J. 2003. Econometric analyses of nonindustrial forest landowners: Is there anything left to study? Journal of Forest Economics, 9, 137-164.

Amacher, G.S., Ollikaainen, M & Koskela, E. (2009) Economics of Forest Resources, Massachusetts Institute of Technology. 30 April 2009

American Forest Foundation (AFF). 2009. Family Forests: Solutions to Climate Change. Retrieved at http://www.forestfoundation.org/policy_climate.html

Armitage, C.J., and Conner, M. 2001. Efficacy of the theory of planned behavior: A meta-analytic review. British Journal of Social Psychology, 40, 471-499.

Bandura, A. 1977. Self-efficacy: toward a unifying theory of behavioral change. Psychological Review, 84, 191-215.

Baranowski, T. 1993. Beliefs as motivational influences at stages in behavior change. International Quarterly of Community Health Education, 13, 3-29.

Benitez, P. and Obersteiner, M. 2004. Site identification for carbon sequestration in Latin America: A grid based economic approach. Forest Policy and Economics, 8, 636-651.

Birdsey, R., Alig, R., Adams, D. 2000. Mitigation options in the forest sector to reduce emissions or enhance sinks of greenhouse gases. In: Joyce, L.A. & Birdsey, R. (eds.). The impact of climate change on America's forests. General Technical Report PNW-GTR-59. US Department of Agriculture, Forest Service, Portland.

Bonan, G.B. 2008. Forests and climate change: forcings, feedbacks, and the climate benefits of forests. Science, 320, 1444-1449.

Brody, M.J., Kahn, D.O. and Matuszak, E.J. 2009. Real Estate Investment Trust income: selected issues and recent changes in the law. Journal of Taxation and Investments, 62: 45-68.

Brooks, D.J. 1993. US forests in a global context: an issue paper for the Resource Planning Act Assessment. USDA Forest Service General Technical Report RM-GTR-228. Rocky Forest and Range Experiment Station, Ft. Collins, CO. 24 p.

Bull, L. and Thompson, D.W. 2010. Developing forest sinks in Australia and the United States: a forest owner's prerogative. Forest Policy and Economics (Accepted)

Burnham, M. 2009, May 15. US Chamber of Commerce sharpens critique of House climate bill. *The New York Times*. Retreived from http://www.nytimes.com

Butler, B.J., and Leatherberry, E.C. 2004. America's family forest owners. Journal of Forestry, October/November, 4-14.

Bright, A.D., Fishbein, M., Manfredo, M.J., and Bath, A. 1993. Application of the Theory of Reasoned Action to the National Park Service's controlled burn policy. Journal of Leisure Research, 25(3), 263-280.

Cairns, R.D. and Lasserre, P. 2004. Reinforcing economic incentives for carbon credits for forests. Forest Policy and Economics, 6, 321-328.

Canadell, J.G. and Raupach, M.R. 2008. Managing forests for climate change mitigation. Science, 320: 1456-1457.

Capoor, K. and Ambrosi, P. 2008. State and Trends of the Carbon Market 2008. Washington D.C., World Bank Institute.

CCAR, 2007. Forest Project Protocol: Version 2.1. California Climate Action Registry. Retreived from http://www.climateregistry.org

CCX. 2009a. Chicago Climate Exchange. Retrieved from http://www.chicagoclimatex.com

CCX. 2009b. CCX Offsets Data. CCX Offset Report. Volume 1, Number 2, February/March Issue. Retrieved at http://www.forestalbancaria.com

Clean Air-Cool Planet. 2006. A Consumers' Guide to Retail Carbon Offset Providers. Retrieved from http://www.cleanair-coolplanet.org

Climate Registry. 2009. The Climate Registry: North America's leaders solving climate change together. Retrieved from http://www.theclimateregistry.org

Comis, D., Becker, H., and Stelljes, K.B. 2001. Depositing carbon in the bank. Agric. Res., 49(2), 4-7.

Conway, C., Amacher, G.S., and Sullivan, J. 2002. Decisions forest landowners make. Virginia Tech Deparment of Forestry, Blacksburg VA., USA.

Cordano, M. and Frieze, I.H. 2000. Pollution reduction preferences of US environmental managers: applying Ajzen's Theory of Planned Behavior. Academy of Management Journal, 43(4): 627-641.

Dennis, D.F. 1989. An economic analysis of harvest behavior: integrating forest and ownership characteristics. Forest Science, 35, 1088-1104.

DOE. 2009. Voluntary reporting of greenhouse gases program. Energy Information Administration. Retrieved at http://www.eia.doe.gov/oiaf/1605/

Edquist, C., 2001. The Systems of Innovation Approach and Innovation Policy: An account of the state of the art. DRUID Conference: National Systems of Innovation, Institutions and Public Policies, Aalborg.

EIA. 2006. Voluntary Reporting of Greenhouse Gases 2005 – Summary. Report#: DOE/EIA-0608(2005/S).

Eilperin, J. 2009. EPA says emissions are threat to public. Washington Post. Retrieved from http://www.washingtonpost.com/wp-dyn/content/article/2009/04/17/

Eliasch, J. 2008. Eliasch Review: Climate Change: Financing Global Forests. Crown Copyright.

Fernholz, K., Bowyer, J., and Howe J. 2007. TIMOs and REITs: What, why, and how they might impact sustainable forestry. Dovetail Partners, Inc. Retrieved from http://www. dovetailinc.org

Fishbein, M. 2000. The role of theory in HIV prevention. AIDS Care, 12, 273-278.

Fishbein, M. and Ajzen, I. 1975. *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Fishbein, M. and Cappella, J.N. 2006. The role of theory in developing effective health communications. Journal of Communication, 56, S1-S17.

Forest Carbon Standards (FCS). 2009. Forest Carbon Standards. Retrieved from http://www.forestcarbonstandards.org/home.html

Garnaut, R. 2008. The Garnaut Climate Change Review, Port Melbourne, Australia, Cambridge University Press.

Germain, R.H., Anderson, N., and Bevilacqua, E. 2007. The effects of forestland parcelization and ownership transfers on nonindustrial private forestland forest stocking in New York. Journal of Forestry, December, 403-408.

Godin, G., Kok, G., 1996. The theory of planned behavior: A review of its applications to health-related behaviors. American Journal of Health Promotion, 11(2), 87-98.

Greene, J.L. and Blatner, K.A. 1986. Identifying woodland owner characteristics associated with timber management. Forest Science, 32(1), 135-146.

Gunasekera, D., Ford, M., and Tulloh, C., 2007. Australian Commodities September Quarter, 2007; Climate Change Issues and Challenges for Australian agriculture and forestry. ABARE. Canberra Australia.

Hamilton, K., Sjardin, M., Marcllo, T. & Xu, G. 2008. Forging a Frontier: State of the Voluntary Carbon Markets 2008. Ecosystem Marketplace & New Carbon Finance. The Katoomba Group.

Herbohn, J.L., Emtage, N.F., Harrison, S.R. and Smorfitt, D.B. 2005. Attitudes of Landholders to Farm Forestry in Tropical Eastern Australia. Australian Forestry, 68(1), 50-58.

Hickman, C. 2007. TIMOs and REITs: Situation brief. National Timber Tax Website. USDA.

Hodges, D.G., and Cubbage, F.W. 1990. Nonindustrial private forest management in the South: Assistance foresters' activities and perceptions. Southern Journal of Applied Forestry, 14, 44–48.

Hoyer, S.H., 2009. Petition to the Committee on Energy and Commerce. Retrieved from http://www.majorityleader.gov

IPCC. 2000. Special report on land use, land use change, and forestry. Intergovernmental Panel on Climate Change. Geneva, Switzerland. Cambridge Press.

IPCC. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In Pachauri, R.K.& Reisinger, A. (Eds.) Geneva, Switzerland.

Johnson, R.L., Alig, R.J., Moore, E., and Moulton, R.J. 1997. NIPF landowner's view of regulation. Journal of Forestry, 95(1) 23–28.

Karppinen, H. 2005. Forest owners' choice of reforestation method: an application of the theory of planned behavior. Forest Policy and Economics, 7, 393-409.

Kimble, J.M., R.A. Birdsey, R. Lal, & L.S. Heath. 2003. Introduction and general description of US forests. In: The Potential of US forest soils to sequester carbon and mitigate the greenhouse effect, Kimble, J.M., L.S. Heath, R.A. Birdsey, and R. Lal (eds.). CRC Press, Baton Rouge, FL.

King, M.R. 2008. An overview of carbon markets and emissions trading: lessons for Canada. Bank of Canada. Discussion Paper 2008-1.

Kline, J., Alig, R.J. and Johnson, R.L. 2000. Fostering the production of nontimber services among forest owners with heterogeneous objectives. Forest Science, 46, 302-311.

Kraxner, F., Yang, J., and Yamagata, Y. 2009. Attitudes toward forest, biomass and certification – A case study approach to integrate public opinion in Japan. Bioresource Technology, 100, 4058-4061.

Kubeczco, K., Rametsteiner, R. and Weiss, G. 2006. The role of sectoral and regional innovation systems in supporting innovations in forestry. Forest Policy and Economics, 8, 704 - 715.

Lal, R., Kimble, J.M., Follett, R.F., and Cole, C.V.. 1998. The Potential of US Cropland to Sequester Carbon and Mitigate the Greenhouse Effect. Taylor and Francis, Inc. London.

Maraseni, T.N. and Dargusch, P. 2008. Expanding woodland regeneration on marginal southern Queensland pastures using market-based instruments: a landowners perspective. Australasian Journal of Environmental Management, 15, 65-132.

MarketWatch. 2007. For-sale signs pop up on US timberlands. Retrieved from http://www.marketwatch.com

Markey, E.J., 2009. Global warming. The Select Committee on Energy Independence and Global Warming. Retrieved from http://globalwarming.house.gov

Martin, S.R., and McCurdy, K., 2009. Wilderness food storage in Yosemite: Using the theory of planned behavior to understand backpacker canister use. Human Dimensions of Wildlife, 14, 206-218.

McKinsey & Company. 2009. Pathways to a Low-Carbon Economy; Version 2 of the Global Greenhouse Gas Abatement Cost Curve.

Mollicone, D., Federici, S., Archard, F., Grassi, G., Eva, H.D., Nir, E., Schulze, E-D, and Stibig, H-J., 2008. An Accounting Mechanism for Reducing Emissions from Deforestation and Degradation of Forests in Developing Countries in Streck, C., O'Sullivan, R., Janson-Smith, T., Tarasofsky, R. (Eds.), Climate Change and Forests, Emerging Policy and Market Opportunities. Royal Institute of International Affairs, London.

Natural Resources Council of Main (NRCM). 2009. Major land sales in Maine since 1998. Retrieved from http://www.nrcm.org

Neilson, D.A. 2007. Corporate private sector dimensions in planted forest investments. Planted Forests and Trees Working Paper, FAO, FP/40E.

Newman, D.H., and Wear, D.N. 1993. Production economics of private forestry: a comparison of industrial and nonindustrial forest owners. American Journal of Agricultural Economics, 75(3), 674-684.

Nigg, C.R., Allegrante, J.P. and Ory, M. 2002. Theory-comparison and multiple-behavior research: Common themes advancing health behavior research. Health Education Research, 17, 670-679.

NRCS (Natural Resources Conservation Service). 1996. 1996 Farm Bill: Conservation Provisions. USDA, Washington, DC.

Olander, L.P. and Murray, B.C. 2007. A new opportunity to help mitigate climate change, save forests, and reach development goals. Nicholas Institute for Environmental Policy Solutions, Duke University. NI WP 07-03.

Olander, L.P., Boyd, W., Lawlor, K., Madeira, E.M., and Niles, J.O. 2009. International forest carbon and the climate change challenge: issues and options. Nicholas Institute for Environmental Policy Solutions, Duke University. NI R 09-04.

Olenick, K.L., Kreuter, U.P., and Conner, J.R. 2005. Texas landowner perceptions regarding ecosystem services and cost-sharing land management programs. Ecological Economics, 53(2), 247-260.

OpenCongress. 2010. H.R.2454 – American Clean Energy and Security Act of 2009. http://www.opencongress.org/bill/111-h2454/show [07 May 2010]

Oreskes, N. 2004. The scientific consensus on climate change. Science, 306: 1686.

Parks, P.J. and Hardie, I.W. 1995. Least-cost forest carbon reserves: cost-effective subsidies to convert marginal agricultural land to forests. Land Economics, 71(1), 122-136.

Pattanayak, S., Murray, B., and Abt, R. 2002. How joint is joint forest production: an econometric analysis of timber supply conditional on endogenous amenity values? Forest Science 48 (3): 479–491.

Portela, R., Wendland, K.J. and Pennypacker, L.L. 2008. The Idea of Market Based Mechanisms for Forest Conservation and Climate Change. In Streck, C., O'Sullivan, R., Janson0Smith, T. & Tarafosky, R. (Eds.) Climate Change and Forests Emerging Policy and Market Opportunities. London, Royal Institute of International Affairs.

Pouta, E., and Rekola, M. 2001. The Theory of Planned Behavior in predicting willingness to pay for abatement of forest regeneration. Society and Natural Resources, 14, 93-106.

Rametsteiner, E. and Weiss, G. 2006. Innovation and innovation policy in forestry: Linking innovation process with systems models. Forest Policy and Economics, 8, 691-703.

Revkin, A.C. and Seelye, K.Q. 2003. Report by the EPA leaves out data on climate change. New York Times, 19 June 2003.

RGGI. 2009a. Regional Greenhouse Gas Initiative Model Rule. Regional Greenhouse Gas Initiative. Retreived from http://www.rggi.org

RGGI. 2009b. RGGI Fact Sheet. Regional Greenhouse Gas Initiative. Retreived from http://www.rggi.org

Ribon, L and Scott, H. 2007. Carbon Offset Providers in Australia 2007. Melbourne, Global Sustainability at RMIT University.

Romm, J., Tuazon, R. and Washburn, C. 1987. Relating investment to the characteristics of nonindustrial provate forestland owners in northern California. Forest Science, 33(1), 197-209.

Schmiege, S.J., Bryan, A., and Klein, W.M.P. 2009. Distinction between worry and perceived risk in the context of the Theory of Planned Behavior. Journal of Applied Social Psychology, 39(1), 95-119.

Schulte, K.M. 2008. Scientific consensus on climate change? Energy and Environment, 199(2): 281-286.

Seager, J. 2009. Personal communication. Program Manager, Voluntary Carbon Standard Association. 15 April 2009.

Shabman, L., Zepp, L., Wainger, L., King, D., 2002. Incentives for reforestation of agricultural land: What will a market for carbon sequestration credits contribute? American Journal of Alternative Agriculture, 17(3), 116-124.

Shifter, D.B., and Ajzen, I. 1985. Intention, perceived control, and weight loss: An application of the theory of planned behaviour. Journal of Personality and Social Psychology, 49(3), 842-851.

Springston, R. 1998. Enviros create timber bank to stem logging. Richmond Times-Dispatch, 17 August 1998.

Stavins, R. and Richards, K. 2005. The cost of US forest-based carbon sequestration. Pew Center on Global Climate Change.

Stern, N. 2007. Stern Review on the Economics of Climate Change. Home Treasury London. Retrieved from http://www.hm-treasury.gov.uk

Streck, C., O'Sullivan, R., Janson-Smith, T., and Tarasofsky, R., 2008. Climate Change and Forests Emerging Policy and Market Opportunities. Royal Institute of International Affairs, London. Retrieved from http://www.hm-treasury.gov.uk/ sternreview_index.htm

Till, N. 2009. The forest carbon offsetting survey 2009. Ecosecurities.

Timberland Report. 2006. Wood and timberland markets in the Midwestern US Timberland Report 8(2): 1-6.

TimberLink. 2006. The rapid rise of TIMOs may be slowing; US-based investors face diverse global competition for offshore timberland. Timber News. Retrieved from http://www.timberlink.net

Tuerk, A., Streck, C., Johns, T. and Pena, N. 2008. The role of land-based offsets in Emissions Trading Systems: Key design aspects and considerations for linking. Joanneum Research, Climate Focus, Woodshole Research Center.

Turner, B., Finley, J., and Kingsley, N. 1977. How reliable are woodland owners' intentions? Journal of Forestry, 75(8), 498-499.

UNFCCC. 2006. Report of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol on its first session, held at Montreal from 28 November to 10 December 2005. Document number: FCCC/KP/CMP/2005/8/Add.3.

USDA Forest Service. 2003. An analysis of the timber situation in the United States: 1952-2040. USDA Forest Service General Technical Report PNW-GTR-560. Pacific Northwest Research Station, Portland, Oregon. 254 p.

US Department of State. 1997. Climate action report: 1997 submission of the United States of America under the United Nations framework convention on climate change. Dep. State Publ. 10,496, US Gov. Print. Off., Washington, D.C.

US EPA. 2007. Inventory of US greenhouse gas emissions and sinks: 1990-2005. US Environmental Protection Agency 430-R-07-002. Washington, DC.

US Forestry Incentives Program (FIP). 2002. The United States Forestry Incentives Program. Retrieved from http://scf.rncan.gc.ca/files/367

Valle, P.O.D., Rebelo, E., Reis, E., and Menezes, J. 2005. Combining behavioral theories to predict recycling involvement. Environment and Behavior, 37, 364-396.

van den Hove, S., Menestrel, M. and de Bettignies, H.C. 2002. The oil industry and climate change: strategies and ethical dilemmas. Climate Policy, 2(1): 3-18.

Vidaurrazaga, J. 2010. Trees fare well in latest US climate bill. Ecosystem Marketplace. Retrieved from http://www.ecosystemmarketplace.com

Voluntary Carbon Standard (VCS). 2008. Voluntary Carbon Standard: Tool for AFOLU Methodological Issues. Retrieved from http://www.v-c-s.org

Vogt, C.A., Winter, G., and Fried, J.S. 2005. Predicting homeowners' approval of fuel management at the wildland-urban interface using the Theory of Reasoned Action. Society and Natural Resources, 18, 337-354.

Weinstein, N.D., and Rothman, A.J. 2005. Commentary: Revitalizing research on health behavior theories. Health Education Research, 20, 294-297.

Western Climate Initiative (WCI). 2008. Design Recommendations for the WCI Regional Cap-and-Trade Program. Retreived from http://www.westernclimateinitiative.org

Western Climate Initiative (WCI). 2009. Overview: The Western Climate Initiative's cap-and-trade program design recommendations. Retreived from http://www.westernclimateinitiative.org

World Resources Institute (WRI). 2009. The American Clean Energy and Security Act: Key elements and next steps. [http://www.wri.org Accessed 03 August 2009].

Young, R.A., and Reichenbach, M.R. 1987. Factors influencing the timber harvest intentions of nonindustrial private forest owners. Forest Science, 33(2), 381-393.

Zomer, R.J., Trabucco, A., Verchot, L.V., and Muys, B. 2007. Land Area Eligible for Afforestation and Reforestation within the Clean Development Mechanism: A Global Analysis of the Impact of Forest Definition. Mitigation and Adaptation Strategies for Global Change, 13(3), 219-239.

CHAPTER 3

INTENTIONS OF U.S. NON-INDUSTRIAL PRIVATE FORESTLAND OWNERS TO PARTICIPATE IN CARBON SEQUESTRATION AND TRADING: AN APPLICATION OF THE THEORY OF PLANNED BEHAVIOR

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ABSTRACT

Leading scientific experts in the field of climate change suggest that a multifaceted response to global warming should include the use of forests carbon offsets (forest sinks). Emerging emissions reduction legislation in the United States (US) accounts for this recommendation by allowing for carbon offsets derived from domestic forestry projects (e.g. reforestation, afforestation, avoided deforestation). Given that the majority of US forestland is privately owned and non-industrial, the current research employs a behavioral model to measure intentions of private non-industrial forestland owners to participate in carbon sequestration and trading. Results suggest that very few (5.1%) of these forestland owners are currently involved in carbon sequestration and trading, but half (50.4%) were at least somewhat interested in exploring opportunities to do so. The classic model developed under the Theory of Planned Behavior was extended in the current research to include environmental orientation, innovativeness, perceived risk and tested knowledge, all of which had significant effects on core model constructs: attitude, subjective norms, perceived behavioral control and behavioral intentions. The extended model explained a significant amount of the variance related to behavioral intentions to sequester carbon on forestland (R^2=.53).

INTRODUCTION

Although effects of human activity on climate change cannot be proven to certainty, there is a general consensus within the scientific community that the earth is warming due to human influence and this warming may be detrimental the earth's inhabitants (IPCC 2007; Oreskes 2004). In response to the concern regarding the detrimental impacts that climate change may have on both nature and humans, a multifaceted response will be required from countries throughout the world. Integral to this approach is utilization of forest carbon sequestration (or *forest sinks*), a mitigation option gaining in recognition and acceptance (IPCC 2000). Forests in the United States (US) hold a significant opportunity for forest carbon sequestration simply due to the area of forestland available for alternative forest management practices (Alig 2003).

In the US, market-based emissions trading frameworks (both voluntary and regulatory) are developing; many of which recognize forest carbon offsets as tradable units. As national climate change legislation emerges in the US (the American Clean Energy and Security Act), demand for these tradable offsets is expected to grow (Olander et al. 2009). The proposed legislation allows for a significant percentage of carbon emissions to be offset by domestic forestry projects. Key to meeting the demands of the carbon market will be the willingness of forestland owners to develop forest carbon offsets on their private lands. Although previous research has analyzed the hierarchy of players involved in the demand-side of the carbon market (e.g. government, firms, NGO's, etc.),

there is little extant work regarding supply-side dynamics; namely, private forestland owners and their intentions to develop forest carbon offsets (Bull and Thompson 2010). Ultimately, a clearer understanding of the motivations and barriers experienced by forestland owners will be valuable as programs and policies are developed to attract forestland owners to the carbon marketplace.

The present research applies the Theory of Planned Behavior (TPB) (Ajzen 1991), a model of behavioral intentions, and examines forest management decision-making literature in order to theorize potential antecedents influencing the decision of private forestland owners to develop forest carbon offsets. In addition to the original constructs of the model, this research aims to extend the model to better explain these intentions.

RESEARCH OBJECTIVES

This survey based research employed a well tested behavioral model to investigate the potential motivations and barriers experienced by US non-industrial private forestland owners as they consider development of forest carbon offsets. In response to knowledge gaps identified in this paper, the following specific research objectives are made:

1. Use the Theory of Planned Behavior (TPB) to measure the effect of *attitude*, *subjective norms* and *perceived behavioral control* on *behavioral intentions* of forestland owners to develop forest carbon offsets (to sequester and trade forest carbon);

2. Extend the TPB to include the effects of the following constructs on intentions of forestland owners to sequester carbon on forestlands:
    a. Environmental orientation
    b. Innovativeness
    c. Perceived risk attached to carbon sequestration and trading
    d. Knowledge of carbon sequestration and trading

THEORETICAL BACKGROUND

The media and scientific literature has reported ongoing debate within the scientific community regarding the causes and effects of climate change (e.g. Revkin and Seelye 2003; van den Hove et al. 2002). However, reports submitted by the United Nations Intergovernmental Panel on Climate Change (IPCC) and an extensive review of the scientific literature (Oreskes 2004) reveals an overwhelming consensus on the subject. The IPCC suggests that a multifaceted, global response is required in order to successfully mitigate the effects of climate change. Included within this multifaceted response is the use of forests as carbon sinks (IPCC 2000; Cairns and Lasserre 2004; McKenney et al. 2004; Eliasch 2008).

Forests cover approximately 30% of the Earth's land surface (42 million km^2) capable of sequestering 2.6 billion tons C per year; equivalent to more than 33% of the anthropocentric carbon emissions resulting from fossil fuel consumption and land use changes (Bonan 2008). In 2005, approximately 14% of US greenhouse gas emissions

were offset by domestic land uses, the vast majority of which occurred due to carbon sequestration by forests (US EPA 2007).

CARBON MARKETS

As of early 2010, emissions reduction legislation (the American Clean Energy and Security Act - ACESA) had passed the House but had not yet passed the Senate (OpenCongress 2010). This legislation proposes a cap-and-trade emissions reduction framework that allows industrial emitters to buy and trade carbon offsets within a market-like system. The ACESA makes reference to the use of domestic forests carbon offsets, however, details have yet to be finalized. Until the ACESA passes the Senate, various other mandatory and voluntary emissions trading frameworks are available in the US to both buyers and sellers of carbon offsets. These frameworks vary in scope, size and regulation, including the inclusion/exclusion of forest offsets. For example, the Regional Greenhouse Gas Initiative (RGGI), a cap-and-trade program, regulates CO_2 emissions, primarily from power plants, in ten Northeast and mid-Atlantic states. Currently, RGGI only accepts forest carbon offsets derived from afforestation (RGGI 2009b), however, no forestry offsets have been registered to-date, as rules for such offsets are still in development.

Other proposed and functioning frameworks in the US tend to have a more expansive inclusion of forest carbon offsets. The Western Climate Initiative (WCI), a regional

regulatory framework under development that recognizes seven partner states and four partner Canadian provinces, plans to include forest offsets from afforestation, reforestation, forest management, forest preservation, and wood products (WCI 2008). Voluntary frameworks in the US, most notable being the Chicago Climate Exchange, also accept forest carbon offsets derived from forestry related activities (CCX 2009a; CCAR 2007; VCS 2008).

Forests and Forestland Owners in the United States

The abundance of productive forestland in the US creates excellent opportunities for forestland owners to generate non-timber revenue through forest carbon sequestration. Approximately 620 million acres of forested land exists in the US, 63% of which is privately owned (Butler and Leatherberry 2004). These private forestland holdings are split amongst industrial and non-industrial private forest owners (NIPF). There are approximately 10.3 million NIPF owners in the US accounting for 49% (304 million acres) of the nation's forestland. It has been estimated that 94% of the NIPFs are individual owners (rather than groups or organizations) (Birch 1996; Butler and Leatherberry 2004).

Private Forests and Carbon Offsets

To achieve a multifaceted emissions reduction strategy in the US, carbon sequestered by forestland will likely be included as part of a legislated solution. Given that NIPF owners

hold nearly half of the nation's forestland, it is likely that private forest owners will become key players in any mitigation strategy involving increased carbon sequestration on forestland (Alig 2003). Nearly two-thirds of carbon stored in US forests is located on private lands and these lands have capacity for further storage (Birdsey et al. 2000). Decisions made by these owners regarding participation in carbon sequestration will be crucial to future timber supply. It is suggested that the motivations of these owners will depend to some degree upon incentive availability (Alig 2003), however, NIPF owners do not always respond to prices and incentives in the same way as forest product companies. The multi-objective nature of NIPF owners often becomes evident as decisions are made for reasons other than financial returns.

The literature lacks previous investigation related to the willingness of forestland owners to participate in forest carbon sequestration and trading, however, empirical studies suggest non-timber management goals are often incorporated in overall land management objectives by NIPF owners (e.g. Conway et al. 2002; Pattanayak et al. 2002; Hodges and Cuddage 1990). Similar studies have suggested that NIPF owners are increasingly interested in generating income from both timber and non-timber sources (Newman and Wear 1993; Conway et al. 2002; Pattanayak et al. 2002). Surveys of southern US rangeland owners revealed an overall disproval of publicly funded programs aimed to sequester carbon through afforestation. However, those owners with more supportive

attitudes about climate change mitigation strategies tended to be more supportive and willing to participate (Olenick et al. 2005).

THE THEORY OF PLANNED BEHAVIOR

To examine and better understand intentions of forest owners to participate in carbon sequestration, behavioral models, such as the Theory of Planned Behavior (TPB), can be applied. The TPB (Ajzen 1991) is an extension of the Theory of Reasoned Action (TRA) developed by Fishbein and Ajzen (1975). The TRA suggests that a given behavior is dependent upon the intention to perform the behavior, where intentions are dependent upon attitudes towards the behavior and subjective norms (or social pressures). The TPB extended the TRA by including a *perceived behavioral control* construct which also acts as an antecedent to behavioral intentions.

The TPB has been used in a variety of applications such as health (Godin and Kok 1996), leisure (Ajzen and Driver 1992), wildlife and recreation (Martin and McCurdy 2009), recycling (Valle et al. 2005) and forest management decisions regarding reforestation (Karppinen, 2005). Although the model is most commonly used in health related studies, a meta-analysis conducted by Armitage and Conner (2001) demonstrated support for the use of the TPB in a multitude of research fields.

Since the inception of the TPB, there has been a growing recognition of the value of integrative models which uniquely combine the TPB with constructs from other theoretical frameworks (Baranowski 1993; Fishbein 2000; Nigg et al. 2002; Fishbein and Cappella 2006; Schmiege et al. 2009). These integrations not only test the reliability of single theories, but continually nurture theory development by extending and improving existing theories.

THE THEORY OF PLANNED BEHAVIOR AND FOREST CARBON OFFSETS

The TRA (the TPB's predecessor) and the TPB have been successfully applied to studies related to natural resources (e.g. Bright et al. 1993; Cordano and Frieze 2000; Vogt et al. 2005), timber harvesting, forest management (Young and Reichenbach 1987) and silviculture (Karppinen 2005). Each found strong relationships between attitude, subjective norms, and perceived behavioral control (in TPB models), and intentions. Karppinen (2005) applied the TPB to forest owner decision making related to reforestation methods and found a significant effect of each antecedent on behavioral intentions to allow natural regeneration rather than alternative regeneration (e.g. planting). Karppinen also extended the model to include past experience, a new construct also found to influence all other constructs in the model. Pouta and Rekola (2001) applied the TPB to willingness-to-pay research related to forest management in Finland resulting in another successful application of the model. Turner et al. (1977) suggest that

behavioral intentions of forestland owners remained constant over the long term in 65% of those surveyed, and those that altered their intentions did so to a very minimal extent.

THEORETICAL FRAME OF REFERENCE

The TPB acts as the theoretical frame of reference for this research. The literature suggests that the addition of four constructs (environmental orientation, innovativeness, perceived risk, and knowledge) may better explain behavioral intentions by forestland owners to develop forest carbon offsets than the original TPB model. Figure 6 indicates the hypothesized relationships between each construct in the extended model.

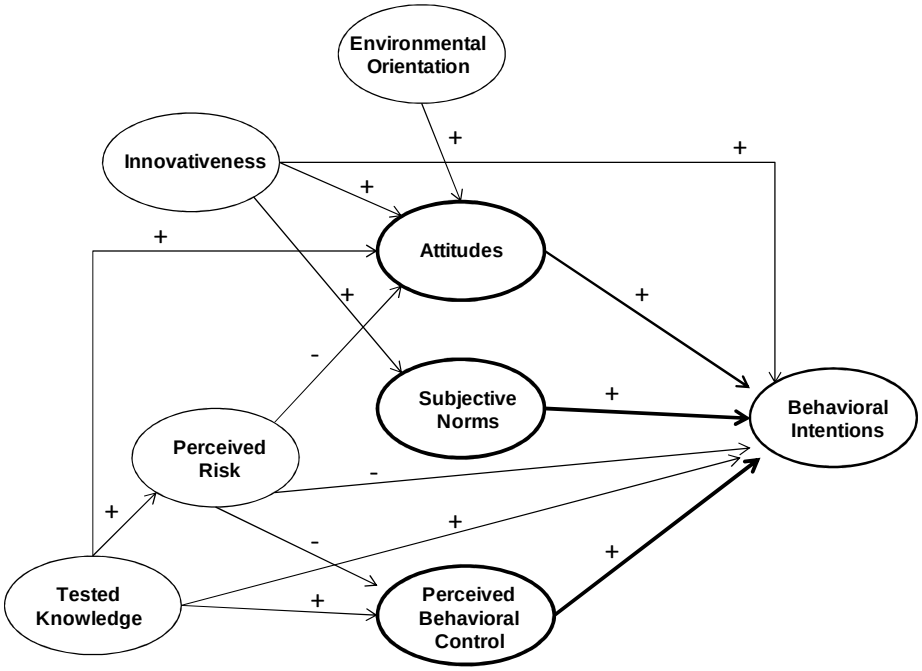


Figure 6. Extended Theory of Planned Behavior model: including environmental orientation, innovativeness, perceived risk, and knowledge.

THEORY OF PLANNED BEHAVIOR CONSTRUCTS

Here, the classic constructs within the TPB are defined as found in Ajzen (1991). It is theorized that, within the context of the present research, the original constructs will behave as predicted by the TPB.

Behavioral Intentions

Behavioral intentions indicate one's willingness and preparedness to perform a given behavior and are assumed to be a direct antecedent of actual behavior. It is based on attitude towards the behavior, subjective norms, and perceived behavioral control, the influence of each varying based on specific behavior and population of interest.

Attitudes

An antecedent of behavioral intentions, *attitude* toward a behavior indicates one's evaluation (positive or negative) of one's self-performance of the given behavior. Attitude (A), as expressed in the equation below, is determined by a series of salient beliefs (b_i) regarding the behavior, each combined multiplicatively with a subjective evaluation (e_i) of the belief's attribute (*n* denotes the total number of salient beliefs).

$$A = \sum_{i=1}^{n} (b_i e_i)$$

H1: Attitude will positively influence behavioral intentions to participate in forest carbon sequestration and trading.

Subjective Norms

An individual's *subjective norm* refers to his/her perceived social normative pressures which may influence (positively or negatively) the intention to perform a given behavior. As shown in the equation below, Subjective norms (SN) are developed from normative beliefs (nb_i) regarding the behavior, each combined multiplicatively with a measure of the motivation to comply (mc_i) for each normative belief (*n* denotes the total number of normative beliefs).

$$SN = \sum_{i=1}^{n} (nb_i mc_i)$$

Normative beliefs derived from forest management consultation professionals (Royer 1985) and forestland owner associations (Straka and Doolittle 1988) have been found to be influential in forestland owner decision making. The impact of one forestland owner's decision on the structure, diversity, or boundary of forestland used by another owner can be considered a type of economic externality in the realm of private forest management (Amacher et al. 2002b).

Although studies recognize the importance of examining the effects of adjacent landowners on a given forest landowner's behavior (Swallow et al. 1997; Sample 1996; Amacher et al. 2003), there is little empirical evidence available to support or refute a significant effect of adjacent landowners on forest management behavior. While

evidence of willingness to cooperate with adjacent landowners exists (Klosowski et al. 2001; Kurttila et al. 2001; Jacobson 2002), the literature lacks behavioral modeling which may expose potential antecedents to behavioral intentions to participate in a given management activity. This is especially relevant to carbon sequestration and trading, as there are often benefits to selling aggregate carbon credits. Jacobson (2002) adds that interest in joint management of forestland decreases if landowners do not understand the benefits of coordination with other landowners.

H2: Positive subjective norms will positively influence behavioral intentions to participate in forest carbon sequestration and trading.

Perceived Behavioral Control

The single construct that differentiates the TPB from the TRA, *perceived behavioral control*, refers to the perceived ease or difficulty one experiences regarding the performance of a particular behavior. As illustrated in the equation below, perceived behavioral control (PBC) is created based on control beliefs (cb_i) which express one's beliefs about the presence of factors that may assist or hinder performance of a behavior. These beliefs are combined multiplicatively with the perceived power (pp_i) of the control belief under consideration (*n* denotes the total number of control beliefs).

$$PBC = \sum_{i=1}^{n} (cb_i pp_i)$$

H3: Perceived behavioral control will positively influence behavioral intentions to participate in forest carbon sequestration and trading.

Logical Extensions of the Theory of Planned Behavior

Innovativeness

Innovativeness has been defined as "the degree to which an individual is relatively more ready to adopt an innovation than other members of his system" (Rogers and Shoemaker 1971). The diffusion of innovations approach, developed by Straka and Doolittle (1988), was modified from the agricultural technology adoption literature with an aim to examine how information regarding products and processes is communicated and whether individuals responded to it through changes in behavior. Their results suggest that more innovative forestland owners tended to be more likely to participate in reforestation and forest rehabilitation activities.

The TPB is suitable for the inclusion of an innovativeness construct given that the TPB utilizes the effect of social influence (subjective norms), a variable traditionally associated with the diffusion of innovations (Bass 1969; Gatignon and Robertson 1985; Mahajan et al. 1990; Moore and Benbasat 1991; Rogers 1983, 1995). These studies outline the importance of an innovative individual/company's ability to act in response to the needs and wants of important members of the value chain.

The TPB has previously been extended to include innovativeness into the traditional model (Damanpour 1991; Crespo and del Bosque 2008; Unsworth et al. 2009).

Examining the acceptance of new consumer aiding technologies, Crespo and del Bosque (2008) found innovativeness to have a significant positive effect on both attitude and behavioral intention (Figure 7).

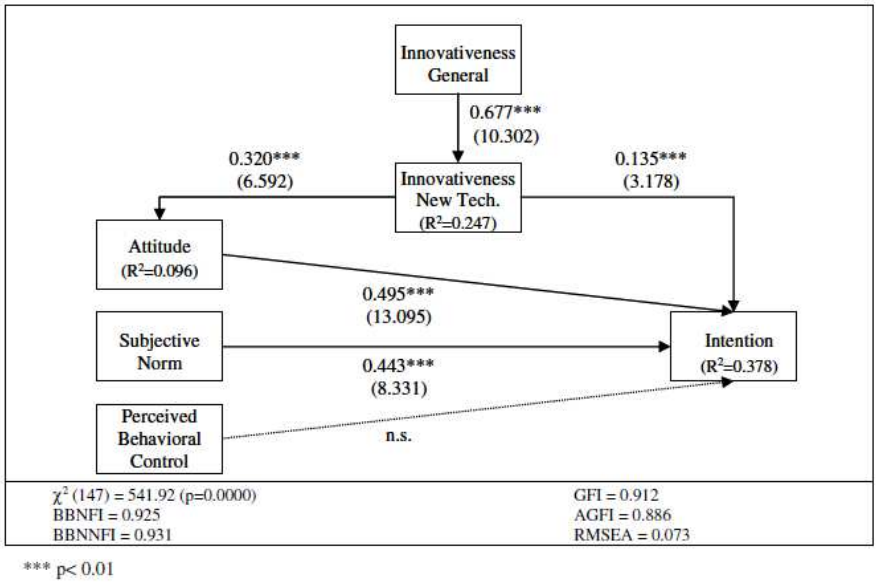


Figure 7. An adaptation of the Theory of Planned Behavior to include innovativeness. (Crespo and del Bosque 2008)

Based on the innovativeness literature and capabilities of the TPB, the following hypothesis is proposed:

H4: Increasing innovativeness will positively influence attitudes, subjective norms and intentions regarding forest carbon sequestration and trading.

Perceived Risk

Perceived risk can be described as a cognitive assessment of a threat or hazard (Schmiege et al. 2009). Studies that have examined the role of risk perception related to various forest management decisions suggest that perceived risk is an important predictor of

behavioral intentions to undertake various management practices (e.g. Conway et al. 2002). Hardner et al. (2000) concluded that perceived risk plays an important role in the willingness of landowners to participate in any sort of carbon sequestration project. Health related literature includes meta-analyses suggesting that perceived risk has a moderate to strong relationship with behavior (e.g. Harrison et al. 1992; Janz and Becker 1984; Schmiege et al. 2009). Both direct and indirect effects of perceived risk on intentions through attitudes are well-supported (Bryan et al. 1997; Jackson and Aiken 2000; Lobb et al. 2007; Sheeran and Taylor 1999; Kakoko et al. 2006). Schmeige et al. (2009) also found perceived risk to negatively influence self-efficacy (i.e. perceived behavioral control). Similar findings have been found in consumer behavior (Jarvenpaa et al. 2000; Pavlou 2003), accident prevention behaviors (Forward 2009), and technology adoption (Huang and Chang 2007), which also suggested that knowledge and past experience negatively influence perceived risk.

H5: Increasing perceived risk perceived by forestland owners will negatively influence attitudes, perceived behavioral control, and intentions related to carbon sequestration and trading.

Environmental Orientation

Two widely used measures of environmental orientation exist in the literature. First, Dunlap and Van Liere's (1978) New Environmental Paradigm (NEP) Scale, since revised and termed the New Ecological Paradigm Scale (Dunlap et al. 2000), suggests that a pro-environmental orientation acts as a possible antecedent of attitudes regarding pro-

environmental activities (Hansla et al. 2008; Fielding et al. 2008). Another scale used to assess environmental orientation can be referred to as the anthropocentric/biocentric value orientation scale which suggests that value orientations related to natural resources range on a scale from anthropocentric (human-centered) to biocentric (nature-centered) (Skog et al. 1996; Steel et al. 1994; Thompson and Barton 1994).

Previous studies (e.g. Vaske and Donnelly 2000; Vaske et al. 2001) have employed four questionnaire items to measure biocentric basic beliefs and five items to measure anthropocentric basic beliefs. For example, a biocentric statement might be: *Forests have value, whether people are present or not*. An anthropocentric statement may be: *The value of forests exists only in the human mind*. Vaske and Donnelly (2000) reported that the biocentric/anthropocentric value orientations positively influenced preservation-based attitudes; a relationship that is supported by results from similar studies of natural food shopping (Homer and Kahle 1988), wildlife harvesting (Fulton et al. 1996), and conservation behaviors by agricultural landowners (Cary and Wilkinson 2008).

The challenge related to the present research is the classification of carbon sequestration as a pro-environmental activity as the issue has been debated from both sides. Based on the overwhelming support of forest carbon sequestration as a climate change mitigation tool (IPCC 2000), this research will classify forest carbon offset development as a pro-environmental activity.

The NEP and the biocentric/anthropocentric scales both adequately measure environmental orientation; however, biocentric/anthropocentric scales were employed to meet page limit constraints of the mail survey (i.e. fewer questionnaire items were required to measure the biocentric/anthropocentric continuum).

H6: Increasing biocentric environmental orientation of forestland owners will positively influence attitudes towards forest carbon sequestration and trading.

Knowledge of Forest Carbon Offsets

Empirical studies involving forestland owners reveal an overall lack of familiarity and knowledge related to alternative forest management practices (e.g. ecosystem management), despite showing significant interest in participation (Jacobson 2002b). There is some evidence to suggest that knowledge of the environment (in general) as well as specific knowledge of a particular pro-environmental behavior act as antecedents to both attitudes and intentions towards a particular behavior (Hines et al. 1987; Vinning and Ebreo 1990; Gamba and Oskamp 1994; Cheung et al. 1999). Similarly, knowledge gained through past behavior has been found to positively influence both 'every day' tasks (Bagozzi et al. 1992; Bamberg et al. 2003; Schmiege et al. 2009; Sheeran and Taylor 1999; Chih-Chung and Chang 2005) and pro-environmental behavioral intentions (Hamid and Cheng 1995; Kilgore et al. 2008).

Knowledge has also been found to positively influence subjective norms and self-efficacy (perceived behavioral control) related to behavioral intentions towards behaviors (e.g. environmental management, reforestation, harvesting) (Royer 1985; Hyberg and Holthausen 1989; Cordano and Frieze 2000; Schmiege et al. 2009). Particularly relevant to the TPB, the literature suggests that knowledge of an innovation directly influences one's perceived behavioral control regarding intentions to utilize the innovation (Iacovou et al. 1995; Lehman et al. 2002; Snyder-Halpern 2001). Huang and Chang (2007) add that knowledge based on past experience negatively influences perceived risk related to a given behavior.

H7: Increasing knowledge of forest carbon offset development will positively influence attitudes, perceived behavioral control and intentions regarding forest carbon sequestration and trading.

H8: Increasing knowledge of forest carbon offset development will reduce perceived risk related to forest carbon sequestration and trading.

OPERATIONALIZATION OF MODEL CONSTRUCTS

Individual constructs within the original model are measured using scales adapted from previous applications of the model. Scales generated in forest management studies are used wherever possible. Table 3 shows the questionnaire items used to measure each construct and the corresponding literature from which items were adapted. Multiple

measures of attitude, subjective norms and perceived behavioral control are used and grouped based on reliability analyses where appropriate.

Behavioral intentions to participate in carbon sequestration and trading were measured based on four items regarding plans to use forestland for carbon sequestration and trading in the future. Answers are based on agreement with statements and provided on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Attitudes regarding carbon sequestration were measured in two ways. First, an agreement scale measuring self-appraised disposition or overall attitude regarding the behavior within the next five years was applied using a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). Second, attitude (A) was measured based on five salient belief statements (b) and belief outcome evaluations (e). Each belief statement was measured on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). For each belief, respondents were asked to indicate belief outcome evaluations which were also measured on a 5-point scale ranging from 1 (not at all important) to 5 (very important).

Subjective Norms were first measured by two scale items regarding the opinion of important people in a respondent's life, ranging from 1 (strongly disagree) to 5 (strongly agree). Second, subjective norms (SN) were measured based on five normative beliefs

(nb) and corresponding measures of motivation to comply (mc). Each normative belief was measured on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). For each normative belief, respondents were asked to indicate their motivation to comply (the importance of these normative beliefs) on a 5-point scale ranging from 1 (not at all important) to 5 (very important).

Perceived behavioral control was first measured by two scale items regarding the plausibility of sequestering carbon on forestland. These 5-point scales range from 1 (strongly disagree) to 5 (strongly agree). Perceived behavioral control (PBC) was also measured based on two control beliefs (cb) and perceived power of the control factor (pp). Each control belief was measured on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). For each control belief, perceived power of the control factor was measured based on a 5-point scale ranging from 1 (not at all important) to 5 (very important).

Table 3. Theory of Planned Behavior constructs and questionnaire items.

ITEM	Adapted From
Behavioral intention (BI)	
BI_1 I plan to use (or continue to use) at least part of my forestland for forest carbon sequestration.	Harland et al. (1999)
BI_2 I intent to participate in the forest carbon trading market.	
BI_3 I plan to take (or have already taken) the necessary steps to use my forestland for carbon sequestration.	Karppinen (2005)
BI_4 I am interested in exploring carbon sequestration opportunities on my forestland.	
Attitude (A)	
A_1 I feel positively about the possibility of participating in carbon sequestration and trading on my forestland.	Karppinen (2005)
Belief strength (b) x Belief outcome's evaluation (e)	
b_1 In the long term, carbon sequestration and trading can increase the revenue generated from my forestland.	Francis et al. (2004)
b_2 Participating in forest carbon sequestration and trading, helps minimize climate change.	
b_3 Carbon sequestration would improve other forest values on my land (e.g. scenery, naturalness, tree quality etc.)	
b_4 In the short term, carbon sequestration and trading will provide increased revenue from my forestland.	
b_5 The cost of managing my forests for carbon sequestration is too high.	Pouta and Rekola (2001)
Subjective norm (SN)	
SN_1 Most people important in my life would approve of my participation in forest carbon sequestration and trading.	Karppinen (2005)
SN_2 Most people important in my life think that I should participate in forest carbon sequestration and trading.	
Normative beliefs (nb) x Measure of the motivation to comply (mc)	
nb_1 Family members believe I should participate in forest carbon sequestration and trading	Karppinen (2005) Francis et al. (2004)
nb_2 Forestry professionals and/or forest management associations believe I should participate in forest carbon sequestration and trading	
nb_3 Neighbors (adjacent landowners) believe I should participate in forest carbon sequestration and trading.	
nb_4 Friends believe I should participate in forest carbon sequestration and trading.	
nb_5 Most forestland owners I know are involved in (or considering) carbon sequestration on their land.	
Perceived behavioral control (PBC)	
PBC_1 It is possible to participate in carbon sequestration and trading on my forestland.	Karppinen (2005) Pouta and Rekola (2001)
PBC_2 I think I can manage my forestland for carbon sequestration values.	
Control beliefs (cb) x Perceived power of the control factor (pp)	
cb_1 I have the necessary financial resources to manage my forestland for carbon sequestration.	Karppinen (2005) Francis et al. (2004)
cb_2 The characteristics of my forestland are suitable for forest carbon sequestration.	

GENERATION OF EXTENDED MODEL CONSTRUCTS

Innovativeness (Innov) in forestland owners was measured with four scale items which focused on the adoption of forest management practices. This series of items aimed to measure the adoption of management techniques/strategies and the importance of external innovations. Each of the four items was measured on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree) (see Table 4 for a complete list of constructs and variables).

Environmental orientation was measured using four biocentric (bio) belief statements and four anthropocentric (anthro) belief statements to which respondents were to respond using a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). The set of belief statements was reduced to meet constraints of the mail questionnaire. Anthropocentric responses were reverse coded post-survey. The mean of responses to each belief statement represented overall environmental orientation (higher scores indicated a more biocentric orientation).

Perceived risk (PR) was measured using hazard scales adapted from measures used in both forestry and non-forestry related studies. Responses to the existence of four distinct hazards (h) related to forest carbon sequestration were measured using 5-point scales ranging from 1 (strongly disagree) to 5 (strongly agree). For each hazard, corresponding hazard importance scores (his) measured the importance respondents place on each

hazard and were measured on 5-point scales ranging from 1 (not at all important) to 5 (very important). The mean of *h x his* for each hazard resulted in an overall perceived risk (PR) score.

Knowledge (Kn) of the behavior was first measured by a self-appraised knowledge scale (Skn) adapted from the literature. Respondents were asked to indicate their agreement with two statements related to their knowledge and understanding of carbon sequestration and trading based on two 5-point scales ranging from 1 (strongly disagree) to 5 (strongly agree). In addition, knowledge was assessed by a series of five true/false questions related to carbon sequestration and trading. Respondents were asked to indicate their perception of the statement using a 5-point scale ranging from 1 (quite confident this is false) to 5 (quite confident this is true). Correct responses were assigned a value of '1' and incorrect (or neutral responses) were assigned a value of '0'. Assigned values were summed for each respondent to create an overall knowledge score.

Demographics and *land characteristics* data was collected in addition to model constructs in order to provide a respondent profile and generalized characteristics of forestland belonging to the target population. At the end of the mail questionnaire, respondents were given the opportunity to provide comments regarding carbon sequestration and trading on forestland.

Table 4. Extended model constructs and questionnaire items.

ITEM	Adapted from
Innovativeness (Innov)	
$Innov_1$ I tend to use new forest management techniques before my fellow forestland owners	Deshpande et al. (1993) Wang and Ahmed (2004)
$Innov_2$ I am able to implement new management strategies used by other forestland owners.	Jerez-Gomez et al. (2005)
$Innov_3$ I consider ideas about management practices from external sources to be critical to the sound management of my forestland.	Jerez-Gomez at al. (2005)
$Innov_4$ I actively seek new forest management practices.	Hurley and Hult (1998) Jerez-Gomez et al. (2005)
Environmental Orientation (EO)	
Biocentric beliefs (bio)	Vaske and Donnelly (2000)
bio_1 Forests have value, whether people are present or not.	
bio_2 Forests have as much right to exist as people.	
bio_3 Nature has as much right to exist as people.	
bio_4 Wildlife, plants, and people have equal rights to live and develop.	
Anthropocentric beliefs (anth)	
$anth_1$ Nature's primary value is to provide products useful to people.	Vaske and Donnelly (2000)
$anth_2$ The primary value of forests is to provide timber, grazing land, and minerals for people who depend on them for their way of life.	
$anth_3$ The primary value of forests is to generate money and economic self-reliance for communities.	
$anth_4$ Forests are valuable only if they produce jobs and income for people.	
Perceived Risk (PR) (Hazard (h) x Hazard Importance Score (his))	
h_1 I may notice a decrease in revenue from my forestland if I participate in carbon sequestration and trading..	Dowling and Staelin (1994)
h_2 The price of forest carbon is unpredictable.	Blennow and Sallnas (2002)
h_3 Sequestering carbon may decrease the dollar value of my land.	
h_4Sequestering and trading carbon may prevent me from managing my forestland for other values that are important to me.	
Knowledge of Behavior (Kn)	
Self-appraised carbon sequestration knowledge (SKn)	
My knowledge of forest carbon sequestration and trading is quite good.	Uliczka et al. (2004)
My understanding of the steps required to participate in forest carbon sequestration and trading is quite good.	
Measured Knowledge (MK) (Correct responses (cr))	
cr_1 Any forestland owner can enter the carbon trading market.	McFarlane and Boxall (2000)
cr_2 The largest voluntary carbon market in the US is the Chicago Climate Exchange.	
cr_3 Forest carbon is traded in units called 'Forbons'.	
cr_4 Only softwood tree species are eligible for carbon credits.	
cr_5 Forest carbon sequestration and trading can be done without a written management plan.	

METHODS

SAMPLING

Target Population

This research evaluated the intentions of US NIPF owners to participate in the development of forest carbon offsets. Consistent with previous landowner surveys (eg. Olenick et al. 2005; Butler 2008), forestland owners with a minimum of 10 acres of land were included in the target population.

Sampling Frame

A mailing list with addresses and telephone numbers was purchased from Martin Worldwide ™, a mailing list provider. After consulting with experts in the field of national forestland owner surveys, mailing list providers were identified as the preferable source of a reliable sampling frame within the budgetary constraints of the project. Martin Worldwide identified forestland owners based on land-use classifications assigned by the county assessor for tax purposes. If tax records indicate that the "land use" is "forest," the owner of the land is identified as a "forestland owner." Martin Worldwide's database included 91,700 potential forestland owners (nationwide) meeting the specifications of this study. Other providers were considered, but Martin Worldwide was chosen primarily based on its use of tax records to identify reliable leads.

Sampling Procedure

Consistent with national surveys of forestland owners by the USDA Forest Service, stratified random sampling was employed to ensure adequate sample sizes in each of the three distinct US forest regions (North, South and West) (Butler and Leatherberry 2004; Butler 2008) (Figure 8).

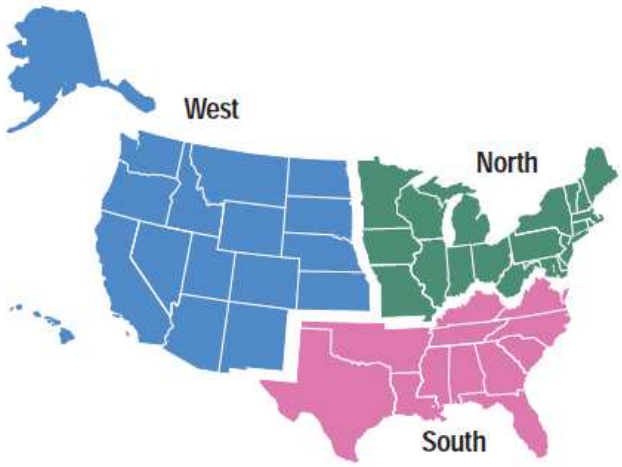


Figure 8. Distinct forest regions of the United States (USDA 2001).

According to Thompson (1992), samples sizes should be determined by population size, desired precision, willingness to accept an incorrect answer, variance in the data, anticipated response rate and budgetary constraints. Based on 5% error and a 95% confidence interval, a sample size of 384 or more is required, regardless of the population. Questionnaires were mailed to 2949 forestland owners (North: n=984; South: n=982; West: n=983).

DATA COLLECTION

Questionnaire Development

The content, layout, and design of a mail questionnaire can drastically improve or hinder both the quality of responses and the overall response rate (Dillman 2007). The questionnaire used in this research was developed with special attention placed on clarity of the posed questions in order to elicit the most accurate information possible. Once in draft stage, the questionnaire was reviewed by two experts in the field of US private forestland owners to ensure it was logical, understandable, and consistent with the goals and objectives of the research project. After initial reviews, the questionnaire was pretested on six forestland owners (>10 acres) known to the researchers. Comments and critiques were addressed in order to improve the clarity and relevance of the questionnaire.

Finally, a pilot survey was conducted using 100 potential respondents randomly selected from the mailing list. Using the same mail survey approach outlined below, the pilot survey provided an indication of response rate as well as feedback related to questionnaire clarity and relevance. The questionnaire was shortened from twelve to eight pages in response to respondent feedback.

Mail Survey Approach

This study employed a self-administered questionnaire as the primary survey instrument. Questionnaires were delivered via mail and returned in a pre-paid, pre-addressed return envelope. The survey procedure included many of the elements identified by Dillman (2007) that are thought to improve survey response rates. Approximately three weeks after the first mailing of the questionnaire, a follow-up questionnaire was mailed. Each questionnaire was accompanied by an individually signed letter outlining the intent of the study, the importance of feedback, and the rights of the potential respondent.

Questionnaire Processing

Returned questionnaires were manually entered into a project spreadsheet. Once questionnaires were received, the respondents were removed from any future mailings. If a respondent returned more than one completed questionnaire, only the first questionnaire was recorded. All responses remain confidential and only aggregate results are presented.

Non-response Bias

To examine potential non-response bias, respondents were compared to those that did not return a questionnaire. A random sample of 50 non-respondents were telephoned and asked five questions from the mail survey. Questions were chosen that could be easily communicated via telephone and did not require extensive explanation. Each variable

was continuous, allowing for comparison between samples using a t test. Insignificant results ($p>.05$) indicate that respondents and non-respondents were statistically similar. Non-response bias test questions and t test results were as follows:

- How many acres of land do you own? (t value = .56; p = .57; r_{pb}=.02)
- I actively seek new forest management practices (t value = .95; p = .34; r_{pb}=.04)
- Forests have as much right to exist as people (t value = 1.89; p = .16; r_{pb}=.09)
- Nature's primary value is to provide products useful to people (t value = .56; p = .58; r_{pb}=.02)
- How long have you owned your land? (t value = 1.48; p = .14; r_{pb}=-.06)

The sample was also compared based on demographic characteristics listed in the National Woodland Owner Survey conducted semi-annually by the US Department of Agriculture Forest Service. No significant differences were found based on income, age and education.

STATISTICAL ANALYSES

Prior to statistical analyses, data was checked for missing or invalid responses, as well as normality (e.g. skewness or kurtosis). All statistical analyses were performed using SPSS statistical software. Reliability analysis was performed to ensure that variables were measuring the same latent construct. OLS regression and path analysis were used to test the significance of relationships between model constructs. Regression and path analysis has to been found to be a suitable form of analysis in similar studies examining

hypothesized cause-effect relationships (e.g. Barr 2007; Meentemeyer et al. 2008). Insignificant relationships were removed and regressions rerun. A path diagram was plotted with standardized β values for each relationship and R^2 values describing the explained variance for each criterion.

Construct Reliability

To test for measurement invariance, SPSS 16 statistical software was used to perform reliability analyses on multiple variables used to measure single constructs. Cronbach's alpha values ≥ .65 indicated acceptable reliability of construct measures (Nunnelly 1970). Provided that Cronbach's alpha *if item deleted* values were less than overall Cronbach's alpha values, and corrected item-total correlations were ≥ .40, reliability was acceptable. Analyses showed reliability within each of the main constructs of the TPB. See Table 5 for reliability analyses related to each construct.

Table 5. Construct reliability - core constructs within the Theory of Planned Behavior.

Concepts and variables	Mean	Std Dev.	Item Total Correlation	Cronbach Alpha if Item Deleted	Cronbach Alpha
Behavioral intention (BI)					.86
BI_1	2.92	0.95	.73	.81	
BI_2	2.70	0.89	.77	.79	
BI_3	2.60	0.95	.69	.82	
BI_4	3.42	1.17	.65	.85	
Attitudes (A)					.82
A_1	3.15	1.13	.66	.82	
$b_1 x e1$	11.49	5.50	.76	.75	
$b_2 x e_2$	11.24	6.50	.61	.80	
$b_3 x e_3$	12.18	5.51	.69	.77	
$b_4 x e_4$	10.85	4.92	.64	.78	
$b_5 x e_5$ [a]	11.09	3.62	.51	.81	
Subjective Norms (SN)					.84
SN_1	3.25	0.96	.48	.84	
SN_2	2.80	0.86	.64	.84	
$nb_1 x mc_1$	8.73	4.58	.63	.82	
$nb_2 x mc_2$	9.41	4.05	.67	.81	
$nb_3 x mc_3$	7.09	3.69	.73	.80	
$nb_4 x mc_4$	7.84	3.92	.78	.79	
$nb_5 x mc_5$	6.67	3.61	.69	.81	
Perceived Behavioral Control (PBC)					.67
PBC_1	3.18	0.89	.62	.67	
PBC_2	3.23	0.89	.64	.66	
$cb_1 x pp_1$	11.72	4.73	.64	.45	
$cb_2 x pp_2$	12.51	5.16	.69	.41	

[a] reverse-coded; see Table 3 for variable descriptions

Constructs developed as extensions to the TPB were also tested for construct reliability. Innovativeness and perceived risk were found to be reliable; however, the environmental orientation (anthropocentric-biocentric continuum) contained two variables that increased

the overall Cronbach's alpha if removed. See Table 6 for a full list of reliabilities for constructs used in the extended model.

Table 6. Construct reliability - innovativeness, environmental orientation, perceived risk.

Concepts and variables	Mean	Std Dev.	Item Total Correlation	Cronbach Alpha if Item Deleted	Cronbach Alpha
Innovativeness (Innov)					.79
$Innov_1$	3.02	0.9	.63	.73	
$Innov_2$	3.23	0.91	.63	.72	
$Innov_3$	3.28	1.06	.54	.77	
$Innov_4$	3.22	1.04	.62	.73	
Environmental Orientation (EO)					
Biocentric basic beliefs (bio)					.86
bio_1	4.47	0.82	.34	.93[a]	
bio_2	3.67	1.35	.87	.75	
bio_3	3.82	1.32	.87	.75	
bio_4	3.51	1.37	.80	.78	
Anthropocentric basic beliefs (anth)					.86
$anth_1$	3.18	1.30	.76	.81	
$anth_2$	3.23	1.23	.79	.79	
$anth_3$	2.80	1.18	.77	.80	
$anth_4$	2.06	1.06	.54	.89[a]	
Percieved Risk (PR)					.83
h_1 x his_1	10.25	4.01	.71	.76	
h_2 x his_2	11.15	4.40	.60	.81	
h_3 x his_3	11.75	4.25	.68	.78	
h_4 x his_4	12.18	4.41	.64	.79	

[a] removed due to Cronbach alpha if item deleted > overall Cronbach alpha
see Table 4 for a description of each variable

RESULTS

RESPONSE INFORMATION

After accounting for bad addresses, respondents outside of the target population, and the deceased, the adjusted sample size was 2742. A total of 435 completed questionnaires were returned, resulting in an adjusted response rate of 15.9%.

RESPONDENT PROFILE

Respondents were asked to provide basic demographic and land characteristic data in order to allow for further analysis regarding influences on behavioral intentions. The mean acreage size and length of ownership was 267.6 acres and 25.6 years, respectively. Respondents reported a mean age of 60.1 years (Table 7).

Table 7. Respondent descriptors: Acres of forestland, years of ownership, and age.

Descriptor	Mean	Std. Dev.	Min	Max	n
Acres of land	267.6	1186.8	10.0	15,000	429
Years owned	25.6	18.0	1	85	425
Age	60.1	12.6	24	92	409

* One outlier was identified and removed (845,000 acres)

The majority of respondents held forestland in the West and the Northeast (38% and 37%, respectively), were predominantly male (76%), Caucasian (92%) and non-retired (56%), and had completed at least a four-year college degree (four year degree: 30%; advanced degree: 29%). Income was relatively evenly distributed across income classes.

Household income of $50,000-74,999 was reported most frequently (21%) (Table 8). Approximately 74% of the respondents lived in the same state as their forestland holdings and 45 % had a primary residence on their forestland.

Table 8. Demographic profile of respondents.

Descriptor	n	%	Descriptor	n	%
Region			Education		
West	162	37.6	Less than high school diploma	6	1.4
Northeast	161	37.4	High school diploma	107	25.4
South	105	24.5	2-year assoc. degree/trade school	64	15.2
	428		4-year college degree	124	29.5
Gender			Advanced degree beyond 4-year degree	120	28.5
Male	315	76.1		421	
Female	99	23.9	Household Income		
	414		Less than $15,000	15	4.0
Retired			$15,000 - 34,999	62	16.7
No	232	55.5	$35,000 - 49,999	52	14.0
Yes	139	32.3	$50,000 - 74,999	78	21.0
Semi-retired	47	10.9	$75,000 - 99,999	59	15.9
	418		$100,000 - 129,999	45	12.1
Race			$130,000 - 149,999	17	4.6
American Indian	6	1.5	$150,000 - 199,999	22	5.9
Black / Afr. Amer	13	3.2	$200,000 or more	22	5.9
Spanish/Latino	2	0.5		372	
Caucasian	376	92.4			
Other	10	2.5			
	407				

USES OF FORESTLAND

In addition to measuring land characteristics, questionnaire items addressed current and planned uses of forestland. Half of the respondents indicated their desire to leave their forestland 'as is' (50%). Other planned activity included some type of timber harvest (24%), bequest to children or heirs (15%), collection of non-timber forest products (NTFP) (9%), and the sale of all or part of the forestland (8%). Nearly half of the respondents indicated that a timber cruise had been conducted on their forestland (45%), however, fewer respondents reported that a written management plan was prepared for their forestland (26%). Few respondents had forestland certified by the Forest Stewardship Council (FSC) (6%), Sustainable Forestry Initiative (SFI) (3%) or American Tree Farm Systems (ATFS) (8%). Few forestland owners managed their forestland for carbon sequestration (5%) and a slightly higher proportion were unsure about carbon management on their property (15%).

COMPONENTS OF THE THEORY OF PLANNED BEHAVIOR

The means and standard deviations of the main components in the TPB are shown in Table 5. The following observations represent forestland owners that agreed (either strongly or moderately) with questionnaire items related to forest carbon offsets. Approximately 18% of respondents planned to manage their forestland for carbon offsets (BI_1=2.92) and 37% reported an overall positive attitude towards the idea of managing their forestland for carbon (A_1=3.15). However, half of the respondents (50%) were

supportive of exploring carbon sequestration opportunities on their land (BI_4 = 3.42). Measures of subjective norms suggested that 36% felt important people in their life would approve of the decision to manage for carbon (SN_1=3.25), but only 9% suggested that these important people would encouraged them to do so (SN_2=2.80). With regards to perceived behavioral control, 30% of the respondents believed it was possible to participate in carbon sequestration and trading on their forestland (PBC_1=3.18).

COMPONENTS OF THE EXTENDED MODEL

The means and standard deviations of the extended components of the model used in this research can be found in Table 6. Results show that 22% of respondents claimed to use new forest management techniques before their fellow forestland owners, 38% are able to implement new management strategies used by other forestland owners, 40% considered ideas about management practices from external sources to be critical to the sound management of their forestland, and 38% actively sought new forest management practices. Over half of the respondents (58%) reported more biocentric than anthropocentric views regarding environmental orientation.

The majority of respondents did not perceive risks relevant to managing forestland for carbon offsets. Very few respondents agreed with the presence of risks such as reduction in revenue from forestland (8%), the unpredictable price of carbon (24%), decreased value of land (11%) or prevention of managing forestland for other values (20%).

Overall, respondent knowledge, based on answers to true/false questions, was quite low. Nearly half (49%) failed to answer a single true/false question correctly, 14% were able to answer one question correctly, 16% were able to answer two questions correctly, 16% were able to answer three questions correctly, and 6% were able to answer four questions correctly. None of the respondents were able to correctly answer all five true/false questions.

Relationships Within the Extended Model

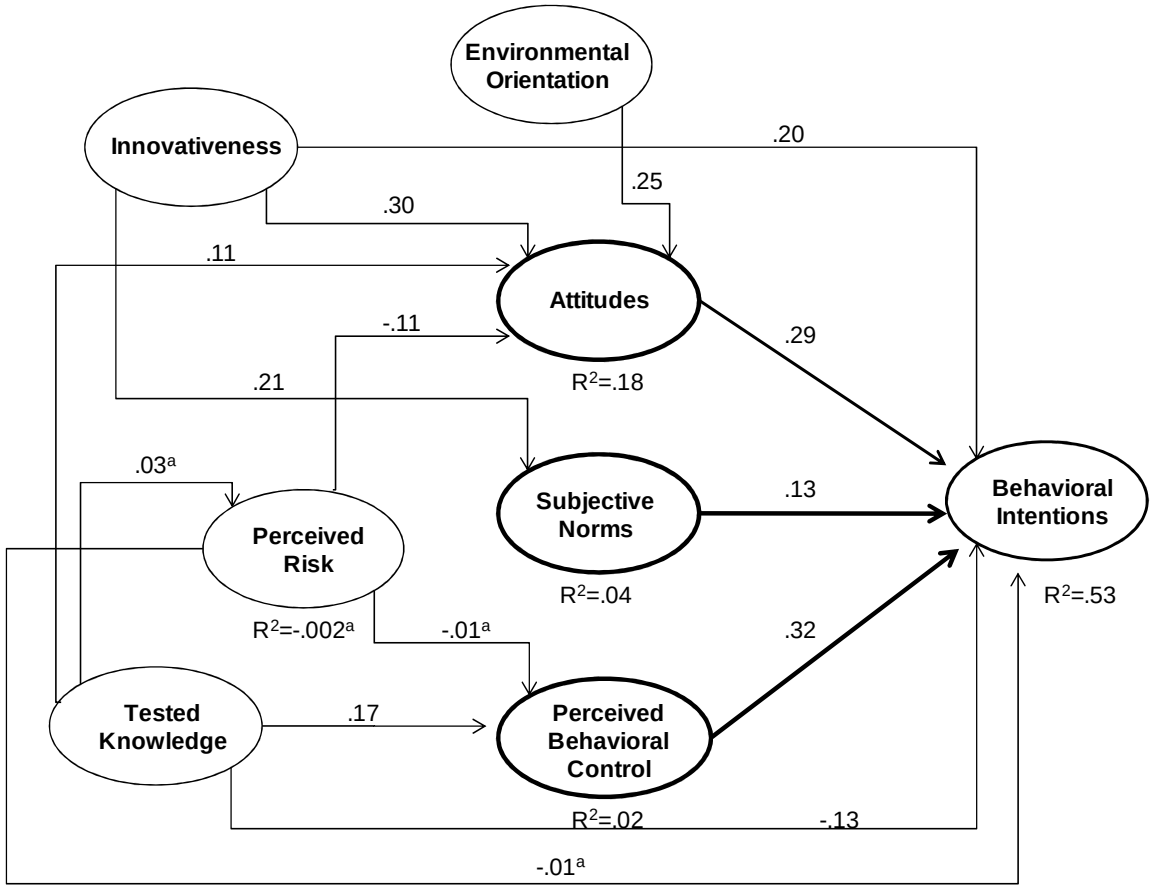
As shown in Table 9, TPB constructs correlated as theorized by Ajzen (1991). Attitudes subjective norms and perceived behavioral control each had large positive effects on behavioral intentions to manage forestland for carbon offsets (Pearson's correlation = .65, .50, and .59, respectively).

Table 9. Correlations between constructs explaining the intention to participate in carbon sequestration and trading (BI). Pearson's correlation coefficients and number of observations.

	BI	A	SN	PBC	Innov	EO	Perc. Risk
BI	1.00						
A	.65**	1.00					
	n=384						
SN	.50**	.60**	1.00				
	380	380					
PBC	.59**	.69**	.40**	1.00			
	390	382	380				
Innov	.40**	.32**	.21**	.29**	1.00		
	396	379	375	385			
EO	.17**	.28**	.23**	.13**	.05	1.00	
	391	377	373	382	391		
Perc. Risk	-.11*	-.13*	-.12*	-.02	.02	-.15**	1.00
	387	381	379	385	381	380	
Knowledge	-0.03	.13**	-.12*	.17**	.11*	-.002	.03
	395	376	373	386	388	380	377

** Significant at p<0.01; * Significant at p <0.05

Regression analyses were performed consistent with hypothesized relationships within the extended TPB (Figure 9). Insignificant predictors were removed and the regressions rerun as necessary (Figure 10). All direct effects on behavioral intentions were found to be significant with the exception of perceived risk (β= -.01; p=.74). Hypothesized direct effects on attitudes and subjective norms were also found to be significant. The effect of perceived risk on perceived behavioral control was insignificant (β= -.01; p=.81) as was the effect of knowledge on perceived risk (β= .03; p=.52) (fail to support **H8**).



[a] insignificant (p>0.05); all other relationships are significant (p<0.01)

Figure 9. Extended Theory of Planned Behavior model (with significant and insignificant relationships)

Direct effects explained a substantial amount of variance within the criterion (behavioral intentions) (R^2=.53). Perceived behavioral control was found to have the largest standardized coefficient (β=.32), followed by attitudes (β=.29) and subjective norms (β=.14) (in support of **H1**, **H2** and **H3**). Innovativeness also had a significant coefficient of β=.20 (in support of **H4**). Knowledge had a significant negative effect on behavioral intentions (β= -.13) (partial support for **H7**). Hypothesized predictors of attitudes

resulted in a coefficient of determination of R^2=.18. More innovative forestland owners tended to have a more positive attitude regarding carbon sequestration (β=.30) (in support of **H4**). Similar positive relationships with attitudes were found for environmental orientation (β=.25) (in support of **H6**) and knowledge (β=.11 (partial support for **H7**). As hypothesized, perceived risk negatively influenced attitudes in the extended model (β= -.11) (partial support for **H5**).

Coefficients of determination were relatively low for subjective norms and perceived behavioral control given that only one predictor was found to be significant for each. Innovativeness positively influenced subjective norms (β=.21; R^2=.04). Similarly, knowledge positively influenced perceived behavioral control (β=.17; R^2=.03).

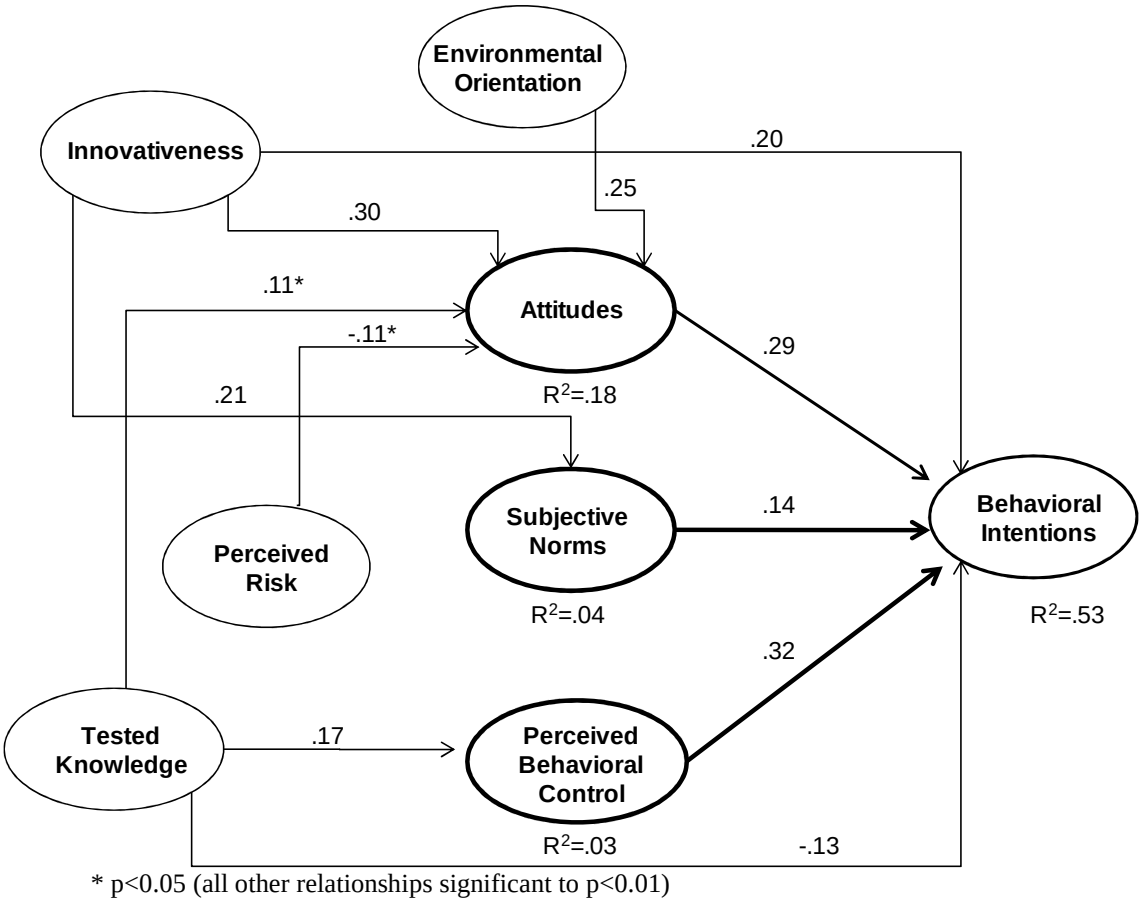


Figure 10. Final extended Theory of Planned Behavior model (only significant relationships).

Additional regression analyses were used to determine mediation by model constructs. Following Baron and Kenny (1986), mediation is detected by comparing standardized coefficients and significance between direct effects (predictor to criterion) before and after the addition of a potential mediator. A reduced significant direct effect β with the addition of a mediator indicates partial mediation. A near-zero or insignificant β indicates full mediation.

Attitude was found to fully mediate the relationship between perceived risk and behavioral intentions. With other constructs removed, the direct effect of perceived risk on intentions (β=-.11; p=.03) decreased and became insignificant (β=.01; p=.77) with the addition of attitude to the model. Attitude partially mediated the relationship between innovativeness and intentions (direct effect: β=.40; p<0.001, with attitude: β=.22; p<.001). Attitude was found to fully mediate the relationship between knowledge and behavioral intentions (direct effect: β=-.03; p=.59, with attitude: β=-.11; p=.05). The relationship between innovativeness and intentions was also partially mediated by subjective norms (direct effect: β=.40; p<0.001, with subjective norms: β=.31; p<.001). Perceived behavioral control fully mediated the relationship between knowledge and intentions (direct effect: β=-.03; p=.59, with perceived behavioral control: β=-.14; p=.001).

DISCUSSION

This research investigated intentions of US NIPF owners to manage their forestland for carbon offsets. The Theory of Planned Behavior is applied as a theoretical frame of reference and allows the researcher to identify constructs associated with owners that influence these behavioral intentions. Despite 95% of the mail survey respondents reporting a lack of current experience with carbon sequestration practices, 50% were

interested in exploring carbon offset opportunities on their forestland. Given the vast area of forestland owned by non-industrial forestland owners in the US, a significant opportunity for domestic carbon sequestration is evident.

When applied to behavioral intentions to participate in forest carbon sequestration and trading, the core constructs of the TPB acted as theorized by Ajzen (1991). Attitudes, subjective norms, and perceived behavioral control each positively influenced these intentions ($p<.001$). Perceived behavioral control had the strongest relationship with behavioral intentions, suggesting that forestland owners having the perception of necessary resources (finances and land characteristics) and ability to manage for carbon offsets generally reported higher intentions to do so. Typically, within the TPB, attitude is the strongest predictor of intentions (e.g. Karppinen 2005). Perhaps the overall lack of familiarity with carbon sequestration and trading prompts forestland owners to focus on the practicality of carbon offsets with regard to the availability of necessary resources. Indeed, knowledge regarding carbon sequestration positively influenced both attitude and perceived behavioral control. However, this effect was stronger with perceived behavioral control, suggesting that increasing knowledge regarding the practice positively influences the forestland owner's perception of the necessary personal resources and ability to carry out the practice. Carbon sequestration and trading is a relatively uncommon practice in the US, however, as climate change mitigation strategies continue to develop and emission reduction legislation progresses, familiarity and knowledge

regarding the practice will undoubtedly increase within the target population. According to model results, the positive influence of knowledge on attitude and perceived behavioral control may, in turn, positively influence behavioral intentions. However, at time of sampling, more knowledgeable respondents reported lower intentions to sequester carbon on their forestland. This relationship suggests that forestland owners with knowledge of the practice may have also understood that the state of the carbon offset market presented an unattractive investment opportunity at time of publication.

Subjective norms, although a significant predictor of intentions in this case, had less influence on behavioral intentions than attitude and perceived behavioral control. As noted, forestland owner knowledge influenced the latter two constructs. The current research does not show a similar relationship between knowledge and subjective norms. Given that subjective norms refer to perceived normative pressures rather than personal attitude, personal knowledge of the practice is unlikely to influence the presence of these pressures. Therefore, rather than a direct effect on subjective norms, it is likely that knowledge held by important individuals in the forestland owner's life would be more impactful in the current model. Knowledge of 'important individuals' was not measured in the current research but it can be speculated that, as with knowledge held by forestland owners, knowledge held by important individuals will develop along with opportunities for carbon sequestration arising through mitigation strategies and legislation.

Innovativeness had a significantly positive influence on attitudes and subjective norms, as well as intentions regarding carbon offsets. The management of forestland for carbon offsets aligns with the classic definition of 'innovation'. Similarly, forestland owners currently managing, or interested in managing, forest carbon offsets can be considered 'early adopters' (or perhaps the 'early majority') showing a high degree of innovativeness (Rogers and Shoemaker 1971). There was a distinct positive relationship between self-appraised innovativeness and attitudes/intentions related to carbon offset generation, suggesting that those forestland owners with a history of early adoption and/or implementation of new practices are more likely to view the carbon offset 'innovation' as a positive opportunity and plan accordingly. In addition, the positive relationship between innovativeness and subjective norms agrees with previous studies of innovation diffusion (Gatignon and Robertson 1985; Mahajan et al. 1990; Moore and Benbasat 1991; Rogers 1983). Given that innovative individuals recognize normative influences as valuable sources of new ideas and practices, results from the current study confirm that subjective norms tend to have a stronger positive effect on intentions in more innovative forestland owners. Therefore, as commonly noticed in the adoption of innovations, management of forestland for carbon offsets will be more readily adopted by a segment of early adopters and the early majority as opposed to the late majority and laggards. As suggested by Rogers (1962), the late majority and laggards tend to be 'suspicious' of innovations, as is illustrated by comments made by some forestland owners reporting low innovativeness and minimal interest in managing their forestland for carbon offsets:

> "I do not believe that sequestration will help climate change or make me any money. I don't want the government making decisions about my land." - *Tennessee landowner (40 acres)*

Conversely, forestland owners reporting innovative tendencies often provided positive insights regarding carbon offset opportunities:

> "Sequestering carbon promotes better forest management practices and opportunities for added revenue. The environmental benefits are a bonus." - *Vermont landowner (50 acres)*

As hypothesized, environmental orientation positively influenced attitudes regarding carbon offset management, suggesting that those forestland owners with a more biocentric value orientation formed more positive attitudes regarding the prospect of managing forestland for carbon offset generation. Given the presence of an emerging post-material (or post-industrial) society in which a biocentric orientation regarding forests and the natural environment is becoming more commonplace (e.g. Steel and Lovrich 1997; Tarrant and Cordell 2002), attitudes regarding pro-environmental practices such as carbon offset generation may become increasingly positive over time. More biocentric individuals tend to be distanced from Pietarinen's (1987) materialism typology, and are more closely linked to a humanism-mysticism-primitivism continuum, therefore, the current findings seem logical in that the influence of environmental orientation on attitude discounts purely monetary or materialistic motivation; a motivation commonly less emphasized by NIPF owners (Dennis 1989).

CONCLUSIONS

The Theory of Planned Behavior provided a theoretical framework that adequately explained intentions of US private forestland owners to participate in carbon sequestration and trading on their forestland. Results suggest that one's perceived behavioral control was most influential on these intentions, more so than attitudes and subjective norms. It is posited here that the limited knowledge regarding carbon offsets, as reported by respondents, prompts them to place more emphasis on having the necessary resources or ability to manage their land for carbon rather than attitudes towards the behavior which may be dependent upon familiarity. The extended model illustrated this relationship between knowledge, attitude and perceived behavioral control. Similarly, innovativeness tended to positively influence attitudes, subjective norms and intentions related to carbon sequestration, aligning with innovativeness theory. Carbon management can be considered a pro-environmental activity based on the benefits the practice provides to the environment. Accordingly, respondents with a more biocentric environmental orientation tended to hold more positive attitudes about carbon sequestration and trading. Overall, the core components of the TPB, as well as the constructs added in the extended model, explained 52% of the variance measured within behavioral intentions of private, non-industrial forestland owners to sequester and trade carbon on forestland.

Few forestland owners were currently managing their forestland for sequestered carbon; however, over half were interested in the prospect. The policy and timber supply implications relevant to this research relate to the identification of forestland owner characteristics that influence intentions to participate in an innovative forestry practice. In particular, the effect of knowledge on attitudes suggested that the provision of educational materials for forestland owners through associations, academic institutions, and government agencies may lead to positive attitudes and increasing perceived behavioral control regarding carbon sequestration and trading. Given that knowledge of the practice is quite low, informing these forestland owners will be key if domestic forests are to become a component of a multifaceted climate change mitigation strategy.

LIMITATIONS

This research measured intentions of US private forestland owners to participate in carbon sequestration and trading. Given that an exhaustive list of these owners was not available, a mailing list was purchased which included a random selection of owners with defined parameters. List coverage was unequal across US states; therefore, care should be taken when making generalizations to the target population based on findings from this research. Overall, familiarity with the subject matter was relatively low resulting in frequent 'neutral' responses to questionnaire items. However, sufficient non-neutral responses allowed for statistical analyses. The newness of the subject matter addressed in the questionnaire, coupled with the length of the questionnaire, may have affected response rate.

LITERATURE CITED

Ajzen, I. 1991. The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50, 179-211.

Ajzen, I., and Driver, B.L., 1992. Application of the theory of planned behavior to leisure choice. Journal of Leisure Research, 24(3), 207-224.

Alig, R.J. 2003. US landowner behavior, land use and land cover changes, and climate change mitigation. Silva Fennica, 37(4), 511-527.

Amacher, G.S., Koskela, E., and Ollikainen M. 2002b. Forest rotation and interdependent stands: ownership structure and timing of decisions. University of Helsinki Discussion Paper Series.

Amacher, G.S., Conway, M.C., Sullivan, J. 2003. Econometric analyses of nonindustrial forest landowners: Is there anything left to study? Journal of Forest Economics, 9, 137-164.

Armitage, C.J., and Conner, M. 2001. Efficacy of the theory of planned behavior: A meta-analytic review. British Journal of Social Psychology, 40, 471-499.

Baranowski, T. 1993. Beliefs as motivational influences at stages in behavior change. International Quarterly of Community Health Education, 13, 3-29.

Bagozzi, R.P., Baumgartner, H., and Yi, Y. 1992. State versus action orientation and the theory of reasoned action: An application of coupon usage. Journal of Consumer Research, 18, 505-518.

Bamberg, S., Ajzen, I., and Schmidt, P. 2003. Choice of travel mode in the theory of planned behavior: the roles of past behavior, habit and reasoned action. Basic and Applied Social Psychology, 25(3), 175-187.

Baron, R.M. and Kenny, D.A. 1986. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. Journal of Personality and Social Psychology, 51(6): 1173-1182.

Barr, S. 2007. Factors influencing environmental attitudes and behaviors: a U.K. case study of household waste management. Environment and Behavior, 39(4): 435-473.

Bass, F.M. 1969. A new product growth model for consumer durables. Management Science, 15(5), 215-227.

Birch, T.W. 1996. The private forest-land owners of the United States, 1994. USDA Forest Service. Northeastern Forest Experiment Station, Res. Bull. NE-134. 183 p. Radnor, PA.

Birdsey, R., Alig, R., Adams, D. 2000. Mitigation options in the forest sector to reduce emissions or enhance sinks of greenhouse gases. In: Joyce, L.A. & Birdsey, R. (eds.). The impact of climate change on America's forests. General Technical Report PNW-GTR-59. US Department of Agriculture, Forest Service, Portland.

Blennow, K. and Sallnas, O. 2002. Risk perception among non-industrial private forest owners. Scandinavian Journal of Forest Resources, 17, 472-479.

Bonan, G.B. 2008. Forests and climate change: forcings, feedbacks, and the climate benefits of forests. Science, 320: 1444-1449.

Bright, A.D., Fishbein, M., Manfredo, M.J., and Bath, Alistair. 1993. Application of the Theory of Reasoned Action to the National Park Service's controlled burn policy. Journal of Leisure Research, 25(3), 263-280.

Bryan, A.D., Aiken, L.S., and West, S.G. 1997. Young women's condom use: the influence of acceptance of sexuality, control over the sexual encounter, and perceived susceptibility to common STD's. Healthy Psychology, 16, 468-479.

Butler, B.J. 2008. Family forest owners of the United States, 2006. Gen. Tech. Rep. NRS-27. Newtown Square, PA: US Department of Agriculture, Forest Service, Northern Research Station. 72 p.

Butler, B.J., and Leatherberry, E.C. 2004. America's family forest owners. Journal of Forestry, October/November, 4-14.

Cairns, R.D. and Lasserre, P. 2004. Reinforcing economic incentives for carbon credits for forests. Forest Policy and Economics, 6, 321-328.

Cary, J.W. and Wilkinson, R.L. 2008. Perceived profitability and farmers' conservation behaviour. Journal of Agricultural Economics, 48(1-3), 13-21.

CCAR, 2009. Forest Project Protocol: Version 2.1. http://www.climateregistry.org/resources/docs/protocols/project/forest/Forest_Project_Protocol_Version_2.1_Sept2007.pdf [02 April 2009]

CCX. 2009a. Chicago Climate Exchange. http://www.chicagoclimatex.com [09 April 2009]

Cheung, S.F., Chan, D.K.S., and Wong, Z.S.Y. 1999. Reexamining the theory of planned behavior in understanding wastepaper recycling. Environment and Behavior, 31(5), 587-612.

Chih-Chung, C. and Chang, Su-Chao. 2005. Discussion on the behavioral intention model of consumer online shopping. Journal of Business and Management, 11(1), 41-57.

Conway, C., Amacher, G.S., and Sullivan, J. 2002. Decisions forest landowners make. Virginia Tech Deparment of Forestry, Blacksburg VA., USA.

Cordano, M. and Frieze, I.H. 2000. Pollution reduction preferences of US environmental managers: applying Ajzen's Theory of Planned Behavior. Academy of Management Journal, 43(4): 627-641.

Crespo, A.H. and del Bosque, I.R. 2008. The effect of innovativeness on the adoption of B2C e-commerce: A model based on the Theory of Planned Behaviour. Computers in Human Behavior, 24, 2830-2847.

Damanpour, F. 1991. Organizational innovation: a meta-analysis of effects of determinants and moderators. Academy of Management Journal, 34(3): 555-590.

Deshpande, R., Farley, J.U., and Webster Jr., F.E. 1993. Corporate culture, customer orientation, and innovativeness in Japanese firms: A quadrad analysis. Journal of Marketing, 57(1), 23-37.

Dillman, D.A. 2007. Mail and Internet Surveys: The Tailored Design Method, 2nd Ed. John Wiley and Sons: Hoboken, NJ, USA. 523 p.

Dowling, G.R., and Staelin, R. 1994. A model of perceived risk and intended risk-handling activity. Journal of Consumer Research, 21(June), 119-134.

Dunlap, R.E., and Van Liere, K.D. 1978. The "new environmental paradigm": A proposed measuring instrument and preliminary results. Journal of Environmental Education, 9, 10-19.

Dunlap, R.E., Van Liere, K.D., Mertig, A.G., and Jones, R.E. 2000. Measuring endorsement of the New Ecological Paradigm: A Revised NEP scale. Journal of Social Issues, 56(3), 425-442.

Eliasch, J. 2008. Eliasch Review: Climate Change: Financing Global Forests. Crown Copyright.

Fielding, K.S., McDonald, R., and Louis, W.R. 2008. Theory of planned behaviour, identity and intentions to engage in environmental activism. Journal of Environmental Psychology, 28(4), 318-326.

Fishbein, M. 2000. The role of theory in HIV prevention. AIDS Care, 12, 273-278.

Fishbein, M. and Ajzen, I. 1975. *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Fishbein, M. and Cappella, J.N. 2006. The role of theory in developing effective health communications. Journal of Communication, 56, S1-S17.

Forward, S.E. 2009. The theory of planned behavior: The role of descriptive norms and past behaviour in the prediction of drivers' intentions to violate. Traffic Psychology and Behaviour, 12(3), 198-207.

Francis, J.J., Eccles, M.P., Johnston, M., Walker, A., Grimshaw, J., Foy, R., Kaner, E.F.S., Smith, L., and Bonetti, D. 2004. Constructing questionnaires based on the Theory of Planned Behaviour. Centre for Health Services Research, University of Newcastle, UK. ISBN: 0-9540161-5-7.

Fulton, D.C., Manfredo, M.J., and Lipscomb, J. 1996. Wildlife value orientations: a conceptual and measurement approach. Human Dimensions of Wildlife, 1(2): 24-47.

Gamba, R.J., and Oskamp, S. 1994. Factors influencing community residents' participation in commingled curbside recycling programs. Environment and Behavior, 26, 587-612.

Gatignon, H., and Robertson, T.S. 1985. A propositional inventory for new diffusion research. Journal of Consumer Research, 11(4), 849-867.

Godin, G., Kok, G., 1996. The theory of planned behavior: A review of its applications to health-related behaviors. American Journal of Health Promotion, 11(2), 87-98.

Hamid, P.N., and Cheng, S.T. 1995. Predicting antipollution behavior: The role of molar behavioral intentions, past behavior, and locus of control. Environment and Behavior, 27, 679-698.

Hansla, A., Gamble, A., Juliusson, A., and Garling, T. 2008. Psychological determinants of attitude towards and willingness to pay for green electricity. Energy Policy, 36(2), 768-774.

Hardner, J.J., Frumhoff, P.C., and Goetze, D. 2000. Prospects for mitigating carbon, conserving biodiversity, and promoting socioeconomic development objectives through the clean development mechanism. Mitigation and Adaptation Strategies for Global Change, 5, 61-80.

Harland, P., Staats, H., Wilke, H.A.M. 1999. Explaining proenvironmental intention and behavior by personal norms and the Theory of Planned Behavior. Journal of Applied Social Psychology, 29(12), 2505-2528.

Harrison, J.A., Mullen, P.D., and Green, L.W. 1992. A meta-analysis of studies of the health belief model with adults. Health Education Research, 7, 107-116.

Hines, J., Hungerford, H., and Tomera, A. 1987. Analysis and sysnthesis of research on environmental behavior: A meta-analysis. Journal of Environmental Education, 18, 1-8.

Hodges, D.G., and Cubbage, F.W. 1990. Nonindustrial private forest management in the South: Assistance foresters' activities and perceptions. Southern Journal of Applied Forestry, 14, 44–48.

Homer, P.M., and Kahle, L.R. 1988. A structural equation test of the value-attitude behavior hierarchy. Journal of Personality and Social Psychology, 54, 638-646.

Huang, E., and Chuang, M.H. 2007. Extending the theory of planned behaviour as a model to explain post-merger employee behaviour of IS use. Computers in Human Behavior, 23, 240-257.

Hurley, R.F. and Hult, T.M. 1998. Innovation, market orientation, and organizational learning: an integration and empirical examination. Journal of Marketing, 62(7), 42-54.

Hyberg, B.T. and Holthausen, D.M. 1989. The behavior of non-industrial private forest landowners. Canadian Journal of Forest Research, 19, 1014-1023.

Iacovou, C.L., Benbasat, I., and Dexter, A.S. 1995. Electronic data interchange and small organizations: adoption and impact of technology. Management Information Systems Quarterly, December: 465-485.

IPCC. 2000. Special report on land use, land use change, and forestry. Intergovernmental Panel on Climate Change. Geneva, Switzerland. Cambridge Press.

IPCC. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In Pachauri, R.K.& Reisinger, A. (Eds.) Geneva, Switzerland.

Jacobson, M. 2002. Ecosystem management in the United States: Interest of forest landowners in joint management across ownerships. Small Scale Forest Economics, Management and Policy, 1(1), 71-92.

Jacobson, M. 2002b. Factors affecting private forest landowner interest in ecosystem management: linking spatial and survey data. Environmental Management, 30(4), 577-583.

Jackson, K.M., and Aiken, L.S. 2000. A psychosocial model of sun protection and sunbathing in young women: the impact of health beliefs, attitudes, norms and self-efficacy for sun protection. Health Psychology, 19, 469-478.

Janz, N.K., and Becker, M.H. 1984. The health belief model: a decade later. Health Education Quarterly, 11, 1-47.

Jarvenpaa, S.L., Tractinsky, N., and Vitale, M. 2000. Consumer trust in an internet store. Information Technology and Management, 1, 45-71.

Jerez-Gomez, P., Ce'spedes-Lorente, J., and Valle-Cabrera, R. 2005. Organizational learning capability: a proposal of measurement. Journal of Business Research, 58(6), 715-725.

Kakoko, D.C., Astrom, A.N., Lugoe, W., and Lie, G.T. 2006. Predicting intended use of voluntary HIV counseling and testing services among Tanzanian teachers using the theory of planned behaviour. Social Science and Medicine, 63, 991-999.

Karppinen, H. 2005. Forest owners' choice of reforestation method: an application of the theory of planned behavior. Forest Policy and Economics, 7, 393-409.

Kilgore, M.A., Snyder, S.A., Schertz, J. and Taff, S.J. 2008. What does it take to get family forest owners to enroll in a forest stewardship-type program? Forest Policy and Economics, 10, 507-514.

Klosowski, R., Stevens, T., Kittredge, D., and Dennis, D. 2001. Economic incentives for coordinating management of forest land: A case study of southern New England. Forest Policy and Economics, 2, 29-38.

Kurttila, M., Hamalainen, K., Kajanus, M., Pesonen, M. 2001. Non-industrial private forest owners' attitudes towards the operation environment of forestry: a miltinomial logit model analysis. Forest Policy and Economics, 2(1), 13-28.

Lehman, W.E.K., Greener, J.M., and Simpson, D.D. 2002. Assessing organizational readiness for change. Journal of Substance Abuse Treatment, 22(4): 197-209.

Lobb, A.E., Mazzocchi, M., Traill, W.B. 2007. Modelling risk perception and trust in food safety information within the theory of planned behaviour. Food Quality and Preferences, 18, 384-395.

Mahajan, V., Muller, E., and Bass, F.M. 1990. New product diffusion models in marketing: A review and directions for research. Journal of Marketing, 54(1), 1-26.

Martin, S.R., and McCurdy, K., 2009. Wilderness food storage in Yosemite: Using the theory of planned behavior to understand backpacker canister use. Human Dimensions of Wildlife, 14, 206-218.

McFarlane, B.L. and Boxall, P.C. 2000. Factors influencing forest values and attitudes of two stakeholder groups: the case of the Foothills Model Forest, Alberta, Canada. Society and Natural Resources, 13, 649-661.

McKenney, D.W., Yemshanov, D., Fox, G. and Ramlal, E. 2004. Cost estimates for carbon sequestration from fast growing poplar plantations in Canada. Forest Policy and Economics, 6, 345 - 358.

Meentemeyer, R.K., Rank, N.E., Anacker, B.L., Rizzo, D.M., and Cushman, H. 2008. Influence of land-cover change on the spread of invasive forest pathogen. Ecological Applications, 18(1): 159-171.

Moore, G.C. and Benbasat, I. 1991. Development of an instrument to measure the perceptions of adopting an information technology innovation. Information Systems Research, 2(3), 1992-222.

Newman, D.H., and Wear, D.N. 1993. Production economics of private forestry: a comparison of industrial and nonindustrial forest owners. American Journal of Agricultural Economics, 75(3), 674-684.

Nigg, C.R., Allegrante, J.P. and Ory, M. 2002. Theory-comparison and multiple-behavior research: Common themes advancing health behavior research. Health Education Research, 17, 670-679.

Nunnelly, J.C. 1970. Psychometric Theory. Second ed., 1978. New York: McGraw Hill.

Olander, L.P. and Murray, B.C. 2007. A new opportunity to help mitigate climate change, save forests, and reach development goals. Nicholas Institute for Environmental Policy Solutions, Duke University. NI WP 07-03.

Olenick, K.L., Kreuter, U.P., Conner, J.R. 2005. Texas landowner perceptions regarding ecosystem services and cost-sharing land management programs. Ecological Economics, 53(2), 247-260.

OpenCongress. 2010. H.R.2454 – American Clean Energy and Security Act of 2009. http://www.opencongress.org/bill/111-h2454/show [07 May 2010]

Oreskes, N. 2004. The scientific consensus on climate change. Science, 306: 1686.

Pattanayak, S., Murray, B., and Abt, R. 2002. How joint is joint forest production: an econometric analysis of timber supply conditional on endogenous amenity values? Forest Science 48 (3): 479–491.

Pavlou, P.A. 2003. Consumer acceptance of electronic commerce: integrating trust and risk with the technology acceptance model. International Journal of Electronic Commerce, 7(3), 101-134.

Pietarinen, J. 1987. Man and the forest: four basic attitudes. Silva Fennica, 21(4): 323-331.

Pouta, E., and Rekola, M. 2001. The Theory of Planned Behavior in predicting willingness to pay for abatement of forest regeneration. Society and Natural Resources, 14, 93-106.

Revkin, A.C. and Seelye, K.Q. 2003. Report by the EPA leaves out data on climate change. New York Times, 19 June 2003.

RGGI. 2009b. RGGI Fact Sheet. http://www.rggi.org/docs/RGGI_Executive%20Summary_4.22.09.pdf [04 April 2009]

Rogers, E.M. 1983. *Diffusion of innovations*. New York: The Free Press.

Rogers, E.M. 1995. *Diffusion of innovations* (4th ed.). New York: The Free Press.

Rogers, E.M., and Shoemaker, F.F. 1971. *Communication of innovations*. New York: The Free Press.

Royer, J.P. 1985. The effects of markets and public policies on the reforestation behavior of southern landowners. Southeastern Center for Forest Economics Research WP 12, Research Triangle Park, NC.

Sample, A. 1996. Sustainability in forest management: an evolving concept. International Advances in Economic Research, 2(2), 165-173.

Schmiege, S.J., Bryan, A., and Klein, W.M.P. 2009. Distinction between worry and perceived risk in the context of the Theory of Planned Behavior. Journal of Applied Social Psychology, 39(1), 95-119.

Sheeran, P., and Taylor, S. 1999. Predicting intentions to use condoms: A meta-analysis and comparison of the theories of reasoned action and planned behavior. Journal of Applied Social Psychology, 29(8), 1624-1675.

Shifter, D.B., and Ajzen, I. 1985. Intention, perceived control, and weight loss: An application of the theory of planned behaviour. Journal of Personality and Social Psychology, 49(3), 842-851.

Skog, K.E., Marcin, T., and Heath, L.S. 1996. Opportunities to reduce carbon emissions and increase storage by wood substitution, recycling, and improved utilization. In: Forests and Global Change, Volume 2: Forest management opportunities for mitigating carbon emissions,. 209-215.

Snyder-Halpern, R. 2001. Indicators of organizational readiness for clinical information technology/systems innovation: a delphi study. International Journal of Medical Informatics, 63: 179-204.

Steel, B.S., List, P., and Shindler, B. 1994. Conflicting values about federal forests: A comparison of national and Oregon publics. Society and Natural Resources, 7, 137-153.

Steel, B.S., and Lovrich, N.P. 1997. An introduction to natural resource policy and the environment: Changing paradigms and values. *In* B.S. Steel (ed.) "Public lands management in the west." Greenwood Publishing, Wesport, CT, pp.3-15.

Stern, N. 2007. Stern Review on the Economics of Climate Change. Home Treasury London. London: http://www.hm-treasury.gov.uk/sternreview_index.htm [08 February 2009]

Straka, T.J. and Doolittle, S. 1988. Propensity of nonindustrial private forest landowners to regenerate following harvest: relationship to socioeconomic characteristics, including innovativeness. Resource Management and Optimization, 6(2), 121-128.

Swallow, S., Talukdar, P., and Wear D. 1997. Spatial and temporal specialization in forest econsystem management under sole ownership. American Journal of Agricultural Economics, 79, 311-326.

Tarrant, M.A., and Cordell, H.K. 2002. Amenity values of public and private forests: examining the value-attitude relationship. Environmental Management, 30(5): 682-703.

Thompson, S.K. 1992. Sampling. New York: Wiley. 343 p.

Thompson, S.C. and Barton, M.A. 1994. Ecocentric and anthropocentric attitudes toward the environment. Journal of Environmental Psychology, 14, 149-158.

Turner, B., Finley, J., and Kingsley, N. 1977. How reliable are woodland owners' intentions? Journal of Forestry, 75(8), 498-499.

Uliczka, H., Angelstam, P., Jansson, G., and Bro, A. 2004. Non-industrial private forest owners' knowledge of and attitudes towards nature conservation. Scandinavian Journal of Forest Research, 19, 274-288.

Unsworth, K.L., Sawang, S., Murray, J., and Sorbello, Tamma. 2009. Developing an integrative model for understanding innovation adoption. The Academy of Management 2009 Annual Meeting Proceedings: Green Management Matters.

U.S. Department of Agriculture (USDA). 2001. U.S. Forest Facts and Historical Trends. USDA Forest Service - FS-696-M.

US EPA. 2007. Inventory of US greenhouse gas emissions and sinks: 1990-2005. US Environmental Protection Agency 430-R-07-002. Washington, DC.

Valle, P.O.D., Rebelo, E., Reis, E., and Menezes, J. 2005. Combining behavioral theories to predict recycling involvement. Environment and Behavior, 37, 364-396.

van den Hove, S., Menestrel, M. and de Bettignies, H.C. 2002. The oil industry and climate change: strategies and ethical dilemmas. Climate Policy, 2(1): 3-18.

Vaske, J.J. and Donnelly, M.P. 2000. A value-attitude-behavior model predicting wildland preservation voting intentions. Society and Natural Resources, 12: 523-537.

Vaske, J.J., Donnelly, M.P., Williams, D.R., and Jonker, S. 2001. Demographic influences on environmental value orientations and normative beliefs about National Forest Management. Society and Natural Resources, 14(9): 761-776.

VCS. 2008. Voluntary Carbon Standard: Tool for AFOLU Methodological Issues. http://www.v-c-s.org/docs/Tool%20for%20AFOLU%20Methodological%20Issues.pdf [08 April 2009]

Vogt, C.A., Winter, G., and Fried, J.S. 2005. Predicting homeowners' approval of fuel management at the wildland-urban interface using the Theory of Reasoned Action. Society and Natural Resources, 18, 337-354.

Vinning, J., and Ebreo, A. 1990. What makes a recycler? A comparison of recyclers and nonrecyclers. Environment and Behavior, 22, 55-73.

Wang, C.L., and Ahmed, P.K. 2004. The development and validation of the organizational innovativeness construct using confirmatory factor analysis. European Journal of Innovation Management, 7(4), 303-313.

WCI. 2008. Design Recommendations for the WCI Regional Cap-and-Trade Program. http://www.westernclimateinitiative.org/ewebeditpro/items/O104F21252.pdf [01 April 2009]

Young, R.A., and Reichenbach, M.R. 1987. Factors influencing the timber harvest intentions of nonindustrial private forest owners. Forest Science, 33(2), 381-393.

CHAPTER 4

EFFECTS OF LAND CHARACTERISTICS, LAND USE PLANNING, AND DEMOGRAPHICS ON U.S. FORESTLAND OWNERS' ATTITUDES TOWARDS CARBON SEQUESTRATION AND TRADING

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ABSTRACT

Leading climate change experts within the international scientific community support the use of forest carbon sinks as a climate change mitigation tool. Functioning regulatory and voluntary carbon offset frameworks within the United States recognize forest offsets with varying levels of stringency. Emerging carbon emission reduction legislation outlines a regulatory cap-and-trade system with provisions for significant domestic forest-related offsets. Given the opportunity for forest carbon offsets in the US, there exists minimal enquiry regarding the attitudes of private non-industrial forestland owners regarding the management of their forestland for carbon sequestration and trading. The current research employs a nationwide survey of forestland owners and investigates the effect of land characteristics, land use planning, and demographics on non-industrial private forestland (NIPF) owners' attitudes towards these carbon sequestration opportunities. Overall, only 37% of respondents held positive attitudes regarding the management of their forestland for carbon sequestration and trading. Results suggest that acreage size and absentee ownership tended to negatively influence attitudes while plans to harvest timber, plans to bequeath to heirs, and education level positively influenced attitudes.

INTRODUCTION

Forestland characteristics and owner demographics are commonly used to predict forest management practices (e.g. Binkley 1981; Pattanayak et al 2002; Kilgore et al. 2008). However, the literature lacks studies applying these measures in the context of forest carbon sequestration and trading. The scientific community suggests that global warming is indeed occurring and will require a multifaceted mitigation strategy (IPCC 2007; Oreskes 2004). Given the enormous potential of global forests to sequester atmospheric carbon, it is suggested that forests should be part of this strategy (IPCC 2000). Proposed emissions reduction legislation in the US (both the *American Clean Energy and Security Act* and the more recently drafted *American Power Act*) currently includes provisions for significant domestic carbon offsets generated by forest carbon sequestration (WRI 2009). Forest carbon offsets are also included in numerous regulatory and voluntary emissions trading frameworks within the US, such as the Regional Greenhouse Gas Initiative (regulatory) and the Chicago Climate Exchange (voluntary) (RGGI 2009a; CCX 2009b).

Approximately 63% of the forests in the US are privately owned, the majority of which is owned by non-industrial owners (Butler and Leatherberry 2004). It has been suggested that these non-industrial private forestlands will become key players in any climate change mitigation strategy involving increased forest carbon stocks (Alig 2003; Birdsey et al. 2000). Given that attitudes towards alternative forest management practices have

been shown to be influenced by land characteristics, land use planning, and landowner demographics (Schaaf et al. 2006; Kaetzel et al. 2009), a similar investigation is warranted in the realm of forest carbon offsets.

The current research examines attitudes of US NIPF owners regarding emerging carbon sequestration and trading opportunities by examining the effects of the following on attitudinal clusters (respondent groups defined by positive or negative attitudes):

1. Land characteristics (acreage size, forest cover, ownership tenure, absentee ownership, and certification).
2. Land use planning (plans to harvest timber, sell land, and bequeath land to heirs).
3. Demographics (age, gender, income, education, geographic region, and retirement status).

THEORETICAL BACKGROUND

FORESTLAND CHARACTERISTICS

Size of Landholdings

A commonly held belief exists that forestland owners with larger parcels of land will be more willing to practice forestry (Binkley 1981). The literature suggests that the size of landholdings positively affects forest management practices (Boyd 1984; Greene and Blatner 1986), intentions to harvest (Hyberg and Holthausen 1989; Pattanayak et al. 2002; Conway et al. 2002), and willingness to reforest (Straka and Doolittle 1988). The

amount of forest stock available on a parcel of land is also thought to influence intentions to participate in forest management schemes (Dennis 1989; Dennis 1990; Kuuluvainen et al. 1996). While Kline et al. (2000) suggested that the size of landholdings negatively influences willingness to accept incentive payments to forgo harvesting, Jacobson (2002b) found no relationship between the size of landholding and ecosystem management participation. However, Kilgore et al. (2008) suggested that the size of landholdings positively correlated with willingness to enroll in a forest stewardship program. These findings are particularly interesting considering the increasing parcelization of non-industrialized private forests (Sampson and Decoster 2000). The literature suggests that increasing parcelization may reduce domestic forest resource availability over time (Amacher et al. 2003). Although much of the evidence suggests the contrary, Kline's (2000) findings are particularly compelling in the context of carbon sequestration and trading.

H1: Owners of larger landholdings will have more negative attitudes towards carbon sequestration and trading.

Forest Cover

Typically, domestic softwood forests are more intensively managed than hardwood forests. Additionally, hardwood forests are more commonly converted to softwood forests than the opposite conversion (Alig et al. 1999). It has been estimated that softwood reforestation and afforestation will increase in response to climate change mitigation strategies aiming to increase forest area or enhance productivity of existing

forests (Alig et al. 1997). The turbulent market for softwood logs may incentivize owners to seek alternative income streams from their forestland (Alig et al. 2002). However, the demand for softwood species for use in a variety of wood products typically exceeds that of hardwood species by volume (Haynes 2002) and, therefore, provides competing streams of income that may deter forestland owners from carbon sequestration activities.

H2: Forestland with increasing softwood cover will negatively influence attitudes of forestland owners towards carbon sequestration and trading.

Length of Ownership

Ownership tenure has been shown to have little effect on traditional forest management activities of NIPF owners (Germain et al. 2007). However, ownership tenure has been found to positively correlate with enrollment in forest conservation programs (Kaetzel et al. 2009). A study of eastern US forestland owners found that newer owners may not have had the time to formulate strong attitudes and intentions regarding land management and protection (Rickenbach and Kittredge 2009). Mendham and Curtis (2007) suggested that newer owners often have less knowledge regarding forest management practices and alternative management schemes.

H3: Newer forestland owners will have more negative attitudes towards carbon sequestration and trading.

Absentee Ownership

Absentee owners tend to be less motivated to manage and/or protect their forestland than owners with permanent residences on their forestland (Romm et al. 1987; Novais and Canadas 2010; Rickenbach and Kittredge 2009; Schaaf et al. 2006). Close proximity of forestland owners to their forestland often creates a mental connectedness and motivation to participate in forest conservation activities (Van Herzele and Van Gossum 2009).

H4: Absentee ownership will negatively influence attitudes towards carbon sequestration and trading.

Forest Certification

The certification of forestland involves many of the same steps required to manage forestland for carbon offset production (CCX 2009b). Both require inventories and the development of a management plan that outlines short- and long-term management strategies. Given that forestland owners familiar with the forest certification process tend to be more knowledgeable regarding conservation and sustainable forestry issues (Leahy et al. 2008), it seems likely that forestland owners with certified forestland would hold a more positive attitude regarding the prospect of managing forestland for carbon offsets.

H5: Forestland owners with certified forestland hold more positive attitudes regarding carbon sequestration and trading.

LAND USE PLANNING

Plans to Harvest Timber

Revenue derived from timber harvest often takes precedence over other forest management opportunities. Forestland owners concerned with short- to medium-term financial benefits from timber harvest are often less interested in participating in conservation based management of forestland than those interested in long-term timber values (Langpap 2006). Given that current carbon-credit schemes provide disincentive to the harvest of forest products and current carbon prices are at record lows (Taylor 2010), forestland owners may see little reason to forego timber harvest and accept the risk of an unstable carbon offset market or other conservation based management practices with longer-term returns (Uliczka et al. 2004). Owners with plans to harvest have been found to require higher rates of compensation to forgo harvesting (Kline et al. 2000).

H6: Forestland owners with plans to harvest timber will hold less positive attitudes regarding carbon sequestration and trading.

Plans to Sell

The prospect of engaging in alternative forest management (e.g. conservation forestry) tends to become less desirable if owners plan to sell all or part of their forestland holdings (Kendra and Hull 2005; Finley and Kittredge 2006). "Ready to sell" owners represent approximately 23% of the family forestland in the US and tend not to set management

objectives for their land; especially objectives requiring significant resources (e.g. financial, planning, commitment) (Butler et al. 2007). Royer (1985) found that forestland owners planning to sell their forested land within the next 20 years were less likely to invest in post-harvest reforestation.

H7: Forestland owners with plans to sell their land will hold more negative attitudes regarding carbon sequestration and trading.

Plans to Bequeath Land to Heirs

A landowner's willingness to bequeath forestland for use by future generations is potentially important to both timber supply and nontimber values offered by forests (Royer 1985; Amacher et al. 2003). As bequests affect the future contiguity and size of forest landholdings, it is important to measure the potential effect of bequests on current and future forest management practices. This variable is quite important to the literature considering that many NIPF owners in the US have either reached or are nearing retirement (Alig et al. 1990). Any bequest decisions will clearly influence future land use decision-making. As noted by Hultkrantz (1991), if heirs have similar preferences as their parents, bequests may actually be more important to long term forest investment than government incentives. Willingness by a forestland owner to bequeath their forestland tended to be positively influenced by stumpage prices and absentee ownership and negatively influenced by landholding size (Conway et al. 2002; Amacher et al. 2002).

H8: Increasing intentions to bequeath forestland will negatively influence attitudes regarding carbon sequestration and trading.

DEMOGRAPHICS

Age

Increasing age of forestland owners has been found to negatively affect forestland investment behavior (e.g. reforestation) (Romm et al. 1987). However, age has been found to be a positive predictor of willingness of NIPF owners to accept incentive payments to forgo harvesting for benefits such as habitat protection (Kline et al. 2000), interest in forest conservation projects (Van Herzele and Van Gossum 2009), and importance placed on environmental certification (Thompson et al. 2010). This positive relationship could be explained by the diminishing desire of aging forestland owners to harvest timber in favor of less intensive management options (Favada et al. 2009).

H9: Older forestland owners will hold more positive attitudes regarding carbon sequestration and trading.

Gender

There are numerous studies suggesting that women are more likely to hold positive attitudes regarding forest conservation and regeneration practices (Agarwal 2009), certification (Ozanne et al. 1999; Thompson et al. 2010), carbon offset practices (MacKerron et al. 2009) and daily environmentally friendly behaviors (Tindall et al. 2003). Women are also more likely to express greater concern for the environment (McFarlane and Hunt 2006).

H10: Female respondents will hold more positive attitudes regarding carbon sequestration and trading.

Income

As noted by Alig et al. (1990), the personal wealth of forestland owners is thought to influence the extent to which non-timber benefits are managed as leisure goods. In other words, landowners with greater economic means are more likely to manage their forestland for non-timber benefits that do not necessarily provide economic gains. Other studies have found that increasing wealth of forestland owners may decrease intentions to harvest timber (Hyberg and Holthausen 1989; Dennis 1989; Dennis 1990), increase intentions to participate in afforestation/reforestation (Straka and Doolittle 1988; Hyberg and Holthausen 1989; Conway 1998), and increase willingness to accept payments to forgo timber harvesting (i.e. ecosystem services) (Kline et al. 2000). Although regional surveys of forestland owners (e.g. southern US and California) suggest that wealth may actually decrease willingness to participate in conservation activities (Royer 1985; Romm et al. 1987), the majority of the literature supports the following:

H11: Increasing income will positively influence attitudes towards carbon sequestration and trading.

Education

Education has been shown to significantly influence intentions to actively manage forestland (Boyd 1984; Green and Blatner 1986; Dennis 1989; Dennis 1990).

Specifically, increasing education levels positively influenced the likelihood of participating in reforestation (Straka and Doolittle 1988), conservation activities (Van Herzele and Van Gossum 2009) and certification programs (Thompson et al. 2010). Kline et al. (2000) found education to be a positive predictor of willingness of NIPF owners in Oregon and Washington to accept incentive payments to forgo harvesting for habitat protection.

H12: Increasing education will positively influence attitudes toward carbon sequestration and trading.

Geographic Region

Given the marked differences in resource dependency and availability, environmental orientation, and forest characteristics, it is reasonable to expect differences in attitudes towards alternative forest management by forestland owners among US regions (Rickenbach and Kittredge 2009; Nie 1999; Schaaf et al. 2006). Specifically, residents within the western region of the US (Figure 11) tend to favor proenvironmental actions that carry financial burden more so than those in the northern or southern regions (Nie 1999; Hays 1991)

H13: Western forest owners will tend to have more positive attitudes regarding carbon sequestration and trading than owners from the North and South.

Retirement

Studies have observed a decline in the importance placed on income generation by retired NIPF owners. Retired owners often value the importance of stewardship and land

enjoyment more so than economic benefit (e.g. Kingsley et al. 1988; Bliss and Martin 1989). Similar to trends noticed with age, older forestland owners tend to become less interested in timber harvesting activities and may be more open to pursue non-timber values from their forestland (Kline et al. 2000; Van Herzele and Van Gossum 2009).

H14: Retired forestland owners will hold more positive attitudes regarding carbon sequestration and trading than semi- and non-retired owners.

OPERATIONALIZATION OF VARIABLES

In order to measure attitudes of forestland owners regarding carbon sequestration and trading on their forestland, the current research employs measures of attitude consistent with the Theory of Planned Behavior (Ajzen 1991). For example, if the behavior is to participate in carbon sequestration and trading on forest, an attitude might be measured, in part, by a salient belief that forest carbon offsets actually help in the fight against climate change. The *attitude* construct (A) is measured with questionnaire items related to *salient beliefs* (b) regarding carbon sequestration, combined with a *subjective evaluation* (e) of the belief's attribute (*n* denotes the total number of salient beliefs). In the current research, salient beliefs were measured with 5-point agreement scales from 1 (strongly disagree) to 5 (strongly agree). Subjective evaluations were measured with 5-point scales from 1 (not at all important) to 5 (very important). See Table 10 for a list of salient belief questionnaire items measuring attitude. $A = \sum_{i=1}^{n} (b_i e_i)$

METHODS

SAMPLING

Target Population

This research investigated antecedents of attitudes held by US NIPF owners regarding carbon sequestration and trading. Consistent with previous landowner surveys (eg. Olenick et al. 2005; Butler 2008), forestland owners with a minimum of 10 acres of land were included in the target population.

Sampling Frame

A mailing list with addresses and telephone numbers was purchased from Martin Worldwide, a mailing list provider. After consulting with experts in the field of national forestland owner surveys, mailing list providers were identified as the preferable source of a reliable sampling frame within the budgetary constraints of the project. Forestland owners were identified based on land-use classifications assigned by the county assessor for tax purposes. Martin Worldwide's database included 91,700 potential forestland owners (nationwide) meeting the specifications of this study.

Sampling Procedure

Consistent with national surveys of forestland owners by the USDA Forest Service, stratified random sampling was employed to ensure adequate sample sizes in each of the three distinct US forest regions (North, South and West) (Butler and Leatherberry 2004; Butler 2008) (Figure 11).

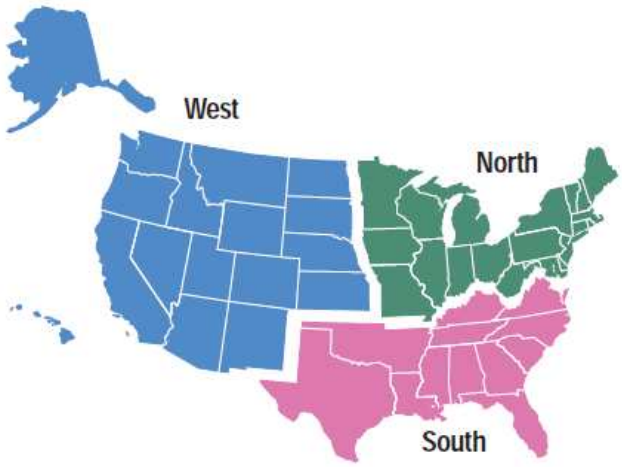

Figure 11. Distinct forest regions of the United States (USDA 2001).

According to Thompson (1992), samples sizes should be determined by population size, desired precision, willingness to accept an incorrect answer, variance in the data, anticipated response rate and budgetary constraints. Based on 5% error and a 95% confidence interval, a sample size of 384 is required regardless of the population. Questionnaires were mailed to 2949 potential respondents nationwide (North: n=984; South: n=982; West: n=983) in addition to the 100 questionnaires mailed during the pilot survey.

DATA COLLECTION

Questionnaire Development

The content, layout, and design of a mail questionnaire can drastically improve or hinder both the quality of responses and the overall response rate (Dillman 2007). The questionnaire used in this research was developed with special attention placed on clarity of the posed questions in order to elicit the most accurate information possible. Once in draft stage, the questionnaire was reviewed by experts in the field of US forestland owners to ensure it was logical, understandable, and consistent with the goals and objectives of the research project.

After initial reviews, the questionnaire was pretested on a sample of forestland owners known to the researchers. Comments and critiques were addressed in order to improve the clarity and relevance of the questionnaire.

Finally, a pilot survey was conducted using 100 potential respondents from the mailing list. Using the same mail survey approach outlined below, the pilot survey provided an indication of response rate as well as feedback related to questionnaire clarity and relevance. The questionnaire was shorted from twelve to eight pages and minor changes were made to some questionnaire items in response to respondent feedback.

Mail Survey Approach

This study employed a self-administered questionnaire as the primary survey instrument. Questionnaires were delivered via mail and returned in a pre-paid, pre-addressed return envelope. The survey procedure included many of the elements identified by Dillman (2007) that are thought to improve survey response rates. Approximately three weeks following the first mailing of the questionnaire, a follow-up questionnaire was mailed. Each questionnaire was accompanied by an individually signed letter outlining the intent of the study, the importance of feedback, and the rights of the potential respondent.

Questionnaire Processing

Returned questionnaires were manually entered into a project spreadsheet. Once questionnaires were received, the respondents were removed from any future mailings. If a respondent returned more than one completed questionnaire, only the first questionnaire was recorded. All responses remain confidential and only aggregate results were presented.

Non-response Bias

To examine potential non-response bias, respondents were compared to those that did not return a questionnaire. A random sample of 50 non-respondents were telephoned and asked four questions from the mail survey. Each variable was continuous, allowing for comparison between samples using a t-test. Insignificant results ($p>.05$) indicate that

respondents and non-respondents were statistically similar. No significant differences were found.

The sample was compared to demographic characteristics listed in the National Woodland Owner Survey which is conducted semi-annually by the US Department of Agriculture Forest Service. No significant differences were found based on income, age, and education.

STATISTICAL ANALYSES

Prior to statistical analyses, data were checked for missing or invalid responses, as well as normality (e.g. skewness or kurtosis). All statistical analyses were performed using SPSS statistical software. A K-means cluster analysis revealed two attitude clusters (negative and positive) based on mean attitude scores derived from six salient belief questionnaire items (Table 10). Negative and positive attitude clusters were found to be significantly different (t value=23.40; $p<0.001$). Using t-tests (continuous variables) and chi-square tests (categorical/dichotomous variables), clusters were compared based on land characteristic, land use planning, and demographic variables. Findings were considered significant at $p<0.05$.

Construct Reliability

To test for measurement invariance within salient beliefs (attitudes), SPSS 16 statistical software was used to perform reliability analyses. Cronbach's alpha values $\geq .65$

indicated acceptable reliability of construct measures (Nunnelly 1970). Provided that Cronbach's alpha *if item deleted* values were less than overall Cronbach's alpha values, and corrected item-total correlations were ≥ .40, reliability was acceptable. Each measure of beliefs related to attitude was found to have sufficient item total correlation and did not lower the overall Cronbach Alpha (.82) (Table 10).

Table 10. Construct reliability for *attitude* regarding carbon sequestration and trading.

Questionnaire Items	Mean	Std Dev.	Item Total Correlation	Cronbach Alpha if Item Deleted	Cronbach Alpha
Attitudes					.82
I feel positively about the possibility of participating in carbon sequestration and trading on my forestland.	3.15	1.13	.66	.82	
In the long term, carbon sequestartion and trading can increase the revenue generated from my forestland.	11.49	5.50	.76	.75	
Participating in forest carbon sequestration and trading helps minimize climate change.	11.24	6.50	.61	.80	
Carbon sequestration would improve other forest values on my land.	12.18	5.51	.69	.77	
In the short term, carbon sequestration and trading will provide increased revenue from my forestland.	10.85	4.92	.64	.78	
The cost of managing my forests for carbon sequestration is too high. [a]	11.09	3.62	.51	.81	

[a] reverse-coded.

*salient beliefs listed here are multiplied by subjective evaluations (not at all important / very important)

RESULTS

RESPONSE INFORMATION

After accounting for bad addresses, respondents outside of the target population, and the deceased, an adjusted sample size of 2742 was confirmed. A total of 435 completed questionnaires were returned resulting in an adjusted response rate of 15.9%.

CLUSTER ANALYSIS

A cluster analysis based on salient belief questionnaire items revealed two distinct attitude clusters with significantly different cluster centers (t value = 23.40; $p<.001$). The negative cluster (n=195; 51%) had a cluster center of 7.38 and the positive cluster (n=189; 49%) had a cluster center of 12.78 (Table 11). Respondents with completely neutral attitudes (neither negative nor positive) regarding carbon sequestration and trading would have overall attitude scores of 8. In other words, if neutral scores were recorded for each question in Table 10, the resulting overall attitude score would be 8.

Table 11. K-means cluster analysis based on *attitude* construct.

	Cluster Center	n	t-value	p-value
Attitude				
Negative	7.38	195	23.40	<.001
Positive	12.78	189		

* A neutral attitude scores would be 8.0

LAND CHARACTERISTICS

Of the forestland characteristics measured, acreage size and absentee ownership were found to be significantly different between clusters. In support of **H1**, individuals in the negative attitude cluster tended to own more land (M=399.1 acres) compared to the positive attitude cluster (M=172.8 acres) (t value = 1.65; p=.05), however, the effect size was small (rpb=.09) (Table 12). In support of **H4**, individuals in the negative attitude cluster tended to be absentee owners (60%) more so than those in the positive cluster (50%) (χ^2 = 4.09; p=.04; Cramer's V=.10) (Table 13). There were no significant differences between clusters based on: (a) Ownership tenure (years), t value = 0.57, p=.57; (b) Forest coverage (% cover), t value=-1.16, p=.25; and (c) Forest certification (yes/no), χ^2 = 0.74, p=.39.

Table 12. The effects of land characteristic and demographics on attitude clusters.

	Attitude Clusters[1]					
	(1) Negative	(2) Positive				
Cluster (n)	195	189				
Cluster %	51%	49%	t-value	*p* -value	r_{pb}	Hypothesis
Acres of land	399.1	172.8	1.65	.05	.09	support H1
Ownership Tenure	25.7	24.7	0.57	.57	.03	n/s
Forest Coverage	74.7	77.7	-1.16	.25	.06	n/s
Age	60.5	59.1	1.10	.27	.06	n/s

LAND USE PLANNING

Plans to harvest timber and plans to bequeath land to heirs were both found to be significantly different between clusters. Forestland owners in the positive attitude cluster

tended to more frequently have plans to harvest timber (30%) as compared to those in the negative attitude cluster (22%) (χ^2=4.04; p=.04) (fail to support **H6**). Similarly, forestland owners in the positive attitude cluster planned to bequeath their land to heirs (20%) more frequently than those in the negative attitude cluster (10%) (χ^2=6.60; p=.01) (fail to support **H8**). Both significant differences had small effect sizes (Cramer's V = .09 and .13, respectively). Plans to sell land were not significantly different between clusters (χ^2 =1.06; p=.30) (Table 13).

Table 13. The effects of demographics and ownership characteristics on attitude clusters.

	Attitude Clusters[1]					
	(1) Negative	(2) Positive				
Cluster (n)	195	189				
Cluster %	51%	49%	χ^2	*p* -value	Cramer's V	Hypothesis
Absentee Owner			4.09	.04	.10	Support H4
Yes	60	50				
No	40	50				
Forest Certification			0.74	.39	-.04	n/s
Yes	17	14				
No	83	86				
Plans to Harvest Timber			4.04	.04	.09	Fail to Support H6
Yes	22	30				
No	78	70				
Plans to Sell Land			1.06	.30	.05	n/s
Yes	7	10				
No	93	90				
Plans to Bequeath			6.60	.01	.13	Fail to Support H8
Yes	10	20				
No	90	80				
Gender			0.27	.60	-.03	n/s
Male	75	78				
Female	25	22				

1. Cell entries are column percentages

DEMOGRAPHICS

Education level was the only demographic measure found to be statistically different between clusters. In support of **H12**, forestland owners in the positive attitude cluster were more often educated with an advanced degree (34%) than those in the negative attitude cluster (23%) (Table 14). Owners in the positive attitude cluster were also less likely to have a high school diploma or less (22%) than those in the negative attitude cluster (30%) (χ^2=3.85; p=.05; Cramer's V=.13). There were no significant differences between clusters based on: (a) age, t value=1.10, p=.27; (b) gender, χ^2=0.27; p=.60; (c) income, χ^2=2.84, p=.94; (d) Region, χ^2=3.07; .22; and (e) Retirement, χ^2=4.00, p=.14.

Table 14. The effects of demographics on attitude clusters.

	Attitude Clusters[1]					
	(1) Negative	(2) Positive				
Cluster (n)	195	189				
Cluster %	51%	49%	χ^2	*p* -value	Cramer's V	Hypothesis
Education			3.85	.05	.13	Support H12
High school diploma or less	30	22				
2-year assoc. degree / trade school	14	16				
4-year college degree	32	28				
Advanced degree beyond 4-year degree	23	34				
Household Income			2.84	.94	.09	n/s
Less than $15,000	4	4				
$15,000 - 34,999	16	17				
$35,000 - 49,999	14	14				
$50,000 - 74,999	20	22				
$75,000 - 99,999	16	14				
$100,000 - 129,999	11	14				
$130,000 - 149,999	5	5				
$150,000 - 199,999	6	7				
$200,000 or more	8	5				
Region			3.07	.22	.09	n/s
West	42	33				
Northeast	35	40				
Southeast	23	27				
Retired			4.00	.14	.10	n/s
Yes	36	27				
No	55	60				
Semi-retired	9	13				

1. Cell entries are column percentages

DISCUSSION

An investigation into the attitudes held by forestland owners regarding carbon sequestration and trading revealed five potential antecedents to such attitudes. A comparison of negative and positive attitudinal clusters revealed significant differences based on certain land characteristics, land use planning, and demographics. The area of land (acreage size) is commonly an influential land characteristic with regards to management practices used by forestland owners. The current research, however,

suggested that increasing acreage size negatively influenced attitudes towards carbon sequestration and trading. Large parcels of land tend to be more intensively managed and have written management plans, timber cruises etc. Accordingly, forestland owners with larger parcels of land may be more firmly committed to an established set of practices that agree with their land use objectives and less likely to consider new practices. Conversely, small forestland owners may adhere to a less established set of practices (or none at all), thus, allowing the owner to be more flexible.

The literature suggests that larger forestland owners tend to be more likely to plan timber harvesting activities in the short-term than smaller forestland owners. Given that acreage size was negatively associated with attitudes towards carbon sequestration and trading, it seems logical to suggest that plans to harvest timber would also negatively influence these attitudes. However, the current research found the opposite. Plans to harvest timber were actually a positive influence on attitudes towards carbon sequestration and trade. Perhaps during more prosperous economic conditions with more appealing timber prices, this finding would change. The current research was conducted following a period of recession in the US economy which resulted in reduced housing starts and poor markets for forest products. Forestland owners with modest timber harvesting operations may simply be interested in alternative revenue streams to supplement their income.

Forest carbon sequestration and trading requires preparation of a management plan and regular inventories; both often necessitating professional assistance. These requirements may seem burdensome to absentee forestland owners that use their land for purposes other than residence or resource extraction (e.g. recreation, real estate investment). Owners using the land as a primary residence are often more motivated to manage/protect their forestland (Romm et al. 1987). Therefore, despite the onerous task of forest carbon management, owners in close proximity to their land may become more engaging participants as the carbon market develops for domestic offsets.

As this research shows, US forestland owners are an aged population (mean = 60 years). Given that age was not found to have an effect on attitude clusters, it appears that land use plans, more so than age, dictated attitudes regarding carbon sequestration and trading. Plans to harvest did not differ by age ($p=.72$). In time, these owners will make decisions regarding their estate and decide whether to sell their land or bequeath their land to heirs. Plans to sell land did not influence attitudes, however, plans to bequeath land to heirs had a positive influence on attitudes, indicating that prolonged ownership within the family provided a more suitable circumstance for consideration of alternative forest management practices such as carbon sequestration.

Finally, the level of education reported by forestland owners positively influenced attitudes towards carbon sequestration and trading. A logical assumption might be that

higher education translates into higher income and, therefore, increasing financial freedom to pursue less traditional practices on forestland. However, income did not significantly affect on attitudes towards the practice. Therefore, rather than a resource availability issue, perhaps the positive relationship between education and attitude was instead driven by egalitarian or biocentric motives (Adeola 2004).

CONCLUSIONS

The attitudes of 429 NIPF owners across the US were surveyed regarding their attitudes towards carbon sequestration and trading on their forestland. Overall, only 37% of respondents held positive attitudes regarding the management of their forestland for carbon sequestration and trading. Using a cluster analysis, the respondents were divided into two clusters representing those that held negative attitudes regarding carbon sequestration and those that held positive attitudes regarding carbon sequestration. Results suggest that acreage size and absentee ownership both negatively influenced these attitudes while plans to harvest, plans to bequeath their land to heirs, and level of education each positively influenced these attitudes. Overall, the clusters were evenly divided and were not influenced by ownership length, forest coverage, certification, plans to sell land, age, income, gender or region. The *capacity to manage* forestland for carbon offsets is hindered by absentee ownership and promoted by concurrent plans to harvest timber (i.e. opportunities for enhanced reforestation) and education level.

LIMITATIONS

This research aimed to measure intentions of US private forestland owners to participate in carbon sequestration and trading. Given that an exhaustive list of these owners is not available, a mailing list was purchased which included a random selection of owners with defined parameters. List coverage was unequal across US states; therefore, care should be taken when making generalizations to the target population based on findings from this research. Overall, familiarity with the subject matter was relatively low resulting in frequent 'neutral' responses to questionnaire items. However, sufficient non-neutral responses allowed for statistical analyses.

LITERATURE CITED

Agarwal, B. 2009. Gender and forest conservation: the impact of women's participation in community forest governance. Ecological Economics, 68(11): 2785-2799.

Alig, R.J. 2003. US landowner behavior, land use and land cover changes, and climate change mitigation. Silva Fennica, 37(4), 511-527.

Alig, R.J., Lee, K.J., and Moulton, R.J. 1990. Likelihood of timber management on nonindustrial private forests: Evidence from research studies. USDA Forest Service, General Technical Report SE-60, Southeasten Forest Experiement Station.

Alig, R., Adams, D., McCarl, B., Callaway, J.M., and Winnett, S. 1997. Assessing effects of mitigation strategies for global climate change with an intertemporal model of the U.S. forest and agriculture sector. Environmental and Resource Economics, 9, 259-274.

Alig, R.J., Adams, D.M., Chmelik, J.T., and Bettinger, P. 1999. Private forest investment and long-run sustainable harvest. New Forest, 17, 307-327.

Alig, R.J., Mills, J., and Butler, B. 2002. Private timberlands: growing demands, shrinking land base. Journal of Forestry, March, 32-37.

Amacher, G.S., Koskela, E., Ollikainen, M. and Conway, M.C. 2002. Bequests and forest landowners: theory and empirical evidence. American Journal of Agricultural Economics, 84(4), 1103-1114.

Amacher, G.S., Conway, M.C., Sullivan, J. 2003. Econometric analyses of nonindustrial forest landowners: Is there anything left to study? Journal of Forest Economics, 9, 137-164.

Binkley, C.S. 1981. Timber supply from private nonindustrial forests, Bulletin No. 92, New Haven, CT: Yale University School of Forestry and Environmental Studies.

Birdsey, R., Alig, R., Adams, D. 2000. Mitigation options in the forest sector to reduce emissions or enhance sinks of greenhouse gases. In: Joyce, L.A. & Birdsey, R. (eds.). The impact of climate change on America's forests. General Technical Report PNW-GTR-59. US Department of Agriculture, Forest Service, Portland.

Bliss, J.C., and Martin, A.F. 1989. Indentifying NIPF management motivations with qualitative methods. Forest Science, 35(2): 601-622.

Boyd, R.G. 1984. Government support of non-industrial production: The case of private forests. Southern Economic Journal, 51, 89-107.

Butler, B.J., and Leatherberry, E.C. 2004. America's family forest owners. Journal of Forestry, October/November, 4-14.

Butler, B.J., Tyrrell, M., Feinberg, G., VanManen, S., Wiseman, L. and Wallinger, S. 2007. Understanding and reaching family forest owners: lessons from social marketing research. Journal of Forestry, October/November, 348-357.

Butler, B.J. 2008. Family forest owners of the United States, 2006. Gen. Tech. Rep. NRS-27. Newtown Square, PA: US Department of Agriculture, Forest Service, Northern Research Station. 72 p.

CCX. 2009b. CCX Offsets Data. CCX Offset Report. Volume 1, Number 2, February/March Issue. (www.forestalbancaria.com).

Conway, C. 2002. Testing the reservation price behavior of nonindustrial forest landowners. PhD dissertation, Virginia Tech Department of Forestry, Blacksburg VA.USA.

Dennis, D.F. 1989. An economic analysis of harvest behavior: integrating forest and ownership characteristics. Forest Science, 35, 1088-1104.

Dennis, D.F. 1990. A probit analysis of the harvest decision using pooled time-series and cross-sectional data. Journal of Environmental Economics and Management, 18, 176-187.

Dillman, D.A. 2007. Mail and Internet Surveys: The Tailored Design Method, 2nd Ed. John Wiley and Sons: Hoboken, NJ, USA. 523 p.

Favada, I.M., Karppinen, H., Kuuluvainen, J., Mikkola, J., and Stavness, C. 2009. Effects of timber prices, ownership objectives, and owner characteristics on timber supply. Forest Science, 55(6): 512-523.

Finley, A.O. and Kittredge, D.B. 2006. Thoreau, Muir, and Jane Doe: different types of private forest owners need difference types of forest management. Northern Journal of Applied Forestry, 23(1): 27-34.

Germain, R.H., Anderson, N., and Bevilacqua, E. 2007. The effects of forestland parcelization and ownership transfers on nonindustrial private forestland forest stocking in New York. Journal of Forestry, December, 403-408.

Greene, J.L. and Blatner, K.A. 1986. Identifying woodland owner characteristics associated with timber management. Forest Science, 32(1), 135-146.

Haynes, R.W. 2002. Forest management in the 21st century: changing numbers, changing context. Journal of Forestry, March, 38-43.

Hays, S.P. 1991. The new environmental West. Journal of Policy History, 3, 223-248.

Hultkrantz, L. 1992. Forest and the bequest motive. Journal of Environmental Economics and Management, 22(2), 164-177.

Hyberg, B.T. and Holthausen, D.M. 1989. The behavior of non-industrial private forest landowners. Canadian Journal of Forest Research, 19, 1014-1023.

IPCC. 2000. Special report on land use, land use change, and forestry. Intergovernmental Panel on Climate Change. Geneva, Switzerland. Cambridge Press.

IPCC. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In Pachauri, R.K.& Reisinger, A. (Eds.) Geneva, Switzerland.

Jacobson, M. 2002b. Factors affecting private forest landowner interest in ecosystem management: linking spatial and survey data. Environmental Management, 30(4), 577-583.

Kaetzel, B.R., Hodges, D.G., Houston, D., and Fly, J.M. 2009. Predicting the probability of landowner participation in conservation assistance programs: a case study of the Northern Cumberland Plateau of Tennessee. Southern Journal of Applied Forestry, 33(1): 5-8.

Kendra, A. and Hull, R.B. 2005. Motivations and behaviors of new forest owners in Virginia. Forest Science, 51(2): 142-154.

Kilgore, M.A., Snyder, S.A., Schertz, J. and Taff, S.J. 2008. What does it take to get family forest owners to enroll in a forest stewardship-type program? Forest Policy and Economics, 10, 507-514.

Kingsley, N.P., Brock, S.M., and DeBald, P.S. 1988. Focus group interviewing applied to retired West Virginia private forest landowners. Northern Journal of Applied Forestry, 5, 198-200.

Kline, J., Alig, R.J. and Johnson, R.L. 2000. Fostering the production of nontimber services among forest owners with heterogeneous objectives. Forest Science, 46, 302-311.

Kuuluvainen, J., Karppinen, H., and Ovaskainen, V. 1996. Landowner objective and non-industrial private timber supply. Forest Science, 42(3): 3300-309.

Langpap, C. 2006. Conservation of endangered species: can incentives work for private landowners? Ecological Economics, 57, 558-572.

Leahy, J.E., Kilgore, M.A., Hibbard, C.M., and Donnay, J.S. 2008. Family forest landowners' interest and perceptions of forest certification: focus group findings from Minnesota. Northern Journal of Applied Forestry, 25(2), 73-81.

MacKerron, G.J., Egerton, C., Gaskell, C., Parpia, A., and Mourato, S. 2009. Willingness to pay for carbon offset certification and co-benefits among (high-)flying young adults in the UK. Energy Policy, 37(4): 1372-1381.

McFarlane, B.L. and Hunt, L.M. 2006. Environmental activism in the forest sector: social psychological, social-cultural, and contextual effects. Environment and Behavior, 38(2): 266-285.

Mendham, E. and Curtis, A. (In Press). Taking over the reins: trends and impacts of changes in rural property ownership, Society and Natural Resources.

Nie, M.A. 1999. Environmental opinion in the America West. Society and Natural Resources, 12, 163-170.

Novais, A. and Canadas, M.J. 2010. Understanding the management logic of private forest owners: a new approach. Forest Policy and Economics, 12, 173-180.

Nunnelly, J.C. 1970. Psychometric Theory. Second ed., 1978. New York: McGraw Hill.

Olenick, K.L., Kreuter, U.P., Conner, J.R. 2005. Texas landowner perceptions regarding ecosystem services and cost-sharing land management programs. Ecological Economics, 53(2), 247-260.

Oreskes, N. 2004. The scientific consensus on climate change. Science, 306: 1686.

Ozanne, L.K., Humphrey, C.R., and Smith, P.M. 1999. Gender, environmentalism, and interest in forest certification: Mohai's paradox revisited. Society and Natural Resources, 12, 613-622.

Pattanayak, S., Murray, B., and Abt, R. 2002. How joint is joint forest production: an econometric analysis of timber supply conditional on endogenous amenity values? Forest Science 48 (3): 479–491.

RGGI. 2009a. Regional Greenhouse Gas Initiative Model Rule. http://www.rggi.org/docs/Model%20Rule%20Revised%2012.31.08.pdf [13 March 2009]

Rickenbach, M. and Kittredge, D.B. 2009. Time and distance: comparing motivations among forestland owners in New England, USA. Small-scale Forestry, 8, 95-108.

Romm, J., Tuazon, R., and Washburn, C. 1987. Relating forestry investment to the characteristics of nonindustrial private forestland owners in Northern California. Forest Science, 33, 197-209.

Royer, J.P. 1985. The effects of markets and public policies on the reforestation behavior of southern landowners. Southeastern Center for Forest Economics Research WP 12, Research Triangle Park, NC.

Sampson, N. and Decoster, L. 2000. Forest fragmentation: implications for sustainable private forests. Journal of Forestry, 98(3), 4-8.

Schaaf, K.A., Ross-Davis, A.L., and Broussard, S.R. 2006. Exploring the dimensionality and social bases of the public's timber harvesting attitudes. Landscape and Urban Planning, 78, 135-146.

Shifter, D.B., and Ajzen, I. 1985. Intention, perceived control, and weight loss: An application of the theory of planned behaviour. Journal of Personality and Social Psychology, 49(3), 842-851.

Straka, T.J. and Doolittle, S. 1988. Propensity of nonindustrial private forest landowners to regenerate following harvest: relationship to socioeconomic characteristics, including innovativeness. Resource Management and Optimization, 6(2), 121-128.

Taylor, A., Lippke, B., and Park, W. 2010. Carbon credit schemes for forest landowners are counterproductive. Environmental Science and Policy, 13, 150-153.

Thompson, D.W., Anderson, R.C., Hansen, E.N., and Kahle, L.R. 2010. Green segmentation and environmental certification: insights from forest products. Business Strategy and the Environment, 19(4), *in press*.

Thompson, S.K. 1992. Sampling. New York: Wiley. 343 p.

Tindall, D.B., Davies, S., and Mauboules, C. 2003. Activism and conservation behavior in an environmental movement: the contradictory effects of gender. Society and Natural Resources, 16, 909-932.

Uliczka, H., Angelstam, P., Jansson, G. and Bro, A. 2004. Non-industrial private forest owners' knowledge of and attitudes towards nature conservation. Scandinavian Journal of Forest Research, 19, 274-288.

Van Herzele, A. and Van Gossum, P. 2009. Owner-specific factors associated with conversion activity in secondary pine plantations. Forest Policy and Economics, 11(4): 230-236.

World Resources Institute (WRI). 2009. The American Clean Energy and Security Act: Key elements and next steps. [http://www.wri.org Accessed 03 August 2009].

CHAPTER 5

INTENTIONS OF LARGE INDUSTRIAL FORESTLAND OWNERS TO DEVELOP FOREST CARBON OFFSETS: AN ORGANIZATIONAL APPLICATION OF THE THEORY OF PLANNED BEHAVIOR

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ABSTRACT

It is estimated that 87 million acres of forestland in the United States (US) is managed by private industrial forestland owners (nearly 14% of the forestland nationwide). Private industrial forestland owners include forest products companies, Timber Investment Management Organizations (TIMOs), and Real Estate Investment Trusts (REITs). Current regulatory and voluntary carbon markets, as well as proposed national emissions reduction legislation, in the US make provisions for substantial carbon offsets from domestic forestry projects. This research employed the Theory of Planned Behavior by means of an online questionnaire in order to survey large industrial forestland owners (>30,000 acres) regarding intentions to manage forestland for carbon sequestration and trading. Quantitative results suggested that few organizations (18%) were currently managing forestland for carbon values. Attitudes towards carbon sequestration and trading were significantly influenced by the managers' beliefs that emissions reduction legislation would become law and US forest carbon offsets were legitimate climate change mitigation tools. Qualitative results revealed that most organizations are taking a passive approach to carbon sequestration and trading until a suitable regulatory framework emerges and carbon prices provide the conditions for a sound investment.

INTRODUCTION

In response to the potentially catastrophic effects of global warming (IPCC 2007; Oreskes 2004), it has been suggested that a multifaceted climate change mitigation strategy will likely include carbon offsets generated from forestry activities (IPCC 2000; Cairns and Lasserre 2004). Given that the majority of forestland in the US is privately owned (63%) (Butler and Leatherberry 2004), it seems reasonable to conclude that private forestland owners will become key players if forest-related climate change mitigation strategies are implemented at the regional, state, and federal levels. Emissions reduction legislation in the US (the American Clean Energy and Security Act) is currently awaiting approval from the Senate. If approved, the legislation includes provisions for carbon offsets generated by domestic forestry projects (WRI 2009).

Private forestlands in the US can be divided into industrial and non-industrial categories. While non-industrial forestland (e.g. family forests) represents the majority of private US forestlands (approximately 304 million acres) (Butler and Leatherberry 2004), industrial forestland owners (e.g. forest products companies) control a substantial area of forestland as well (approximately 87 million acres) (Fernholz et al. 2007). Given the potential significance of forests in climate change mitigation strategies, it is important to understand the intentions and perceptions industrial forestland owners hold regarding forest carbon sequestration and trading. Industrial forestland owners tend to place higher priority on revenue generation, therefore, hypotheses are made regarding effects of

pressures to provide short-term returns on measured intentions to sequester and trade forest carbon. The current research employs the Theory of Planned Behavior (TPB) (Ajzen 1991) as an investigatory framework in order to examine potential antecedents to these intentions.

RESEARCH OBJECTIVES:

Given that the literature lacks sufficient examination of the intentions of large industrial forestland owners to participate in the carbon offset market, this study aims to investigate these intentions using responses to a web-based questionnaire. Specific research objectives were as follows:

1. Test an organizational application of the Theory of Planned Behavior (TPB).
2. Use TPB constructs to assess intentions of large industrial forestland owners to manage forestlands for carbon offset production.
3. Determine the effects of pending climate change legislation, pressures to deliver a short-term return on investment, and belief in domestic forests as a viable climate change mitigation tool, on forest manager intentions to enter the carbon market.
4. Examine differences in intentions due to firm characteristics.
5. Use qualitative data to explore key reasons for and against activity in the carbon market.

THEORETICAL BACKGROUND

In light of impending emissions reduction legislation in the US, it is important to understand the intentions of key players in the forest sector to manage forestland for

carbon offsets. Since the 1980s, the landscape of large industrial forestland owners has gradually changed. Many large forest products companies began selling-off all or part of their land holdings or restructuring their land ownership. Between 1985 and 2005, forestland ownership by large, vertically integrated forest products companies decreased from 58 million acres to 21 million acres. Most of the decrease can be attributed to sales of forestland to Timber Investment Management Organizations (TIMOs) or transfers of forestlands (through reorganization) to Real Estate Investment Trusts (REITs). TIMOs buy, sell, and manage forestland on behalf of investors such as pension funds, insurance companies and foundations. REITs buy, sell, and manage real estate assets on behalf of private investors (Fernholz et al. 2007). As of 2007, it is estimated that TIMO/REITs controlled nearly 7% of the timberland (forestland capable of producing $1.5m^3$/hectare/year of commercial wood) in the US (Fernholz et al. 2007). Weyerhaeuser, a large international forest products company, has announced its plan to convert to a REIT by 2011.

Motivations for forest companies to liquidate forestland holdings vary but were mainly financially driven. These motivations included the need for increases in short-term returns during periods of poor performance (Hickman 2007), avoidance of double-taxation experienced by many forest products corporations (Brody et al. 2009), increasing land values (Fernholz et al. 2007), and forest industry consolidation (Hickman 2007).

Implications of Changing Ownership

The changes in land ownership represented by TIMO and REIT transactions can result in significant changes in the nature of forestland ownership. Considering that TIMOs and REITs often have less of a long-term stake in forestland (Fernholz et al. 2007), unlike forest products companies, there are ongoing concerns about potential environmental and sustainability impacts linked to this new style of forest management (Malmsheimer 2008). Specifically, the growth of TIMOs and REITs raises concerns regarding mass conversion and parcelization of forestland (e.g. subdivisions and development). It has been estimated that over the next three decades, over 44 million acres of timberland will be converted to residential acreage for new housing development (Stein et al. 2005). Even in instances where subdivision does not lead to development, the emergence of small forestland owners often results in restricted access compared to large industrial forestland owners that commonly allow public access (Fernholz et al. 2007).

The obligations of financial return to investors, as experienced by TIMOs and REITs, inevitably influence forest management practices carried out by these organizations. Their short-term focus often leads to plantation forestry which maximizes harvestable volume under short rotation lengths. For instance, in the southern US, where the majority of TIMOs manage forestland, most TIMOs tend to manage their lands for planted pine using high-yield practices. In 2000, 69% of the land managed under TIMOs in the

southern US was managed for planted pine and this figure is estimated to increase to 81% by 2011 (Siry et al. 2001).

FOREST CERTIFICATION

In the absence of stringent forest regulation, voluntary forest certification can aid in providing a baseline level of forest management that considers all forest values, not just timber production and revenue generation. It is also a useful tool that prepares forestland owners for the management of forestlands for carbon offset production. As of 2007, less than half of the TIMOs and REITs managing forestland in the US participated in a third-party certification program, however, the largest TIMOs and REITs tended to participate in either one or both of the major forest certification schemes (Forest Stewardship Council or Sustainable Forestry Initiative) (FSC 2009; SFI 2009). The vast landholdings of TIMO/REITs provides these organizations the ability to "organize against" the more stringent certification scheme, FSC, in favor of the more industry friendly and market-accepted certification scheme, SFI (Correia 2010). The number of TIMO/REIT participants in these certification schemes is thought to increase under three scenarios: 1. market demand for certified products is acknowledged by investors; 2. organizations look internationally for forestland investment opportunities; 3. forestland investment organizations consider investments in carbon sequestration and storage on forestland (Fernholz et al. 2007). Not only does compliance with forest certification provide practices that easily transfer to carbon sequestration and trading (e.g. forest inventory,

management plans etc.), some carbon trading frameworks actually require third-party forest certification (CCX 2009a). Many TIMO/REITs favor SFI because it outlines carbon sequestration activities and satisfies most customers (Correia 2010).

The use of conservation easements has experienced growth within the holdings of TIMOs and REITs. Several partnerships with groups such as The Nature Conservancy and The Conservation Fund, as well as municipalities and state/national parks, have been established with some of the larger players in timber investment (e.g. Hancock Timber, GMO Renewable Resources, and Lyme Timber Company). In many cases, these partnerships involve a combination of conservation easements and managed forestland adhering to third-party certification requirements (Fernholz et al. 2007).

CARBON SEQUESTRATION AND TRADING

Considering the magnitude of forestland holdings by TIMO/REIT's, it is logical to assume that, within current and future carbon trading frameworks, TIMO/REIT's will be influential entities as both a supplier of credits and lobbying force aiming to guide the development of the market (Wear et al. 2008). However, the literature lacks extensive study of TIMO/REITs and their influence on these emerging carbon markets (Bliss and Kelly 2008). The relative likelihood of TIMO/REITs to succeed in these markets can be examined in two ways. On one hand, due to the steadily increasing area of forestland controlled by these organizations, it can be argued that TIMO/REITs manage enough

land to make carbon sequestration profitable across their managed forestlands. This position is also supported in the management literature (Haveman 1993), although opposing theories exist (Hannan and Freeman 1989; Boeker 1997).

A counterargument suggests that the demand for rapid returns placed upon these organizations may limit the diversity of management options available to decision makers. Rather than exploring new markets, the need for short-term returns on investment may promote short rotation lengths, monocultures, crop-style forestry etc. (Stanfield et al. 2003; Bliss and Kelly 2008). Many TIMO/REITs certainly have the capital and land rights to successfully manage for carbon sequestration. The question remains, however, what factors act as motivation and what factors act as hindrances as these organizations strategize forest management options?

Carbon Markets and Forestry Offsets

It is widely posited that a healthy carbon offset market will not develop in the US until the American Clean Energy and Security Act is passed by the Senate and signed into law by the President (EESI 2010). Although the bill passed the House on June 26, 2009, there remains debate over some of its finer points. In particular, law makers are still in the process of developing a list of domestic agricultural and forestry practices that are eligible to generate offset credits within the proposed cap and trade system. The current draft, which allows for a billion tons of domestic carbon offsets, includes forest

management land use changes that increase forest carbon stocks, but this is a point of contention and may be altered before the bill is passed by the Senate (EESI 2010).

The price of US carbon offsets will also dictate the viability of a carbon offset market. The price of carbon, historically, has been both low and quite variable ($1 - $7 per metric ton). However, the price for carbon is expected to increase significantly as cap-and-trade legislation takes effect. The European cap-and-trade system, a model for the American Clean Energy and Security Act, has experienced carbon values as high as $40 per metric ton. It has been estimated that the American Clean Energy and Security Act could increase US carbon prices to between $69 and $137 per metric ton if put into law (Gustafson 2010)

Potential Offset Buyers

Current buyers of carbon offsets (or carbon credits) include a wide array of corporate entities as well as private investors (CCX 2009a). However, assuming that carbon offsets remain attached to the American Clean Energy and Security Act, the majority of offset purchasing will come from CO_2 emitters regulated under the cap-and-trade emissions reduction system (EESI 2010). Much like the Regional Greenhouse Gas Initiative (RGGI), the federally regulated cap-and-trade system will allow large-scale emitters to offset a portion of their annual emissions through the purchase of carbon credits on the open market. Until the necessary legislation passes, however, the market for carbon

offsets will likely remain stagnant. Current buyers tend to purchase carbon credits for either investment opportunities or corporate activities related to corporate social responsibility. The former assume that federal legislation is bound to pass and, therefore, it is prudent to take advantage of relatively low carbon credit prices in the current market. The latter may purchase carbon credits to achieve voluntary carbon neutrality as part of a socially responsible commitment to the environment and/or the community (Frame 2005).

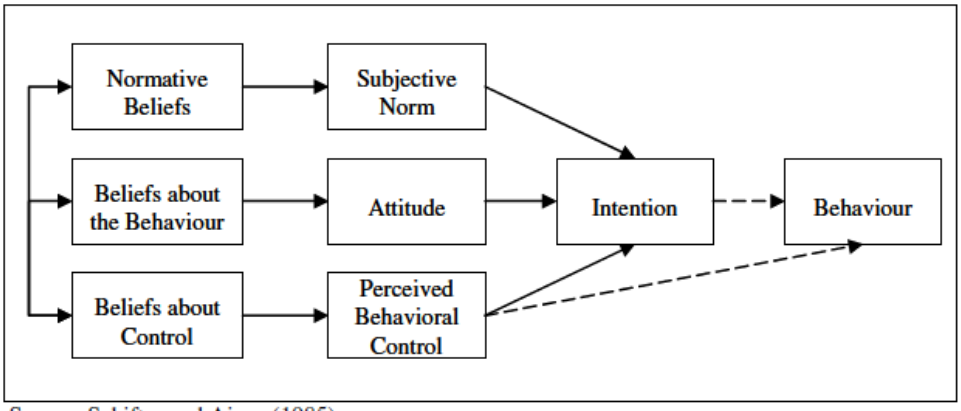
Intentions of Industrial Forestland Owners to Manage for Carbon Offsets

TIMO/REITs have acknowledged the risks involved with forest carbon sequestration as a means of mitigating climate change. These risks include several forms of unintentional release of CO_2 back to the atmosphere due to fire, pests, storms, and land management decisions (Galik and Jackson 2009). However, these risks may be ameliorated by altering land management decisions, creating buffers or "set-asides" to offset any carbon storage lost to natural or man-made disturbance, and/or purchasing insurance (Olander and Murray 2007). Therefore, there are management strategies that may be able to successfully cope with the numerous risks related to forest carbon offset generation. What is lacking, however, is a stable market with suitable rules and regulations under which forestland owners/managers can implement the necessary strategies to participate. Without such a market or framework in place, it is only possible to speculate about the

intentions of large industrial forestland owners to enter a carbon market if one develops (Yancey 2007).

THE THEORY OF PLANNED BEHAVIOR

To examine and better understand the intentions of large industrial forest owners to participate in carbon sequestration, behavioral models such as the Theory of Planned Behavior (TPB) can be applied. The TPB (Ajzen 1991) is as an extension of the Theory of Reasoned Action (TRA) developed by Fishbein and Ajzen (1975). The TPB suggests that a given behavior is dependent upon the intention to perform the behavior, where intentions are dependent upon attitudes towards the behavior, subjective norms (or social pressures), and perceived behavioral control (similar to self-efficacy) (Figure 12).



Source: Schifter and Ajzen (1985)

Figure 12. The Theory of Planned Behavior.

The TPB has been used in a wide range of behavioral studies related to health (Godin and Kok 1996), wildlife and recreation (Martin and McCurdy 2009), recycling (Valle et al. 2005) and forest management decisions regarding reforestation (Karppinen, 2005). A meta-analysis conducted by Armitage and Conner (2001) demonstrated support for the use of the TPB in a multitude of research fields.

Relevant to the current research, the TPB has also been used successfully in business and organizational applications such as environmental management (Cordano and Frieze 2000), adoption of information technology (Harrison et al. 1997), aspirations of business managers (Wiklund and Shepherd 2003), financial reporting (Carpenter and Reimers 2005), electronic commerce adoption (Grandon and Pearson 2004), sales commissions (Kurland 1996), and family business management (Sharma and Chrisman 2003).

As carbon markets develop, TIMO/REITs have expressed interest in participating by managing forestland for carbon sequestration and trading. Many TIMOs in particular have explored the idea in partnership with conservation groups. These partnerships are thought to increase the legitimacy of offset production, however, many of these organizations are skeptical of such endeavors in the absence of a healthy US carbon market (Yancey 2007). Considering the short term pressures for return on investment, it seems unlikely that TIMO/REITs will keep trees growing past the age of economic

maturity for the purpose of carbon offset development unless carbon markets notice an increase in per ton carbon values (Wayburn et al. 2007; Yancey 2007).

H1: Attitudes, subjective norms and perceived behavioral control will positively influence behavioral intentions to manage forestland for carbon offsets.

Additional Variables and Constructs of Interest

As mentioned, large industrial forestland owners have an opportunity in that the expanding size of their land holdings gives these organizations a competitive advantage in the carbon market. Previous research shows that companies with more forestland often have the necessary resources to be accepting of integrated forest management practices (Kreutzwiser and Wright 1990) and open to strategic change (Haveman 1993). However, the pressure of maximizing returns on investment in the short-term may deter TIMO/REITs from participating in the carbon market unless carbon prices increase and stabilize (Stanfield et al. 2003; Bliss and Kelly 2008). Economic "short-termism" (Laverty 1996) should inherently affect managers' attitudes towards any forest management practices that are not necessarily linked to the returns in the short-term.

H2: Organization size will positively influence attitudes and intentions related to forest carbon offset management.

H3: Increasing economic short-termism will negatively influence attitudes towards carbon sequestration and trading.

In the context of institutional theory, pending emissions reduction legislation in the US will undoubtedly influence mangers' decisions regarding the sequestration and trading of forest carbon (Oliver 1991). The current regulatory environment with regards to emissions reduction is uncertain and the availability of economic incentive is unclear. However, pending legislation currently includes provisions for forest carbon offsets. Organizations that believe the American Clean Energy and Security Act will become law may also hold more positive attitudes and higher behavioral intentions related to forest carbon offsets. Similarly, managers that foresee greater opportunity resulting from this legislation may also view forest carbon offsets more favorably. However, legislation notwithstanding, managers may also be motivated by the social and scientific legitimacy of the practice. As the scientific rationale behind forest carbon sequestration as a climate change mitigation tool cannot be supported to a certainty, manager beliefs regarding its effectiveness and acceptance as a legitimate climate change mitigation tool may influence attitudes regarding the implementation of carbon sequestration strategies.

H4: Increasing confidence that the American Clean Energy and Security Act will become law will positively influence attitudes and behavioral intentions related to carbon sequestration and trading.

H5: Increasing perceptions of opportunities linked to the American Clean Energy and Security Act will positively influence attitudes and intentions related to carbon sequestration and trading.

H6: Managers that believe US forest carbon can contribute to the mitigation of climate change are more likely to hold positive attitudes regarding carbon sequestration on their organization's forestland.

THEORETICAL FRAME OF REFERENCE

Previous applications of the TPB (both business and non-business) reveal the adaptability of TPB constructs to decision making processes based on intentions, attitudes, subjective norms and perceived behavioral control. Accordingly, the current research applies the TPB as the theoretical frame of reference by adapting construct measures from both business and non-business applications of the TPB.

Individual constructs within the TPB are measured using both scale-item questions (quantitative) and open-ended questions (qualitative). Although the use of the TPB with qualitative data is uncommon, previous work exists (e.g. Renzi and Klobas 2008; Mynarska 2008). Scales are adapted from previous studies that successfully applied the TPB. Open-ended questions are formulated to allow respondents to provide qualitative measures of each construct. For a complete list of constructs, measures and literature from which measures are adapted, see Table 15. See Figure 13 for the extended TPB model.

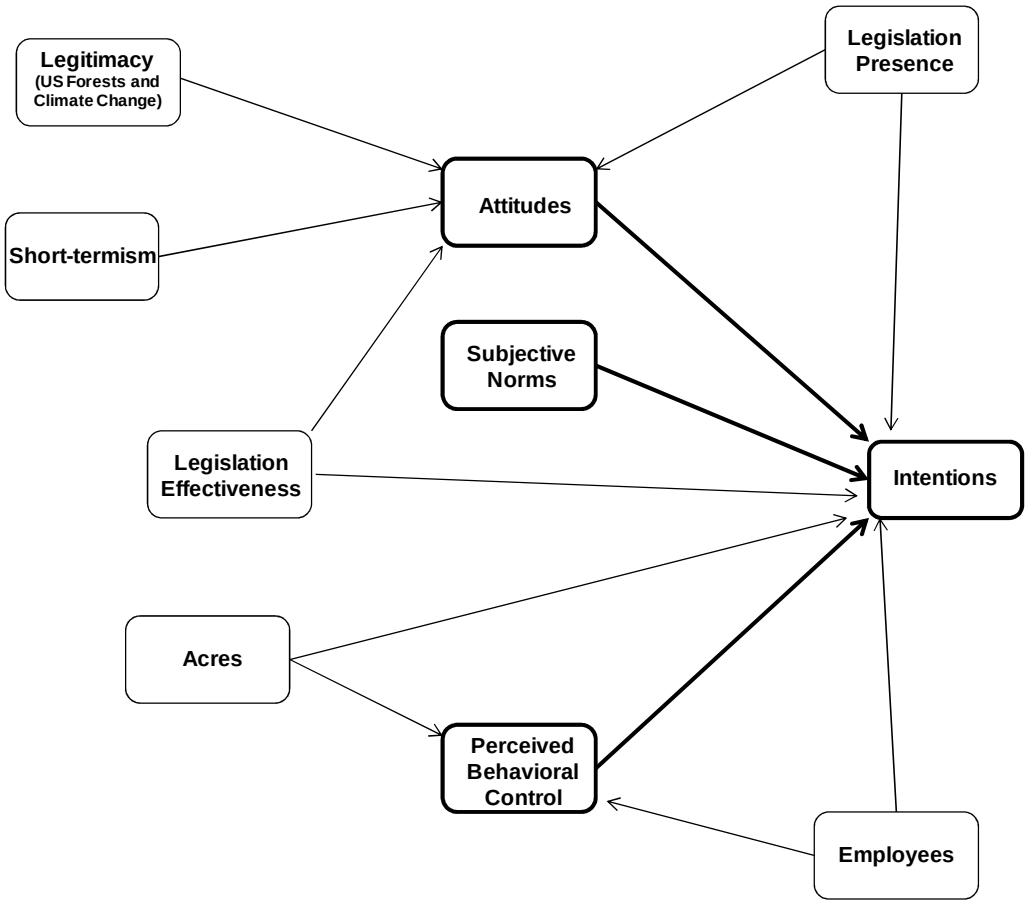


Figure 13. Theorized extension of the Theory of Planned Behavior.

OPERATIONALIZATION OF MODEL CONSTRUCTS

Questionnaire length can have a particularly strong effect on the response rate achieved using web-based questionnaires (Evans and Mathur 2005). The current research employed reduced measures of model constructs to minimize questionnaire length. Table 15 provides a complete list of questions used to measure the core constructs of the TPB. All items were measured using a 5-point scale indicating agreement/disagreement

with relevant statements. The scales ranged from 1 (strongly disagree) to 5 (strongly agree). Respondents were also given the opportunity to elaborate on the scale items by answering open-ended questions.

Intentions to sequester and trade forest carbon were measured using two items regarding plans to manage forestland for carbon values. Attitudes were measured based on four items related to salient beliefs regarding the management of forest carbon offsets. Subjective norms were measured based on three items describing potential normative pressures and actions of similar organizations. Perceived behavioral control was measured based on two control beliefs (organizational and managerial) related to carbon sequestration and trading in their organization.

Table 15. The Theory of Planned Behavior constructs and questionnaire items.

ITEM	Adapted From
Behavioral intentions (BI)	
Qt BI_1 Our organization plans to manage (or is currently managing) our forestland for carbon offset production.	Harland et al. (1999)
BI_2 I intend to manage this organization's forestland holdings for carbon values.	Carpenter and Reimers (2005)
Ql Please describe your organization's plans regarding the management of forestlands for carbon offset production.	Karppinen (2005)
Attitudes (A)	
Qt b_1 Our organization views the management of forestland for carbon offset generation to be a positive business decision.	Karppinen (2005)
b_2 I feel that entering the carbon market is a wise decision for our organization.	Harrison et al. (1997)
b_3 Our organization doubts that a healthy carbon market will develop over the next five years.	
b_4 I view the management of forestland for carbon offset generation to be a positive business decision.	
Ql Please describe your impressions (positive or negative) regarding the management of forestland for carbon offsets.	
Subjective norms (SN)	
Qt nb_1 Other similar organizations are managing their forestland for carbon sequestration and trading.	Karppinen (2005)
nb_2 Other large industrial forestland owners are managing their forestland for carbon offset generation.	Francis et al. (2004)
nb_3 Individuals in the industry whose opinion I value believe managing forestlands for carbon values is a poor business decision.	Harrison et al. (1997)
Ql Please describe what similar organizations are doing with regards to managing forestland for carbon sequestration and trading.	
Perceived behavioral control (PBC)	
Qt cb_1 Our organization has the necessary resources to manage our forestland for carbon offset generation.	Pouta and Rekola (2001)
cb_2 I believe it is possible to make management decisions that will promote carbon offset production on our forestlands.	Harrison et al. (1997)
Ql Please describe the characteristics of your company or the market that promote or hinder your organization's ability to manage your forestlands for carbon values and participate in the carbon market.	

Qt = Quantitative (scale-item); *Ql* = Qualitative (open-ended)

Constructs and corresponding measurement variables used in the extended TPB model can be found in Table 16. Organization size was measured based on acres of forestland managed and number of employees. All other constructs/variables were measured using 5-point scales ranging from 1 (strongly disagree) to 5 (strongly agree). Pressure to provide short-term return on investment (economic short-termism) was measured using one item related to organizational pressure and one item related to pressures felt by the individual manager. Respondents were asked if their organization had identified a market price for sequestered carbon that would make carbon sequestration and storage a feasible business decision. One scale item addressed whether or not the respondent believed that the American Clean Energy and Security Act would become law. An additional two items measured how effective the legislation would be in creating opportunities for carbon offset production. One scale item addressed the manager's belief that US carbon offsets can contribute to the mitigation of global climate change (legitimacy).

Table 16. Extended model constructs and questionnaire items.

ITEM	Sources
Organization Size (OS)	
OS_1 How many acres of forestland does your organization manage	Stanfield et al. (2003)
OS_2 How many employees does your organization employ?	Haveman (1993)
Short-termism (ST)	
ST_1 Our organization feels pressure to provide short term returns on investment.	Fernholz et al. (2007)
ST_2 I personally feel pressure to make management decisions that provide short rather than long-term returns on investment.	
Legislation Presence (LP)	Oliver (1991)
LP_1 I believe the *American Clean Energy and Security Act* is going to be put into law.	
Legislation Effectiveness (LE)	
LE_1 If the *American Clean Energy and Security Act becomes law*, it will create opportunities for our organization to produce forest carbon offsets.	Developed for this study
LE_2 Individuals in our industry tend to think that the *American Clean Energy and Security Act* is going to create opportunities for forest carbon offset generation in the U.S.	
Legitimacy (Domestic Forest Carbon Offsets)	
L_1 I feel that U.S. forest carbon offsets can contribute to the mitigation of global climate change.	Developed for this study
Carbon Prices	
Has your firm identified a price per ton of carbon that would make managing carbon offsets on forestland feasible? (Y/N/Unsure)	Developed for this study
If yes, what is the price (approximately)?	

METHODS

TARGET POPULATION AND SAMPLING FRAME

To examine intentions of large industrial forestland owners to manage forestlands for carbon offset production, the current research targeted managers with influence over the forest resource within all known TIMOs, REITs, and forest products companies with extensive US forestland holdings.

An exhaustive list of TIMOs, REITs, and forest products companies with extensive forestland holdings was supplied by the Forest Landowners Association (FLA). The FLA defined the group as "large industrial forestland owners." Each organization managed at least 30,000 acres of forestland, with the exception of one TIMO that managed only 6,000 acres (removed as an outlier). The list included contact information, including email addresses, for managers within each organization. Managers were consulted regarding the completeness of the list from the FLA resulting in the addition of eight omitted organizations. The final list included, what were defined as, forty-five organizations composed of thirty TIMOs, four REITs, and eleven forest products companies.

DATA COLLECTION

This study employed a combination of quantitative and qualitative techniques. The web-based questionnaire included both closed- and open-ended questions. Closed-ended questions included both ordered and unordered response categories and were used to measure organizational characteristics, perceptions, and behaviors. Open-ended questions were used to qualitatively examine core TPB constructs as they related to carbon sequestration and trading.

Web-based Survey Approach

This study employed a web-based questionnaire as the primary survey instrument. An online questionnaire was developed using SurveyMonkey web-based software. Links to the questionnaire were emailed to members of the target population along with a unique personal identification number (PIN). A PIN was used in order to identify respondents answering the questionnaire. Without the PIN, the respondents were unable to proceed beyond the first page of the online questionnaire. Following Dillman's (2007) four contact email protocol for internet surveys, an email notification explaining the purpose of the study was sent two days prior to sending the questionnaire link and PIN. A reminder/thank-you email, also containing the link and PIN, was sent after a week. Yet another reminder/thank-you email was sent after two weeks. In the event that a recipient was not the most appropriate manager to answer the questionnaire, recipients were instructed to forward the email containing the link and PIN to the most appropriate

manager (i.e. forest resource manager). For each questionnaire item, specific instructions were provided on how to successfully input a response. The questionnaire format allowed respondents to skip questions as well as go back and edit previously answered questions. The software provided a completion bar illustrating the respondent's progress through the questionnaire (e.g. Percent completed). The questionnaire software did not permit a respondent to answer the questionnaire more than once.

STATISTICAL ANALYSES

Quantitative

The relatively small target population and sample size places limitations on statistical analyses. Nevertheless, quantitative statistical analyses included descriptive statistics, comparisons of means (e.g. t-test), correlations, and regression/path analyses based on the extended TPB model. Although small samples are not ideal when applying correlation or regression statistics, small sample sizes do not affect the power of correlations and coefficients but rather the probability of reaching significance by chance (Bonett and Wright 2000). This limitation notwithstanding, correlations and regression were used in the current research to provide a broad sense of relationships between constructs in the model and other variables of interest. All analyses were performed using SPSS statistical software.

Reliability Analysis

Core constructs of the TPB and constructs/variables added to the extended model were tested for reliability. Cronbach's alpha values ≥ .65 indicated acceptable reliability of construct measures (Nunnelly 1970). Provided that Cronbach's alpha *if item deleted* values were less than overall Cronbach's alpha values, and corrected item-total correlations were ≥ .40, reliability was acceptable. Analyses showed reliability within each of the main constructs of the TPB; however, one variable measuring subjective norms was found to increase the overall Cronbach alpha if removed. See Table 17 for reliability analyses related to each construct. It should be noted that, for some constructs, only two variables were measured; therefore, Cronbach alpha *if item deleted* values would be meaningless and are not provided. Perceived behavioral control was measured using two control belief items (organizational and managerial). These items did not correlate; therefore they were applied individually to the extended TPB model.

Table 17. Reliability analysis: core Theory of Planned Behavior model constructs.

Concepts and variables	Mean	Std Dev.	Item Total Correlation	Cronbach Alpha if Item Deleted	Cronbach Alpha
Behavioral Intentions (BI)					.84
BI_1	3.12	0.88	.73	n/a	
BI_2	3.09	0.93	.73	n/a	
Attitudes (A)					.86
b_1	3.12	0.82	.76	.81	
b_2	2.97	0.77	.76	.81	
b_3[c]	2.88	0.74	.65	.83	
b_4	3.33	0.82	.72	.82	
Subjective Norms (SN)					.53
nb_1	2.74	0.75	.50	.13	
nb_2	2.62	0.70	.48	.19	
nb_3[c]	2.85	0.66	.10	.76[a]	
Perceived Behavioral Control (PBC)					.21[b]
cb_1	3.91	0.90	.12	n/a	
cb_2	3.88	0.77	.12	n/a	

see Table 15 for a description of each variable
[a] removed due to Cronbach alpha if item deleted > overall Cronbach alpha
[b] separated into two individual measures due to low correlation
[c] reverse coded

Table 18. Reliability analysis: legislation effectiveness and economic short-termism.

Concepts and variables	Mean	Std Dev.	Item Total Correlation	Cronbach Alpha if Item Deleted	Cronbach Alpha
Legislation Effectiveness (LE)					.67
LE_1	3.38	.65	.51	n/a	
LE_2	3.15	.56	.51	n/a	
Shor-termism (ST)					.82
ST_1	2.03	0.58	.72	n/a	
ST_2	1.94	0.74	.72	n/a	

see Table 16 for a description of each variable

Qualitative

Open-ended questions within the online questionnaire were coded using Nvivo software for qualitative data analysis. Using an iterative process, responses were aggregated and classified into 'free nodes' and higher order 'tree nodes.' Free nodes refer to subthemes noticed within open-ended responses. Tree nodes are broader or higher order themes (Barbour 2008). Frequencies of themes and subthemes were calculated.

The coding process was completed by the principal researcher; therefore, inter-rater agreement was not tested (Miles and Huberman 1994). Thematic responses to each question are presented in frequency tables in order to illustrate their relative importance. Only significant findings are presented (frequency of at least three). Comparisons between responses from open-ended and closed-ended questions acted as a method of triangulation (Yin 1994).

RESULTS

RESPONSE INFORMATION

The initial target population included forty-five industrial forestland owners. After removing one respondent from the target population after reporting less than 30,000 managed acres, the adjusted sample frame included forty-four industrial forestland

owners. Thirty-three organizations responded to the online questionnaire resulting in an adjusted response rate of 75.0%.

RESPONDENT PROFILE

Respondents were asked to provide descriptive information related to firm and employment characteristics in order to allow for further analysis regarding carbon sequestration and trading intentions. Organizations managed between 30,000 and 22,000,000 acres of forestland (mean = 1,996,781) and employed between two and 15,000 employees (mean = 2,660.1). Respondents were in their current position an average of 6.1 years and with their current organization for an average of 13.2 years (Table 19).

Table 19. Respondent profile: forested acres, employees and experience.

Descriptor	Mean	Std. Dev.	Min	Max
Forested Acres	1,996,781.0	4,003,743.0	30,000	22,000,000
Employees	774.5	2,660.1	2	15,000
Years in Postion	6.1	8.3	1	36
Years in Company	13.2	12.0	1	41

The majority of respondent organizations were TIMOs (51.5%), followed by forest products companies (18.2%) and REITS (12.1%). Other organization types were reported by six respondents. The vast majority were privately owned (81.8%) and most managed only domestic forestland (66.7%) (Table 20).

Table 20. Organization descriptors.

Descriptor	n	%	Descriptor	n	%
Organization Type			Ownership Type		
TIMO	17	51.5	Private	27	81.8
Forest Products Co	6	18.2	Public	6	18.2
REIT	4	12.1			
Family Land	2	6.1	International Forests		
Limited Partnership	1	3.0	No	22	66.7
Fund Asset Manager	1	3.0	Yes	11	33.3
Timber Fund	1	3.0			
REIT with TIMO Comonent	1	3.0			

THEORY OF PLANNED BEHAVIOR – QUANTITATIVE RESULTS

The means and standard deviations of core TPB components are displayed in Table 17. Approximately 18% of respondents indicated that their organization currently manages their forestland for carbon offsets (n=6). Based on answers to 5-point agree/disagree scales, responses to the following questions contributed, in part, to the formation of core TPB components (mean values are displayed). For instance, 27% of respondents indicated that their organization plans to manage its forestlands for carbon sequestration and trading (BI_1=3.12). In other words, 27% of respondents responded either 'strongly agree' or 'agree' to statement BI_1.

Measures of overall attitudes regarding carbon sequestration and trading ranged from general perceptions of the practice to specific benefits that might arise from the practice. With regards to perceptions of carbon sequestration and trading as a 'business decision',

30% of indicated that their organization views the management of forestland for carbon offsets as a positive business decision (b_1=3.12). Interestingly, 44% of respondents indicated that they, personally, viewed the management of forestland for carbon offsets as a positive business decisions (b_4=3.34). The mean difference between responses to b_1 and b_4 was found to be significant (t value = -2.24; p = .03), indicating that organizational perceptions regarding the management of forestland for carbon offsets were significantly less positive than those of individual managers with direct influence over the resource.

Responses to questions regarding subjective norms revealed that only 15% of respondents believed that similar organizations are currently managing forestland for carbon (nb_1=2.73). However, only 27% felt that important people in their industry, whose opinion they value, feel that the practice is a poor business decision (nb_3=3.12). Questions related to perceived behavioral control indicated that 82% of the respondents felt that their organization had the necessary resources to manage their forestland for carbon offsets (cb_1=3.97).

The means and standard deviations of some constructs and variables used in the extended TPB model can be found in Table 18. When asked if they felt organizational or personal pressure to deliver returns on investment in the short-term (short-termism), no respondents (0%) reported organizational pressure (p_1=2.03) and only one reported personal pressure (p_2=1.94). Only 24% of respondents believed that the American Clean

Energy and Security Act will pass the Senate and be put into law (LP_1=2.91). However, in the event that the legislation is put into law, 39% believe that the legislation would provide opportunities for their organization to sequester forest carbon (LE_1=3.36). Only 24% believed individuals in the forest sector have the same feelings about opportunities linked to the legislation (LE_2=3.15). Less than half of the respondents (46%) believed that US forest carbon sequestration can contribute to the mitigation of global climate change (L_1=3.06).

Respondents were asked if their organization had identified a price per ton of carbon that would make managing forestland for carbon offsets feasible. Most respondents had not done so, but 27% indicated their organization had established a feasible price. Feasible carbon prices (per ton of sequestered carbon), as reported by respondents, ranged from $10 to $25. Other respondents indicated that a feasible price will vary by property.

RELATIONSHIPS WITHIN THE EXTENDED MODEL

Correlations between core TPB constructs did not follow typical relationships as outlined by Ajzen (1991). As shown in Table 21, intentions significantly correlated with attitudes but did not correlate with subjective norms or perceived behavior control (partial support for **H1**). It should be noted that perceived behavioral control was divided into two measures: 1. Organizational perceived behavioral control (i.e. organization has necessary resources etc.) and, 2. Personal perceived behavioral control (i.e. manager is able to

manage for carbon offsets). Correlations were used to supplement regressions and qualitative findings and did not serve an exploratory function.

Table 21. Correlation matrix: extended Theory of Planned Behavior model

	Intetions	Attutudes	Subjective Norms	Organization PBC	Personal PBC	Acres	Employees	Legislation Presence	Legislation Effective	Short-termism
Intentions	1.00									
Attitudes	.79** <.001	1.00								
Subjective Norms	.24 .18	.14 .44	1.00							
Organization PBC	-.23 .20	-.08 .68	.05 .80	1.00						
Personal PBC	.15 .41	.40* .02	-.25 .16	.21 .23	1.00					
Acres	.16 .38	.19 .29	.50** .004	.39* .03	.11 .55	1.00				
Employees	.21 .25	.16 .38	.07 .70	.27 .13	.40* .02	.52** .003	1.00			
Legislation Presence	.42* .02	.48** .01	-.15 .42	-.04 .82	.19 .30	-.13 .48	-.02 .93	1.00		
Legislation Effective	-.05 .79	.002 .99	.01 .97	-.09 .61	.28 .12	.14 .44	.07 .70	-.06 .76	1.00	
Short-termism	-.10 .60	-.18 .31	.11 .55	.01 .94	.12 .50	-.13 .48	.05 .77	-.18 .33	-.19 .30	1.00
Legitimacy (Clim Chg)	.70** <.001	.62** <.001	.26 .15	-.12 .52	.22 .23	.34 .06	.31 .08	.35* .04	-.05 .79	-.04 .84

** Spearman Correlation significant ($p<0.01$); * Spearman Correlation significant ($p<0.05$)

Regression analyses were performed consistent with hypothesized relationships within the extended TPB model (Figure 14). As found in the correlation matrix (Table 21), of the core constructs, only attitudes showed a significant relationship with intentions to sequester and trade forest carbon. In addition, none of the extended model constructs/variables had a significant effect on intentions. Insignificant relationships

were removed and regressions rerun. R^2 values should be interpreted with care as the sample size is relatively small (n=33). However, β values are measures of relationship comparable to correlation between variables/constructs (Schmid 1955).

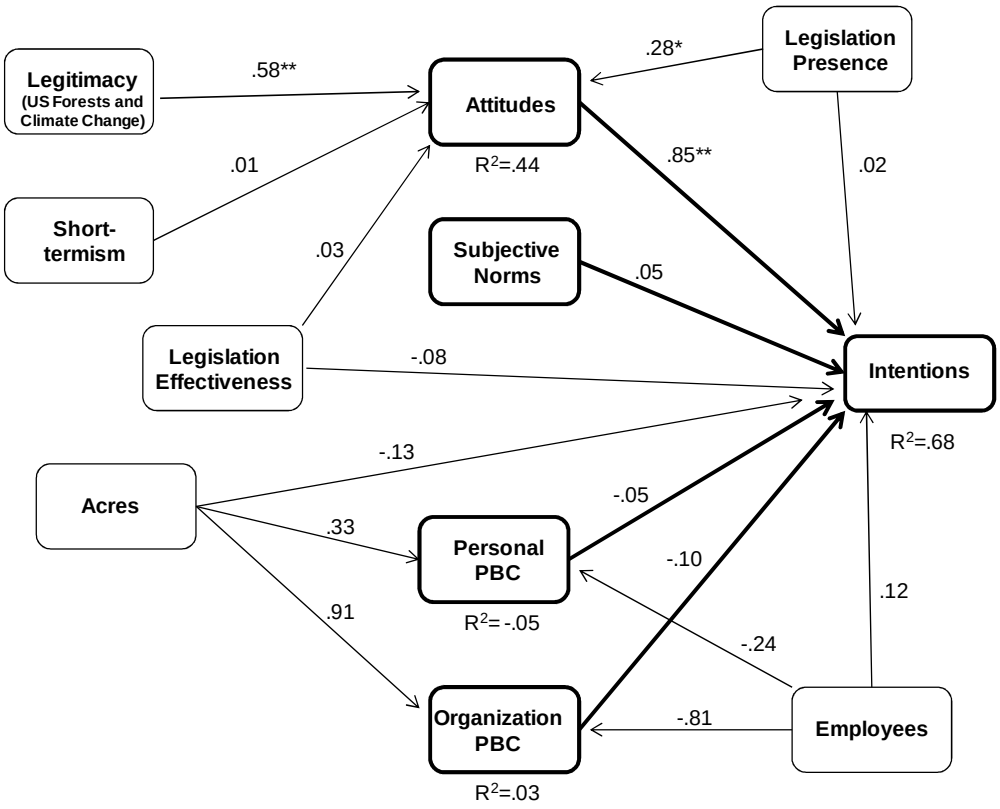


Figure 14. Extended Theory of Planned Behavior model (with insignificant and significant relationships)

Upon removal of insignificant relationships within the extended TPB model, only four variables/constructs remained (Figure 15). As hypothesized and consistent with the classic TBC, attitude had a significant, positive direct effect on intentions (β=.85) (partial

support of **H1**). Respondents' belief that the American Clean Energy and Security Act will become law ('Legislation Presence') positively affected attitudes (β=.28) (support **H4**) as did the belief that US forests can contribute to climate change mitigation ('Legitimacy') (β=.58) (support **H6**). Mediation was tested as outlined in Baron and Kenny (1986) and showed that attitudes fully mediated the relationship between both 'Legislation Presence' and 'Legitimacy' with intentions. Direct effects between the two variables and intentions were significant prior to the addition of attitudes (β=.40 and β=.68, respectively) and insignificant after the inclusion of attitudes (β=.01 and β=.20,respectively).

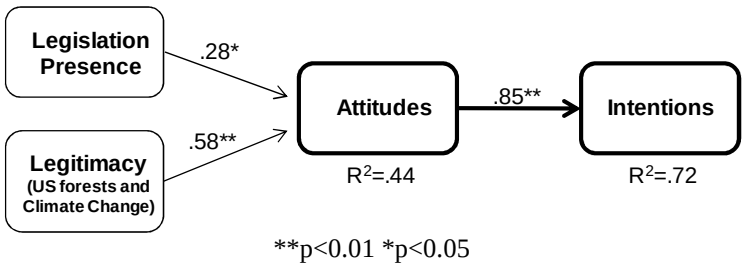


Figure 15. Extended Theory of Planned Behavior model (significant relationships)

THEORY OF PLANNED BEHAVIOR – QUALITATIVE RESULTS

Using the core constructs of the TPB as theoretical framework, open-ended questions from the online questionnaire were classified into themes and subthemes. Significant findings (frequency equal to or greater than three) are presented in Tables 22-25.

Open-ended responses related to current or intended management (behavioral intentions) of forestland for carbon sequestration resulted in three themes: Active, passive and reject (Table 22). Active indicates that the organization is currently participating in or preparing for the development of forest carbon offsets. Passive suggests that the organization is waiting for markets to develop, learning/assessing, or is undecided. Reject indicates that an organization is not currently participating in carbon sequestration and does not plan to do so. Passive themes were most frequently cited (n=27). Passive subthemes most commonly cited suggest that organizations are waiting for carbon prices to increase (n=9) and monitoring policy development (n=8).

> "We will manage for carbon if the revenue stream justifies such action. Management for carbon has to accretive to the investment in order to pursue." *Director Value-Added (TIMO)*

> "Details need to be changed regarding additionality, leakage, and payment for regulated areas before we will seek to monetize carbon on our timberlands." *General Manager Forestry Operations (REIT)*

Table 22. Qualitative themes: behavioral intentions.

Themes	Frequency
Active	**14**
Managing carbon stock	6
Analysis / Planning	5
Currently sequestering/selling carbon	3
Passive	**27**
Waiting for carbon prices to increase	9
Monitoring policy development	8
Assessing / Learning	7
Undecided / Keeping options open	3
Reject	**11**
Regulations will not be favorable	6
Carbon prices will be too low	5

Open-ended questions addressing respondents' attitudes regarding carbon sequestration and trading revealed both positive and negative attitudinal themes (Table 23). Overall, negative belief subthemes (n=63) were reported more frequently than positive belief subthemes (n=20). Negative subthemes most commonly cited related to problematic regulator frameworks (n=31) and carbon offsets being a poor investment (n=23). Commonly cited positive belief subthemes related to optimism that opportunities will develop over time (n=6) and that the science behind forest carbon offsets is sound (n=6).

> "Development of standards and protocols is slow and overly complex and bureaucratic." *Chief Forester (Forest Products Company)*

> "Managing forests for carbon can be an effective strategy for climate change mitigation. However, I expect forest carbon markets to develop slowly over the next ten years. Carbon accounting, additionality, and permanence are complex issues that make it difficult to create a robust regulatory framework for forest carbon."
>
> *Manager, Timber Investments (Investment Management Firm)*

Table 23. Qualitative themes: attitudes.

Themes	Frequency
Positive Attitude	**20**
Opportunities will develop over time	6
The science behind carbon offsets is sound	6
Favorable investment	5
Good for environment/society	3
Negative Attitude	**63**
Regulatory frameworks are problematic	31
Poor investment	23
The science behind carbon offsets is not sound	5
Carbon prices are too low	4

Similar to themes related to current or intended behavior, statements relating to subjective norms were categorized into active, passive and 'no activity' themes (Table 24). Frequency of passive themes was highest (n=18) followed by active (n=8) and 'no activity' (n=6). Most commonly cited passive subthemes included monitoring or evaluating (n=15) and waiting for better market conditions to develop (n=10).

> "I believe our peers are in the early to middle stages of understanding how forest carbon offset projects work, what the voluntary markets can provide, and what a regulated market might look like and mean to their business."
>
> *Acquisitions Manager (REIT)*

> "I have no knowledge of any competitors actually selling credits, although many are studying the prospect. The market for credits is uncertain and there is limited information upon which to make an informed decision."
> *Director (TIMO)*

Table 24. Qualitative themes: subjective norms.

Themes	Frequency
Active	**8**
Sierra Pacific Industries projects	5
Some small scale projects	3
Passive	**18**
Monitoring/Evaluating	15
Waiting for better conditions	10
Learning about the market	3
No Activity	**6**
No significant acres invested	3
Not involved	3

Responses related to perceived behavioral control were categorized into two themes: opportunities and hindrances (Table 25). These themes indicated characteristics that either encourage or hinder organizations with regards to carbon offset production. Opportunity subthemes (n=14) were cited somewhat more than hindrance subthemes (n=12). The most commonly cited opportunity subtheme suggested that organizations had the managerial capacity to sequester and trade forest carbon offsets (n=7). The most common hindrance subtheme was a lack of organizational capacity (n=6).

> "The current carbon market hinders our ability because prices are too low to provide incentive. However, our organization is flexible, entrepreneurial, and experienced at applying science-based actions in the field for a conservation outcome." *Director, Renewable Resources (REIT)*

> "Since we've maintained a high carbon profile in our forests, we have the potential to generate cash by putting up a forest offset project without having to change how we manage. The question is: 'is the value per acre worth the long-term commitment?'"
> *Project Manager (Forest Products Company)*

Table 25. Qualitative themes: perceived behavioral control.

Themes	Frequency
Opportunities	**14**
Managerial capacity	7
Specialized skill set	4
Necessary resources	3
Hindrances	**12**
Lack organizational capacity	6
Require higher carbon prices	3
Require incentives / compensation for risk	3

DISCUSSION

Results from both quantitative and qualitative inquiry suggest that hindrances exist, both economic and regulatory, that influence the intentions of large industrial forestland owners to participate in carbon sequestration and trading. As the extended TPB model suggests, the presence/absence of federally enforced regulation is highly influential on attitudes regarding forest carbon development. Qualitative themes showed that the majority of negative attitude statements identified problems with current or proposed

regulatory frameworks. Therefore, it becomes clear that there may be little investment in forest carbon offsets by industrial landowners without a suitable regulatory framework.

The second hindrance expressed by industrial forestland owners was the unfavorably low price of carbon. The most common explanation for passive behaviors related to carbon sequestration was that organizations were waiting for carbon prices to increase. Given that current prices per ton are less than $1.00 and respondents identified a feasible price range of $10-25, there is little economic incentive to invest in carbon offsets in the current market. It is thought that federal legislation will provide both the stability and market conditions necessary to entice forestland owners to manage forest carbon. Results from this study suggest that industrial forestland owners view the opportunity in that manner.

It has been posited that organizations and managers need to believe in the legitimacy of decisions that might affect society in a broader sense. As shown in the extended TPB model, the perceived legitimacy of forest carbon (as a climate change mitigation tool) is highly influential on attitudes regarding carbon sequestration and trading. While, overall, this perception was not a commonly cited subtheme in the qualitative analysis, the legitimacy of forest carbon offsets as a mitigation tool was the most commonly cited subtheme used to explain positive attitudes towards the practice. Poor legitimacy was also cited, but less frequently. This suggests that personal beliefs regarding the

effectiveness of forest carbon sequestration as a climate mitigation option will influence decision making regardless of the regulatory or market conditions present.

Previous assertions suggested that the reorganization of forestland in the US from forest product companies to TIMOs and REITs would alter return-on-investment dynamics and, thus, augment forest management practices in order to maximize short-term returns. This hypothesis was not supported in the current research, although qualitative data identified subthemes related to the risk of long-term commitments associated with carbon sequestration contracts. However, these concerns were infrequent compared to concerns expressed regarding regulatory and market conditions.

The literature suggests that larger organizations tend to have the necessary resources to support emerging opportunities (e.g. carbon sequestration and trading). If acres of forestland is applied as a function on organization size, the current research does not support this relationship. While larger organizations tended to report higher perceived organizational control beliefs, these beliefs did not influence intentions to participate in the practice.

Overall, the results have illustrated that the current regulatory and market conditions simply do not provide the necessary environment for large industrial forestland owners to commit to alternative forest management practices. Without regulation mandated at the

federal level and more attractive carbon prices, industrial owners are likely to reject an endeavor laden with such uncertainty. Managers are observing and evaluating, but it is unlikely that dedicating forestland to the management of forest carbon will be feasible unless legislation drives the price of carbon and creates a long-term demand for offsets.

CONCLUSIONS

The state of forest carbon sequestration and trading in the United States will be highly dependent upon the emergence of climate change legislation at the federal level. This dependence is illustrated by the results of this study. Both quantitative and qualitative inquiry reveal that industrial forestland owners' attitudes regarding carbon sequestration are highly dependent upon their belief that federal cap-and-trade legislation will develop. Managers within these organizations also utilize their belief in forests as legitimate climate change mitigation tools as an antecedent to these attitudes. Less important factors were subjective norms, perceived behavioral control, economic short-termism and organization size.

LIMITATIONS

Although this study employed an exhaustive list of industrial forestland owners, the target population and respondent pool was small (n=33). This placed limitations on the scope of statistical tests used in this enquiry.

LITERATURE CITED

Armitage, C.J., and Conner, M. 2001. Efficacy of the theory of planned behavior: A meta-analytic review. British Journal of Social Psychology, 40, 471-499.

Barbour, R.R. 2008. Introducing Qualitative Research. London: Sage Publications.

Baron, R.M. and Kenny, D.A. 1986. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. Journal of Personality and Social Psychology, 51(6): 1173-1182.

Bliss, J.C. and E.C. Kelly. 2008. Comparative advantages of small-scale forestry among emerging forest tenures. Small-scale Forestry, 7: 95-104.

Boeker, W. 1997. Strategic change: the influence of managerial characteristics and organizational growth. Academy of Management Journal, 40(1): 152-170.

Bonnet, D.G. and Wright, T.A. 2000. Samples size requirements for estimating Pearson, Kendall and Spearman correlations. Psychometrika, 65(1): 23-28.

Brody, M.J., Kahn, D.O. and Matuszak, E.J. 2009. Real Estate Investment Trust income: selected issues and recent changes in the law. Journal of Taxation and Investments, 62: 45-68.

Butler, B.J., and Leatherberry, E.C. 2004. America's family forest owners. Journal of Forestry, October/November, 4-14.

Cairns, R.D. and Lasserre, P. 2004. Reinforcing economic incentives for carbon credits for forests. Forest Policy and Economics, 6, 321-328.

Carpenter, T.D. and Reimers, J.L. 2005. Unethical and fraudulent financial reporting: applying the Theory of Planned Behavior. Journal of Business Ethics, 60: 115-129.

CCX. 2009a. Chicago Climate Exchange. http://www.chicagoclimatex.com [09 April 2009]

Cordano, M. and Frieze, I.H. 2000. Pollution reduction preferences of US environmental managers: applying Ajzen's Theory of Planned Behavior. Academy of Management Journal, 43(4): 627-641.

Correia, D. 2010. The certified Maine North Woods, where money grows from trees. Geoforum, 41(1): 66-73.

Dillman, D.A. 2007. Mail and Internet Surveys: The Tailored Design Method, 2nd Ed. John Wiley and Sons: Hoboken, NJ, USA. 523 p.

Enironmental and Energy Study Institute (EESI). 2010. Bioenergy, agriculture, and forestry provisions in the American Clean Energy and Security Act of 2009. (www.eesi.org)

Evans, J.R., and Mather, A. 2005. The value of online surveys. Internet Research, 15(2): 195-219.

Fernholz, K., Bowyer, J., and Howe J. 2007. TIMOs and REITs: What, why, and how they might impact sustainable forestry. Dovetail Partners, Inc. (www. dovetailinc.org).

Fishbein, M. and Ajzen, I. 1975. *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Forest Stewardship Council (FSC). 2009. (www.fscus.org).

Frame, B. 2005. Corporate social responsibility: a challenge for the donor community. Development in Practice, 15(3-4): 422-432.

Francis, J.J., Eccles, M.P., Johnston, M., Walker, A., Grimshaw, J., Foy, R., Kaner, E.F.S., Smith, L., and Bonetti, D. 2004. Constructing questionnaires based on the Theory of Planned Behaviour. Centre for Health Services Research, University of Newcastle, UK. ISBN: 0-9540161-5-7.

Galik, C.S. and Jackson, R.B. 2009. Risks to forest carbon offset projects in a changing climate. Forest Ecology and Management, 257: 2209-2216.

Godin, G., Kok, G., 1996. The theory of planned behavior: A review of its applications to health-related behaviors. American Journal of Health Promotion, 11(2), 87-98.

Grandon, E.E. and Pearson, J.M. 2004. Electronic commerce adoption: an empirical study of small and medium US businesses. Information and Management, 42: 197-216.

Gustafson, C. 2010. New Energy Economics. NDSU Agricultural News. (www.ag.ndsu.edu)

Hannan, M.T. and Freeman, J. 1989. Organizational ecology. Cambridge, MA: Harvard University Press.

Harland, P., Staats, H., Wilke, H.A.M. 1999. Explaining proenvironmental intention and behavior by personal norms and the Theory of Planned Behavior. Journal of Applied Social Psychology, 29(12), 2505-2528.

Harrison, D.A., Mykytyn, P.P. and Riemenschneider, C.K. 1997. Executive decisions about adoption of information technology in small businesses: theory and empirical tests. Information Systems Research, 8(2): 171-195.

Haveman, H.A. 1993. Organizational size and change: diversification in the savings and loan industry after deregulation. Administrative Science Quarterly, 38: 20-50.

Hickman, C. 2007. TIMOs and REITs: Situation brief. National Timber Tax Website. USDA.

IPCC. 2000. Special report on land use, land use change, and forestry. Intergovernmental Panel on Climate Change. Geneva, Switzerland. Cambridge Press.

IPCC. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In Pachauri, R.K.& Reisinger, A. (Eds.) Geneva, Switzerland.

Karppinen, H. 2005. Forest owners' choice of reforestation method: an application of the theory of planned behavior. Forest Policy and Economics, 7, 393-409.

Kreutzwiser, R.D. and Wright, C.S. 1990. Factors influencing integrated forest management on private industrial forest land. Journal of Environmental Management, 30(1): 31-46.

Kurland, N.B. 1996. Sales agents and clients: ethics, incentives, and a modified Theory of Planned Behavior. Human Relations, 49(1): 51-74.

Laverty, K.J. 1996. Economic "short-termism": the debate, the unresolved issues, and the implications for management practice and research. Academy of Management Review, 21(3): 825-860.

Martin, S.R., McCurdy, K., 2009. Wilderness food storage in Yosemite: Using the theory of planned behavior to understand backpacker canister use. Human Dimensions of Wildlife, 14, 206-218.

Miles, M.B. and Huberman, A.M. 1994. *Qualitative Data Analysis*. Thousand Oaks, CA: SAGE.

Mynarska, M. 2008. Qualitative studies and the Theory of Planned Behavior. Working Meeting: coordinating comparative qualitative research for the REPRO WP5 European Project, 22-23 September 2008, Max Planck Institute for Demographic Research. Rostock, Germany.

Nunnelly, J.C. 1970. Psychometric Theory. Second ed., 1978. New York: McGraw Hill.

Olander, L.P. and Murray, B.C. 2007. A new opportunity to help mitigate climate change, save forests, and reach development goals. Nicholas Institute for Environmental Policy Solutions, Duke University. NI WP 07-03.

Oliver, C. 1991. Strategic responses to institutional processes. Academy of Management Review, 16(1): 145-179.

Oreskes, N. 2004. The scientific consensus on climate change. Science, 306: 1686.

Pouta, E., and Rekola, M. 2001. The Theory of Planned Behavior in predicting willingness to pay for abatement of forest regeneration. Society and Natural Resources, 14, 93-106.

Renzi, S. and Klobas, J.E. 2008. Using the Theory of Planned Behavior with qualitative research. Carlo F. Dondena Centre for Research on Social Dynamics. Working Paper No. 12.

Schmid, J. 1955. Regression coefficients vs. correlation coefficients. The Journal of Experimental Education, 23(4): 379-381.

Sharma, P. and Chrisman, J.J. 2003. Succession planning as planned behavior: some empirical results. Family Business Review, 16(1): 1-15.

Shifter, D.B., and Ajzen, I. 1985. Intention, perceived control, and weight loss: An application of the theory of planned behaviour. Journal of Personality and Social Psychology, 49(3), 842-851.

Siry, J.P., Cubbage, F.W., and Malmquist, A.J. 2001. Potential impacts of increased management intensities on planted pine growth and yield and timber supply modeling in the south. Forest Products Journal 51(3): 42-48.

Stanfield, B.J., Bliss, J.C. and Spies, T.A. 2003. Landownership and landscape structure: a spatial analysis of 66 Oregon Coast Range watersheds. Landscape Ecology, 17(8): 685-697.

Stein, S., McRoberts, R., Alig, R., Nelson, M., Theobald, D., Eley, M., Dechter, M., and Carr, M. 2005. Forests on the edge: housing development in America's private forests. US Forest Service, General Technical Report. PNW-GTR-636.

Sustainable Forestry Initiative (SFI). 2009. (www.sfiprogram.org).

Valle, P.O.D., Rebelo, E., Reis, E., and Menezes, J. 2005. Combining behavioral theories to predict recycling involvement. Environment and Behavior, 37, 364-396.

Wayburn, L.A., Franklin, J.F., Gordon, J.C., Binkley, C.S., Mladenoff, D.J., and Christensen, N.
L. 2007. Forest Carbon in the United States: Opportunities & Options for Private Lands. The Pacific Forest Trust.

Wear, D.N., J.G. Greis and N. Walters. 2008. The Southern Forest Futures Project: Using public input to define the issues. USDA Forest Service, Working Paper. (www.srs.fs.usda.gov/futures)

Wiklund, J. and Shepherd, D. 2003. Aspiring for, and achieving growth: the moderating role of resources and opportunities. Journal of Management Studies, 40(8): 1919-1941.

World Resources Institute (WRI). 2009. The American Clean Energy and Security Act: Key elements and next steps. [http://www.wri.org Accessed 03 August 2009].

Yancey, H. 2007. Effective instruments for Timber Investment Management Organizations (TIMO) cooperation with conservation groups. Master's Thesis, Duke University.

Yin, R.K. 1994. Case study research: designs and methods (2 ed. Vol. 5). Thousand Oaks, CA: SAGE.

CHAPTER 6 - GENERAL CONCLUSIONS

The primary motivation behind this research was to address an important knowledge gap related to the potential use of sequestered forest carbon as a climate change mitigation tool. As illustrated in Chapter 2, previous investigation has addressed many of the questions that have arisen since forest carbon sequestration was first discussed as a viable climate change mitigation tool. However, there was little extant work addressing the intentions of private forestland owners to manage their forestlands for carbon sequestration and trading. This gap was addressed in the context of US forestland owners (industrial and non-industrial) using survey methodology.

The studies outlined in Chapters 3, 4 and 5 make important contributions to the field. Chapter 3 and Chapter 5 successfully quantify commonly cited anecdotal evidence regarding the current practices of private forestland owners with regards to carbon sequestration and trading. As expected, few owners are engaged in a rather underdeveloped and financially unattractive market at time of publication. Intentions to engage in such behavior were measured within a theoretical framework based on the Theory of Planned Behavior (TPB). The TPB model performed as hypothesized for non-industrial private owners and a reduced model was found to be effective for industrial owners. In both cases, attitudes towards carbon sequestration and trading practices were significant predictors of behavioral intentions to implement the practice.

In both Chapters 3 and 5, the TPB models were extended in order to more completely measure intentions to sequester forest carbon. The study of non-industrial owners added measures of innovativeness, perceived risk, knowledge (of carbon sequestration and trading), and environmental orientation. Although significant direct effects on behavioral intentions were found, these added constructs had a greater explanatory effect on attitudes regarding the behavior. The study of industrial forest owners added measures related to impending cap and trade legislation, the legitimacy of domestic forest carbon as a climate change mitigation tool, economic short-termism, and organization size. Only perceptions regarding the likelihood of cap and trade legislation and the legitimacy of domestic forest carbon as a mitigation tool were found to be significant predictors of attitudes leading to behavioral intentions to manage forestland for carbon sequestration and trading.

The management of natural resources inevitably incurs the influence of human connectedness with the natural environment. Although the decision to manage forestland for carbon values undoubtedly carries with it economic considerations, Chapter 3 illustrates the influence of environmental ideology on this decision by non-industrial owners. One would expect the weight of economic consideration to be even greater in the context of industrial forestland managers due to obligations to owners, shareholders and employees. However, Chapter 5 suggests that environmental ideology influences carbon sequestration attitudes in these owners as well. More influential on attitudes than

the emergence of suitable cap and trade legislation was the legitimacy of domestic forest carbon as a climate change mitigation tool. Therefore, as adequate carbon markets develop, both industrial and non-industrial owners will need to balance economic benefit and personal or organizational environmental beliefs.

Given that few non-industrial owners currently sequester and trade forest carbon or plan to do so, Chapter 4 focused on attitudes regarding the practice and aimed to identify differences in attitudes due to land characteristics, land use plans, and demographics. Unlike industrial owners, increasing acreage size negatively influenced attitudes towards carbon sequestration. This relationship, however, was not entirely due to conflicting land use plans as owners reporting plans to harvest timber held more positive attitudes regarding carbon sequestration and trading. Perhaps *capacity to manage* provides a better explanation for positive attitudes towards carbon sequestration; a theory supported by the negative influence of absentee ownership on attitudes.

As expected, quantitative and, to a greater extent, qualitative results suggest that industrial respondents have a more sophisticated and comprehensive understanding of carbon sequestration and trading than non-industrial owners. Overall, industrial owners report a passive interest in the prospect of forest carbon management, citing a poor regulatory framework and insufficient returns on investment as primary concerns. Key to

a transition from passive to active involvement will be the passing of domestic cap-and-trade legislation with sufficient opportunities for domestic forest carbon offsets.

CONTRIBUTIONS

The key contributions of this research to the advancement of theory lie within the explanatory and predictive capabilities of the models developed from the TPB in relation to the carbon trading phenomena. It should not be stated that these models provide a complete understanding of the processes leading to behavioral intentions of forestland owners to participate in carbon sequestration and trading; however, the current research provides the foundations for further enquiry in an otherwise understudied field.

In particular, results of this research advance the understanding and measurement of attitudes towards carbon sequestration by forestland owners. In the case of non-industrial owners, additional constructs (innovativeness, perceived risk, knowledge and environmental orientation) explained a substantial amount of variance found in attitudes (Chapter 3). Additional analyses suggest that land characteristic, land use planning, and demographics have significant effects on attitudes as well. These findings expand both the array of suitable applications of the TPB and enhance our understanding of the processes that influence the formation of attitudes towards carbon sequestration and trading.

The application of an extended TPB model to organizations within the forest sector is a novel addition to the literature. Although many of the core constructs did not act as hypothesized, the model provides an adequate framework for initial inquiry (qualitative and quantitative) into the intentions of large industrial forestland owners to manage land for carbon sequestration and trading. The data contests common assertions regarding the influence of economic short-termism experienced by large industrial owners on their management decisions. Instead, findings suggest that market conditions and the legitimacy of forest carbon offsets play a significant role in the decision making process of these organizations.

Future Research

The current research suggests that the TPB provides a suitable framework for investigation related to carbon sequestration and trading on US private forestlands. Results from this work are relevant in the context of approximately 63% of the forestland in the US. The remaining area of forestland is publicly managed at either the state or federal level. Extending the current research to measure intentions held by public agencies (e.g. USDA Forest Service) to manage forestland for carbon would provide a comprehensive data set for each of the key players in the domestic forest carbon offset market and address current actions, planned actions, and influential factors.

A review of the literature reveals no similar studies conducted outside of the US. Mirroring the current research in other countries could reveal interesting disparities between influential factors found domestically and abroad. Given their similarities in resource management, common financial markets, and comparable responses to climate change, a comparison between Canada and the US is especially relevant. Canada has delayed the development of a national cap-and-trade framework in hopes of participating in a cap-and trade system initiated by the US. Relevant to this research, perhaps the most notable distinction between the two countries is the preponderance of public land in Canada.

As the international community continues to work collectively to devise and revise climate change mitigation strategies, the public will likely remain a key stakeholder. Absent from the literature is survey research investigating public perceptions of forest carbon sequestration as a mitigation tool. In time, policy makers may have less control over established emission targets and increasing control over the means by which targets are met. A survey of societal members' perceptions of forest carbon sequestration as a mitigation tool compared to, for example, geo-sequestration, biofuels and/or nuclear power, will provide policy makers with a societal perspective and allow for the development of more agreeable mitigation strategies.

Finally, the scientific community agrees that the practicality and stability of forest carbon sequestration varies substantially throughout the world, especially longitudinally. Similarly, types of forest carbon offsets (e.g. reforestation, enhanced forest management, conservation easements, REDD) are not considered to be equivalent in many cases. A survey of carbon trading frameworks (domestic and international) could contribute to the literature by illustrating the variability in offset acceptance due to sequestration method and origin.

LIMITATIONS

As noted in Chapters 3 to 5, there were several limitations to this research. The survey of non-industrial forestland owners was limited by a sample frame that was not completely representative of the target population. However, this was addressed by comparing characteristics of sample frame respondents to data obtained from the National Woodland Owner Survey. The industrial forestland owner sample frame did not encounter the same limitation. Overall, familiarity with carbon sequestration and trading was quite low, resulting in frequent 'neutral' responses to questionnaire items. However, sufficient non-neutral responses were provided to allow for statistical analysis and distribution was found to be normal.

Constraints on the length of the questionnaire limited the number of questionnaire items used to measure latent constructs. In the case of environmental orientation, for example,

the number of belief variables was reduced by one for both biocentric and anthropocentric orientations. These constraints were present in both the mail and web-based questionnaires, thus, limiting the validity of the constructs in each model. Finally, carbon sequestration and trading, if considered in terms of a 'product life cycle,' is in an *introduction* or perhaps *growth* stage. As markets emerge and develop, the behavioral processes leading to intentions to sequester carbon will likely change over time. Care should be taken when comparing results from this study to data collected in a mature market.

Given the environmental focus of the questionnaires used in this research, there is potential for social desirability bias, or the tendency of respondents to reply in a manner that will be viewed favorably by others. However, given that carbon sequestration and trading is defined neither a positively or negatively within the distributed questionnaires, the potential for social desirability bias is minimized.

APPENDICES

Appendix A. Mail Questionnaire: Non-industrial Private Forestland Owners (Chapters 3 and 4)

Opportunities for alternative sources of income from U.S. forestlands: A survey of private forestland owners

A Study by the College of Forestry at Oregon State University and the Institute for Culture and Ecology

This questionnaire is part of a project investigating non-timber income opportunities from private forestlands. The study is particularly focused on ecosystem services and forest carbon sequestration and their importance to forestland owners. Please know that your participation is greatly appreciated and is important for the success of the project. The results of the study will directly influence education programs designed for forestland owners. Your responses will be completely anonymous. If you choose, you can provide contact information at the end and we will provide you with study results. We appreciate your willingness to participate and thank you for your time.

Helpful Definitions (before you start):

Carbon Sequestration: the planting or management of trees and forests to remove and store atmospheric carbon.

Carbon Trading: the purchase and/or selling of stored carbon as a tradable unit. Scientists believe that atmospheric carbon is one of the main causes of global warming.

Ecosystem Services: benefits people obtain from ecosystems/forests (e.g. water quality, biodiversity)

Nontimber Forest Product (NTFP): all wild, wild-simulated, and cultivated species harvested from forests, other than species for industrial wood/timber products. Some examples include wild mushrooms, moss, salal, maple syrup, huckleberries, firewood, native seeds, ginseng, birch bark, pine nuts, and transplants or nursery stock.

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OSU Oregon State University

Institute for Culture and Ecology

CSREES

Questionnaire begins next page

Section 1: Land Ownership, Characteristics and Management

1. How many acres of land do you currently own? _____ acres

2. How long have you owned your land? _____ years

3. Is your home (primary residence) on the forestland that you own? *(check one)* ☐ Yes ☐ No

If No, how often do you work on or visit your forestland? *(check one)*
☐ Daily ☐ Weekly ☐ Monthly ☐ Every 2 - 6 months ☐ Every 7 – 12 months ☐ Less than once per year

4. In what state(s) is your forested land located? *(please write all that apply)* _____

5. What percentage of your land is: *(please fill in percentages for each)*

Covered by softwood tree species (e.g. pine, fir, spruce, larch, cedar, etc.)? _____%
Covered by hardwood tree species (e.g. oak, maple, ash, beech etc.)? _____%
Riparian, marsh, swamp, estuary, or wetland _____%
Non-forested agricultural land _____%

6. What are your plans for your forested land in the next five years? *(check all that apply)*

☐ leave it as is
☐ harvest sawlogs or pulpwood
☐ sell some or all of my forestland
☐ other (specify)_____
☐ give some or all of my forestland to my children or other heirs
☐ collect nontimber forest products
☐ no plans at this time

7. Have you ever had a timber cruise (inventory) done on your forestland? ☐ Yes ☐ No ☐ Unsure

8. Do you currently have a written management plan for your forestland? ☐ Yes ☐ No ☐ Unsure

If yes, does your management plan include a section on: *(check one for each)*

a) Nontimber forest products?	☐ Yes	☐ No	☐ Unsure
b) Ecosystem services?	☐ Yes	☐ No	☐ Unsure
c) Carbon sequestration?	☐ Yes	☐ No	☐ Unsure

9. Is there a conservation easement on any of your forestland? ☐ Yes ☐ No ☐ Unsure

10. Is any of your forestland certified under the following programs?: *(check any that apply)*

☐ Forest Stewardship Council (FSC)
☐ Sustainable Forestry Initiative (SFI)
☐ American Tree Farm System (ATFS)

11. Please indicate your level of agreement with the following statements *(circle one number for each statement)*:

	Strongly Agree	Moderately Agree	Neither	Moderately Disagree	Strongly Disagree
I tend to use new forest management techniques before my fellow forestland owners.	5	4	3	2	1
I am able to implement new management strategies used by other forestland owners.	5	4	3	2	1
I consider ideas about management practices from external sources to be critical to the sound management of my forestland.	5	4	3	2	1
I actively seek new forest management practices.	5	4	3	2	1

Section 2: Carbon Sequestration and Trading on Forestland

Definition - Carbon Sequestration: the management of trees and forests to remove and store atmospheric carbon.

12. Do you currently manage your forestland for forest carbon sequestration? ☐ Yes ☐ No ☐ Unsure

13. Without using outside sources, please indicate whether you think the following statements are true or false.
(please circle one for each)

	Quite Confident this is True	Slightly Confident this is True	Neutral	Slightly Confident this is False	Quite Confident this is False
Any forestland owner can enter the carbon trading market.	5	4	3	2	1
The largest voluntary carbon market in the U.S. is the Chicago Climate Exchange.	5	4	3	2	1
Forest carbon is traded in units called 'Forbons'.	5	4	3	2	1
Only softwood tree species are eligible for carbon credits.	5	4	3	2	1
Forest carbon sequestration and trading can be done without a written management plan.	5	4	3	2	1

14. Please indicate your level of agreement with the following statements (*circle one number for each*):

	Strongly Agree	Moderately Agree	Neither	Moderately Disagree	Strongly Disagree
I plan to use (or continue to use) at least part of my forestland for carbon sequestration.	5	4	3	2	1
I intend to participate in the forest carbon trading market.	5	4	3	2	1
I plan to take (or have already taken) the necessary steps to use my forestland for carbon sequestration.	5	4	3	2	1
I am interested in exploring carbon sequestration opportunities on my forestland.	5	4	3	2	1
I feel positively about the possibility of participating in carbon sequestration and trading on my forestland.	5	4	3	2	1
In the long term, carbon sequestration and trading can increase the revenue generated from my forestland.	5	4	3	2	1
Participating in forest carbon sequestration and trading helps minimize climate change.	5	4	3	2	1

15. Please indicate your level of agreement with the following statements *(circle one number for each)*:

	Strongly Agree	Moderately Agree	Neither	Moderately Disagree	Strongly Disagree
It is possible to participate in carbon sequestration and trading on my forestland.	5	4	3	2	1
I think I can manage my forestland for carbon sequestration values.	5	4	3	2	1
I have the necessary financial resources to manage my forestland for carbon sequestration.	5	4	3	2	1
The characteristics of my forestland are suitable for forest carbon sequestration.	5	4	3	2	1
Incentives are currently available to assist forestland owners with forest carbon sequestration and trading.	5	4	3	2	1

16. Please indicate your level of agreement with the following statements (*circle one number for each*):

	Strongly Agree	Moderately Agree	Neither	Moderately Disagree	Strongly Disagree
Carbon sequestration would improve other forest values on my land (e.g. scenery, naturalness, tree quality).	5	4	3	2	1
In the short term, carbon sequestration and trading will provide increased revenue from my forestland.	5	4	3	2	1
The cost of managing my forests for carbon sequestration is too high.	5	4	3	2	1
I may notice a decrease in revenue from my forestland if I participate in carbon sequestration.	5	4	3	2	1
The price of forest carbon credits is unpredictable.	5	4	3	2	1
Sequestering carbon may decrease the dollar value of my land.	5	4	3	2	1
Sequestering carbon may prevent me from managing my forestland for other values that are important to me.	5	4	3	2	1

17. Please indicate your level of agreement with the following statements *(circle one number for each)*:

	Strongly Agree	Moderately Agree	Neither	Moderately Disagree	Strongly Disagree
Most people important in my life would approve of my participation in forest carbon sequestration and trading.	5	4	3	2	1
Friends believe I should participate in forest carbon sequestration and trading.	5	4	3	2	1
Most forestland owners I know are involved in (or considering) carbon sequestration on their land.	5	4	3	2	1
Family members believe I should participate in forest carbon sequestration	5	4	3	2	1
Forestry professionals and/or forest management associations believe I should participate in forest carbon sequestration and trading.	5	4	3	2	1
Neighbors (adjacent landowners) believe I should participate in forest carbon sequestration and trading.	5	4	3	2	1
Most people important in my life think that I should participate in forest carbon sequestration and trading.	5	4	3	2	1

18. If you were to consider participating in forest carbon sequestration on your forestland, please indicate the importance you would place on each of the following factors:
(circle one number for each):

	Very Important	Important	Neither	Unimportant	Not at all Important
Increased revenue generation from forestland in the short term	5	4	3	2	1
The opinion of family members.	5	4	3	2	1
Participation in carbon sequestration to minimize the effects of climate change.	5	4	3	2	1
The opinion of neighbors or adjacent landowners.	5	4	3	2	1
Increased revenue generation from forestland in the long term.	5	4	3	2	1
The opinion of other forestland owners	5	4	3	2	1
Improvement of other forest values on my land (e.g. scenery, naturalness, tree quality).	5	4	3	2	1
The opinion of forest management associations and forestry professionals.	5	4	3	2	1
The costs of managing my forest for carbon sequestration.	5	4	3	2	1
The opinion of friends.	5	4	3	2	1

19. If you were to consider participating in forest carbon sequestration on your forestland, please indicate the importance you would place on each of the following factors:
(circle one number for each):

	Very Important	Important	Neither	Unimportant	Not at all Important
Having the necessary financial resources to manage forestland for carbon sequestration.	5	4	3	2	1
Your forestland having the necessary characteristics for forest carbon sequestration.	5	4	3	2	1
Maintaining steady revenue from your forestland.	5	4	3	2	1
Volatility of forest carbon prices.	5	4	3	2	1
Maintaining the financial value of your land.	5	4	3	2	1
Managing your forestland for other values that are important to you.	5	4	3	2	1

20. Please indicate your agreement with the following statements *(circle one number for each)*:

	Strongly Agree	Moderately Agree	Neither	Moderately Disagree	Strongly Disagree
Nature's primary value is to provide products useful to people.	5	4	3	2	1
The primary value of forests is to provide timber, grazing land, and minerals for people who depend on them for their way of life.	5	4	3	2	1
The primary value of forests is to generate money and economic self-reliance for communities.	5	4	3	2	1
Forests are valuable only if they produce jobs and income for people.	5	4	3	2	1
My understanding of the steps required to participate in forest carbon sequestration and trading is quite good.	5	4	3	2	1
Forests have value, whether people are present or not.	5	4	3	2	1
Forests have as much right to exist as people.	5	4	3	2	1
Nature has as much right to exist as people.	5	4	3	2	1
Wildlife, plants and people have equal rights to live and develop.	5	4	3	2	1
My knowledge of forest carbon sequestration and trading is quite good.	5	4	3	2	1
Climate change is a legitimate threat to humans.	5	4	3	2	1
Humans are responsible for climate change.	5	4	3	2	1

21. Indicate how useful the following sources of information might be regarding carbon sequestration/trading and ecosystem services: *(circle one for each)*

	Very Useful	Somewhat Useful	Not Very Useful	Not at all Useful	I Don't Know
Publications, books, or pamphlets	5	4	3	2	1
Forest landowner newsletters or magazines	5	4	3	2	1
Forest industry newsletters or magazines	5	4	3	2	1
Websites	5	4	3	2	1
Conferences or workshops	5	4	3	2	1
Video tapes / DVDs for home viewing	5	4	3	2	1
Television or radio programs	5	4	3	2	1
Video conferences/webinars	5	4	3	2	1
Social networking sites such as Facebook or LinkedIn	5	4	3	2	1
Visiting other woodlands or field trips	5	4	3	2	1
Talking with foresters or natural resource professionals	5	4	3	2	1
Talking with other woodland owners	5	4	3	2	1
Talking with family members or friends	5	4	3	2	1
Forest landowner association meetings or events	5	4	3	2	1
Universities / Extension	5	4	3	2	1

22. Are you planning to receive or currently receiving income from your forestland for any of the following?
(circle Y or N for each)

	Planning to Receive Income		Currently Receiving Income	
Rights for the collection, testing and use of genetic material from a designated area on your land	Y	N	Y	N
Nontimber forest product harvesting rights on your land	Y	N	Y	N
Research permits for collecting specimens and/or taking measurements on the vegetation on your land	Y	N	Y	N
Hunting, fishing or gathering permits for wild species	Y	N	Y	N
Ecotourism use such as charging others to enter your land to observe wildlife, camp or hike, or other recreation	Y	N	Y	N
Conservation easements	Y	N	Y	N
Conservation land lease	Y	N	Y	N
Tradable wetland mitigation credits	Y	N	Y	N
Tradable development rights	Y	N	Y	N
Tradable biodiversity credits	Y	N	Y	N
Credits for carbon sequestration in trees	Y	N	Y	N
Credits for carbon sequestration in soil	Y	N	Y	N
Credits for carbon sequestration in non-tree vegetation	Y	N	Y	N

23. Have you ever been approached by a professional from any kind of organization about any of the possible income sources from your forestland listed in the previous question (#22)? *(check one)*

☐ Yes ☐ No ☐ Unsure

Section 4: Demographic Information

24. How many persons are in your household? Adults 18 yrs and older _____ Children (under 18 yrs) _____

25. How many household members have:
Full-time, off-forest/farm employment? _____ Part-time, off- forest/farm employment? _____

26. Do any household members receive other regular payments (e.g. social security, disability, job-related pensions, or low-income assistance)? ☐ Yes ☐ No ☐ Unsure

27. Have you ever received government subsidy payments (e.g. farm subsidies)? ☐ Yes ☐ No ☐ Unsure

28. What is your age: _____ years

29. Are you: ☐ **male** or ☐ **female** *(please check one)*

30. What is the highest level of formal education have you completed? *(check one)*
☐ Less than high school diploma ☐ High school diploma ☐ 2-year associates degree / trade school
☐ 4-year college degree ☐ Advanced degree beyond 4-year degree

31. What is your race? *(check all that apply)*

☐ American Indian ☐ Asian ☐ Black or African-American
☐ Native Hawaiian or other Pacific Islander ☐ Spanish/Latino ☐ White ☐ Other (specify) _____

32. Are you retired? *(check one)* ☐ Yes ☐ No ☐ Semi-retired

33. What is your main occupation (if retired, what was your main occupation)? *(please write)* _____

34. Which of the following broad categories best describes your current approximate *annual household* income before taxes? *(check one)*

☐ Less than $15,000 ☐ $15,000 - $34,999 ☐ $35,000 - $49,999 ☐ $50,000 - $74,999
☐ $75,000 - $99,999 ☐ $100,000 - $129,999 ☐ $130,000 -$149,999 ☐ $150,000 - $199,999 ☐ $200,000 +

35. Would you be willing to be contacted in the future for: *(check all that apply)***:**
☐ A follow up interview?
☐ Distribution of resources developed from this project?

If *yes* to either question, please include your contact information. Your contact information will not be identifiable with your questionnaire responses.
Name Address Email Phone

If you have any comments regarding this questionnaire, please feel free to write them below. Any feedback which may improve the value of this survey process to you and your fellow forestland owners would be greatly appreciated.

_____
_____
_____
_____

THANK YOU FOR YOUR COOPERATION AND FEEDBACK

Appendix B. Online Questionnaire: Industrial Forestland Owners (Chapter 5)

Forest Carbon Offsets: A Survey of Large Industrial Forestland Owners

1. PIN verification

Thank you for taking the time to complete this questionnaire. Your feedback is invaluable to the completion of our research project.

* **1. *Please enter the 3 digit PIN included in the email that delivered the link to this questionnaire:**

2. Your Organization

1. Please indicate the type of organization in which you work:

- ◯ REIT
- ◯ TIMO
- ◯ Forest Products Company
- ◯ Other

Other (please specify)

2. Describe the ownership of your organization:

- ◯ Private
- ◯ Publicly Traded

3. How many acres of forestland does your organization manage?

4. Does your organization manage forestlands outside of the United States:

- ◯ Yes
- ◯ No

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5. Approximately what percentage (%) of your organization's forestland is certified by:

	0%	1 - 20%	21-40%	41-60%	61-80%	81-100%
Forest Stewardship Council (FSC)	◯	◯	◯	◯	◯	◯
Sustainable Forestry Initiative (SFI)	◯	◯	◯	◯	◯	◯
Other	◯	◯	◯	◯	◯	◯

Other (please specify)

6. How many people does your organization employ?

3. Your Position

1. What is your job title?

2. For how many years have you been:

In your current position?

With your organization?

4. Carbon Sequestration and Trading

1. Does your organization currently manage its forestland for carbon offset production?

◯ Yes

◯ No

◯ Unsure

2. Please indicate your agreement/disagreement with the following statements related to carbon sequestration and trading:

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Our organization plans to manage (or is currently managing) our forestland for carbon offset production.	◯	◯	◯	◯	◯
I intend to manage this organization's forestland holdings for carbon values.	◯	◯	◯	◯	◯

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3. Please describe your organization's plans regarding the management of forestlands for carbon offset production: (optional)

5. Carbon Sequestration and Trading

1. Please indicate your agreement/disagreement with the following statements:

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Our organization views the management of forestland for carbon offset generation to be a positive business decision.	◯	◯	◯	◯	◯
I feel that entering the carbon market is a wise decision for our organization.	◯	◯	◯	◯	◯
I believe that the American Clean Energy and Security Act is going to be put into law.	◯	◯	◯	◯	◯
If the American Clean Energy and Security Act becomes law, it will create opportunities for our organization to produce forest carbon offsets.	◯	◯	◯	◯	◯
Our organization doubts that a healthy carbon market will develop over the next five years.	◯	◯	◯	◯	◯
I feel that U.S. forest carbon offsets can contribute to the mitigation of global climate change.	◯	◯	◯	◯	◯
I view the management of forestland for carbon offset generation to be a positive business decision.	◯	◯	◯	◯	◯

2. Please describe your impressions (positive or negative) regarding the management of forestland for carbon offset generation.

6. Carbon Sequestration and Trading

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1. Please indicate your agreement/disagreement with the following statements:

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Other similar organizations are managing their forestland for carbon offset generation.	◯	◯	◯	◯	◯
Other large industrial forestland owners are managing their forestland for carbon offset generation.	◯	◯	◯	◯	◯
Individuals in the industry whose opinion I value believe managing forestlands for carbon values is a poor business decision.	◯	◯	◯	◯	◯
Individuals in our industry tend to think that the American Clean Energy and Security Act is going to create opportunities for forest carbon offset generation in the U.S.	◯	◯	◯	◯	◯

2. Please describe what similar organizations are doing with regards to managing forestland for carbon sequestration and trading:

7. Carbon Sequestration and Trading

1. Please indicate your agreement/disagreement with the following statements:

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Our organization has the necessary resources to manage our forestland for carbon offset generation.	◯	◯	◯	◯	◯
I believe it is possible to make management decisions that will promote carbon offset production on our forestlands.	◯	◯	◯	◯	◯

2. Please describe the characteristics of your organization or the carbon market that promote or hinder your organization's ability to manage your forestlands for carbon values and participate in the carbon market:

8. Carbon Sequestration and Trading

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1. Has your organization identified a price per ton of carbon that would make managing for carbon offsets feasible on your forestland?

- ◯ Yes
- ◯ No
- ◯ Unsure

2. If Yes, and if you feel comfortable sharing this information, please indicate the price per ton (US$/ton). Feel free to enter a range - e.g. $4-7:

9. Carbon Sequestration and Trading

1. Please indicate your agreement/disagreement with the following statements:

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Our organization feels pressure to make management decisions that provide short-term rather than long-term returns on investment.	◯	◯	◯	◯	◯
I personally feel pressure to make management decisions that provide short-term rather than long-term returns on investment.	◯	◯	◯	◯	◯
I feel that managing forestland for carbon offsets will only result in long-term returns on investment.	◯	◯	◯	◯	◯

10. Follow-up Interview

1. Would you be willing to participate in a short (~15 minutes) telephone interview regarding the management of forestland for carbon values?

- ◯ Yes
- ◯ No

If yes, please enter your name and email address and we will contact you to schedule an interview

11. Thank You

Forest Carbon Offsets: A Survey of Large Industrial Forestland Owners

THANK YOU FOR TAKING THE TIME TO COMPLETE OUR QUESTIONNAIRE. WE APPRECIATE YOUR FEEDBACK.

1. If you would like to leave comments/suggestions regarding this questionnaire, please feel free to do so in the text box below.