

An Assessment of Lake States Landowner Interest in Selling Forest Carbon Credits

by

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Abstract

Forests serve as important terrestrial carbon sequestration sinks. In response to industry, individual, and state/regional commitments to reduce emissions of carbon dioxide, carbon is now a commodity that can be sold in the marketplace. Practices that enhance sequestration ability can generate carbon credits that can be sold to entities wishing to offset emissions.

The nation's family forest lands, representing 40 percent of the nation's forest land, can be an important contributor to carbon sequestration efforts. Yet very little is known about how family forest landowners view programs that enable them to sell carbon credits generated from the growth of their forest and the compensation level required to encourage meaningful levels of participation among the nation's family forest owners. To address this information gap, we conducted a contingent valuation study to identify and quantify family forest landowner interest in participating in a voluntary carbon market-trading program in the Lake States. A mail survey was administered to 2,200 randomly selected family forest owners in Michigan, Wisconsin, and Minnesota. The questionnaire assessed landowner interest in participating in a hypothetical carbon credit program at certain compensation levels and sought information on landowner objectives, perspectives and forest land characteristics.

A total of 850 usable responses were used to develop a profile of Lake States family forest owners, estimate required compensation levels, and determine how various program characteristics influence a landowner's interest in participating. A logistic regression model was developed to examine the factors affecting participation in a forest carbon offset project by family forest owners. Results showed that carbon program characteristics, alongside landowner and parcel characteristics, are associated with the decision to participate in a carbon credit program. Specifically, payment amount, contract length, gender, value placed on other nonmarket forest amenities, need for additional income, attitude toward climate change, absentee status, land tenure, and total acres owned were found to be significant determinants. Models were run using all respondents as well as only with those respondents indicating a high certainty in their answer. The study's findings and implications for future forest carbon policy will be discussed in this report.

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1. Introduction

As the United States looks toward future climate policy, there is interest in carbon markets, trading, and sequestration as a means of reducing emissions of greenhouse gases (GHGs).¹ If future discussions determine that cap and trade is the appropriate means to address this issue, it is likely that carbon offset projects will figure prominently in proposed legislation. If carbon is regulated via other policy measures (i.e. national carbon tax, emission caps or mandatory regional and state initiatives), the need for activities that can offset, in a quantifiable way, the emissions of other entities may still play an important role. Irrespective of the source and scale of carbon credit demand, carbon offsetting is a nascent industry in the United States and there is great uncertainty as to the potential supply of carbon credits from domestic offset projects and future ability to meet demand.

Carbon offsets are created when a certain amount of carbon emissions are sequestered or reduced in one location in order to compensate for, or *offset*, an emission made elsewhere. A **carbon credit** is the commodity unit that is created for the market and signifies one metric ton of reduced or sequestered carbon (measured in dioxide-equivalents [CO₂e]). Offsetting lowers the cost of an initiative by reducing an equivalent amount of carbon emissions at an uncapped industry or location, or by sequestering (absorbing) carbon underground or in plants and trees, when doing so at the primary emission location is not feasible or considered cost prohibitive.

Forests are major carbon sinks (storehouses) that can release or sequester (absorb) carbon dioxide (CO₂) and other GHGs depending upon the activity undertaken. Forestry activities have great potential as one of the largest-volume and lowest-cost means of sequestering carbon and generating offsets (Galik et al. 2009, Gorte & Ramseur 2010). Currently, the 731 million forested acres contained within the United States are able to sequester 192.7 billion metric tons of CO₂ (31% stored in trees, 59% in forest soil) (Birdsey, 1992) which is equivalent to 10 percent of United States CO₂ emissions (USDA NRS 2011). By enhancing current forest management practices, or by creating additional forested area, this percentage can be improved upon.

Individual and family forest landowners own 42 percent (262 million acres) of the timberland in the United States (Butler and Leatherberry, 2004). Given their numbers, they are a potentially rich source of carbon offset credits IF they are willing to participate in such a market. At present, little is known regarding this audience's views and opinions toward carbon offset projects, their willingness to participate, and the types of incentives or compensation they would require. More information is needed in order to better assess the requirements necessary to induce their participation. As past federal carbon reduction initiatives have **assumed** that an exponential increase in domestic carbon credits will occur if certain regulatory measures are implemented, it is imperative that research is conducted with the populations most likely to be a source of carbon offsets in order to check the validity of these assumptions.

¹ Greenhouse gases: Gases that trap heat in the atmosphere are often called greenhouse gases and include carbon dioxide (CO₂), methane(CH₄), nitrous oxide(N₂O), and other ozone depleting gases (i.e., CFCs, HCFCs, and halons).

2. Study Objectives

2.1 Purpose

When making future decisions regarding climate and other natural resource policy, it is important to understand the factors that influence the likelihood of participation by various stakeholders. Landowner attitudes and opinions regarding carbon credit program requirements will affect whether they choose to participate in an offset project. The payment amount offered, the types of assistance available and made known, as well as other program characteristics, all will play a part in how these decisions are made. Regarding private forest landowners, who make up 40% of our national forest land base, the answers to these questions largely remained unanswered.

The role family forest owners may play in future carbon sequestration efforts and the supply of offsets may be best ascertained by direct interaction with this audience. It is essential to understand the objectives, goals, and intentions of this audience. Does a forest carbon offset project fit with their ownership objectives and if so, what type of incentives or compensation would be required to encourage participation? As previous constructions of possible national climate bills have relied on virtually untested projections (EPA 2005), it is necessary to check their accuracy with “real-life” data gathering. The purpose of this study was to gauge supply of carbon offsets that could be expected from a specific but representative audience—Family Forest Owners in the Lake States.

2.2. Central Questions

The research questions addressed were: (1) How does family forest owner interest in participating in a carbon credit trading program vary at different carbon credit compensation and time commitment levels? (2) How do owner, forest land tract, and carbon credit-trading program characteristics affect family forest owner interest in participating in a carbon credit-trading program? (3) Do any qualitative descriptions/themes of private forest owner opinions toward carbon credit projects emerge?

In order to analyze the results of the survey, a statistical model was developed to estimate family forest owner interest in participating in a carbon credit offset project. Logistic regression was used to determine which landowner characteristics increase the odds that a landowner will participate in a forest offset project and the probability that a landowner will participate at different compensation levels and under different landowner, parcel, and program characteristics. Building on the previous pilot study (Fletcher et al. 2009), we evaluated the willingness of family forest landowners to participate in carbon offset projects in the Lake States and the levels of compensation that would be required. Quantitative assessments of how landowner characteristics, attitudes, and program attributes could affect carbon offset participation were made.

Specifically, our study investigated and sought answers to the following questions:

1. What direct payment compensation levels are required by private family forest landowners in order to incentivize participation in forest management carbon offset projects in the Lake States?
2. Do certain landowner characteristics (e.g. tract size, absentee status, management plan) or carbon trading attributes (e.g. contract length, payment amount offered) affect whether or not landowners in the Lake States are interested in participating in forest offset projects?
3. Can opportunities and barriers related to family forest owner participation in forest offset projects be identified?

2.3. Significance of Research

The research questions addressed in our study are consistent with the needs identified in the Forest Service's Global Change Research Strategy 2009-2019: "Evaluate the social acceptance of carbon management policies and management practices." The results of our study can aid in estimating the potential supply of domestic forest carbon offsets by private, nonindustrial landowners. Very few studies have examined likely private landowner responses to potential incentives and program requirements for carbon related forest ecosystem services.

Case studies detailing domestic and regional-specific carbon reduction capacities are listed as one of the key research needs for climate change policy listed by The Center for International Environment and Resource Policy/Tufts University (Mathys et al. 2010). Such research is needed in order to "provide specific situational insights into the requisite domestic policy steps for achieving a transition to a low-carbon future" (Mathys et al. 2010).

Currently, very little information exists regarding family forest owner attitudes toward forest carbon credit programs. To our knowledge, only two such studies have been conducted to date—both in the state of Massachusetts. A small pilot study, involving 17 self-selected, private landowners in Massachusetts, interviewed participants and had them rate six carbon credit program alternatives (Fletcher et al. 2009). An extension of this study, investigating Massachusetts landowner preferences toward the same carbon program attributes explored in the pilot study, was carried out with a much larger sample using a mail survey (Dickenson et al. 2011).

Building on the study by Fletcher et al. (2009), this study explored the issue of carbon offset projects and carbon credit trading with a much larger geographic audience—family forest owners in the Lake States.² It also investigated more payment and contract length options as well as additional variables. The case study site chosen contains a large percentage of family owned forest land and is characterized by landowners who fit the profile of family forest landowners in other parts of the nation. These similarities offer the possibility of broad scale-wise comparisons and applications to the nation as a whole.

² Lake States: Michigan, Minnesota, and Wisconsin. This region is heavily forested and is populated by landowners closely resembling the demographics of the average forest landowner in the nation.

The results of this study may be used to provide direction to agencies seeking to improve carbon storage in family forest lands and/or increase the supply of forest carbon offsets. It also has implications for future carbon policy and federal, state and regional decisions regarding carbon credit protocol and registries. Finally, it may provide information to those wishing to assist family forest owners who are interested in pursuing carbon management or initiating forest offset projects.

2.4. Assumptions/Study Boundaries

In evaluating the study responses, certain assumptions were made. It was assumed that all participants understood the questions being asked of them (extra effort was extended to ensure that questions were not confusing to participants by administering a pre-test within the same audience). It was also assumed that participants answered all questions honestly (no coercion, etc.).

The study concentrated on domestic carbon sequestration management and markets as related to those project opportunities available to family forest owners. The project did not explore international forest offset projects and prevention of deforestation in developing countries (i.e. REDD).

The proposed study did not contemplate the ethics of carbon offsets or the challenges and controversy surrounding issues of additionality and leakage. As current national policy is undecided, the study did not represent, or attempt to recommend, any particular policy position. Instead, information was provided to landowners using a neutral tone.

3. Background

3.1. Demand for Carbon Offsets

3.1.1. Federal Policy Initiatives

The current administration had expressed a desire for a market-based cap on United States carbon polluting emissions (Obama Proposal 2009) but may relegate the regulation of CO₂ to the U.S. Environmental Protection Agency (EPA) through the Clean Air Act (Obama 2012 Budget Plan NPR 2011). Several bills addressing the issue of climate change have previously been considered by Congress.³ Another regulatory proposal includes a carbon tax (pollution fee) for CO₂ emitters alongside a subsidy (benefit) for sequestration offset activities. Much is undecided at the present moment. However, it is assumed that at some future date, carbon emissions will be regulated in the United States in some form or another.

³ Waxman-Markey bill, now called the American Clean Energy and Security Act of 2009 (ACES), is a comprehensive cap-and-trade bill. Forestry management is an allowed offset project (ACES 2009). Kerry-Lieberman Bill (or the American Power Act of 2010) is another comprehensive cap-and-trade bill that would allow domestic forest sequestration offset projects (APA 2010).

3.1.2. State and Regional Initiatives

The lack of a federal climate policy notwithstanding, several states and regions have already moved forward to create their own carbon reduction initiatives. The Regional Greenhouse Gas Initiative (RGGI) is one regional compliance initiative that has been agreed to by ten northeastern and mid-Atlantic states (RGGI, 2010). The Western Climate Initiative⁴, covering seven western states and four Canadian provinces, has also set regional reduction targets (WCI 2011). The Midwestern Greenhouse Gas Reduction Accord is a similar initiative that includes six Midwestern states and one more Canadian Province (WRI 2007). Most significantly, California's Air Resources Board (CAR) adopted cap-and-trade regulation in December of 2011. The program will begin January 1, 2013, and run through 2020 (CARB 2011a). Forest carbon offsets are included in the plan and allowable forest projects can be located anywhere within the contiguous United States (CARB 2011b). While the future demand for forest-related carbon credits from California alone may outstrip expected supply⁵, it is expected that other states/regions may follow California's lead and include forest offsets in initiatives of their own—further driving demand (C2ES 2012).

3.1.3. Voluntary Market Initiatives

Concurrent with compliance market initiatives, a growing awareness of climate issues has led some businesses to seek ways of reducing emissions by purchasing offsets on the **voluntary** carbon market. Participation in the voluntary market is driven by a variety of motivations from altruistic concerns about the environment to perceived marketing advantages to preparedness for expected future compliance. Companies engage in the voluntary market for the following reasons:

- **To reach voluntary corporate carbon reduction targets**
 - especially if internal reductions are not feasible or cost-effective
- **To create internal incentives for reductions**
 - by internalizing the cost of carbon and putting financial pressure on managers
- **To gain carbon market experience**
 - and increase authority and influence in policy discussions about carbon regulation
- **To prepare for potential regulation**
 - requiring a range of offset approaches
- **To enhancing brand name and/or differentiate products**
 - possibly with the aim of offering products at a price premium
- **To attract investors**
 - especially those concerned with the risks of a carbon-constrained future

⁴ Western Climate Initiative: an initiative started by states and provinces along the western rim of North America to voluntarily combat climate change. Partners are required to set an overall regional goal to reduce emissions, develop a market-based mechanism to achieve goal, and participate in a GHG registry. Slated to begin 1/1/2012.

⁵ When other sectors (e.g. transportation, natural gas and related fuels.) come under CARB's cap in 2015, ICFI Analysts predict that there will not be enough offset projects available to meet demand, even though no emitter can use more than 8% for compliance (Ryan, *AOL Energy News* 2/7/2012)

- **To enhance intelligence**

- better awareness of production process, inputs and waste data”

(Ecosystem Marketplace 2008)

The voluntary market accommodates diverse projects, a variable numbers of buyers and sellers, and encourages the production of those projects that have environmental “co-benefits”⁶ (House of Commons 2007). Voluntary offsets are generally over-the-counter (OTC) transactions but can be sold in an exchange market. Currently, there is a wide variety of participants, prices, transaction types, and projects involved in the voluntary market with little government involvement in the form of limited consumer protection and technical assistance.

Forestry projects are desirable to those businesses purchasing voluntary carbon offset credits because, while reducing carbon, they also improve water, wildlife, esthetics, which useful when telling their carbon reduction “narrative”⁷ (Lovell et al. 2007). Projects that have appeal for marketing reasons generally are paid a higher premium on the voluntary market. For example, landfill methane projects that remove methane and simply flare it to remove GHGs are accepted for compliance market credits and may be sold on the voluntary market. Landfill methane projects involve a “cut and dried process”—CO₂ equivalents are easily measured and permanent so additionality⁸ can be proven. The offsets produced are fungible because the credits from one methane reduction process are the same as another and therefore can be sold on an exchange market like any other commodity. But such a project only removes carbon. Other projects that remove carbon PLUS provide other environmental side benefits, such as forestry carbon offset projects, offer a narrative with the credit that is more desirable, and therefore often worth more, to purchasers. Because of this, it is expected that the demand for forestry carbon credits will continue on the voluntary market.

3.1.4. General Carbon Sequestration Demand

While efforts around the globe are being extended toward finding revolutionary methods of mitigating climate change, forest carbon sequestration is a method that exists in the immediate term. As pointed out by Pacala and Socolow (2004), the fundamental scientific and technological ability already exists to solve the carbon problem for the next half-century if we choose to implement these solutions. Increasing the ability of forests to sequester carbon is one of the *15 major methods* mentioned in their report. Regardless of the governmental carbon reduction policy ultimately decided upon, whether it is cap and trade or something else entirely, it is expected that the demand for measureable increases in carbon sequestration ability (such as carbon offsets provide) from technologies that can be immediately implemented (such as forestry) will extend well into the future.

⁶ Environmental co-benefits: Other ecosystem services that can be provided alongside carbon sequestration such as: wildlife habitat, recreation, improved water quality, esthetics, protection from soil erosion, buffer zones.

⁷ **Carbon Offset Narrative:** description of a particular carbon offset project that relays the type of project, where it is located, how it is benefiting the community, etc. It is considered the “story” of the carbon offset project.

⁸ **Additionality:** the amount of carbon sequestered beyond business-as-usual efforts.

3.2. Current Supply of Carbon Offsets

There are gaps in the literature regarding current carbon offset supply levels. As carbon reduction currently remains, with the exception of regional or state initiatives, a voluntary measure, no single regulatory body is responsible for administrative oversight and the registering of carbon credits traded. The RGGI program has a regional registry but, to date, allowances have been sufficient to meet current demand and no offsets have been issued (GAO 2010). Information on the number of offsets sold in very recent years is incomplete.

3.2.1. EPA Projections of Carbon Offset Supply (Current and Future)

The current supply of carbon credits would provide 1 percent of the offsets anticipated in recently discussed federal bills. EPA *model projections* of carbon mitigation potential (used previously to determine carbon reduction strategies) are based on assumptions of carbon offset supply at various price points for different activities. For instance, at the lowest price points (\$1 and \$5/Mt CO₂eq—constant prices over time), agricultural soil management, followed by forest management, are determined to have the highest carbon sequestration potential (see Table 1). Forest management is the leading strategy at the mid-range (\$15/Mt CO₂eq) but afforestation is projected to supply the greatest CO₂ mitigation potential at the highest prices modeled (\$20 and \$50/Mt CO₂ eq). More research is needed in order to better quantify price points and, therefore, make more reliable projections regarding potential supply.

Table 1. EPA model predictions of national GHGs mitigation potential for the years 2010 to 2110 according to the activity undertaken: *Annualized averages are used with constant prices over time assumed.* Prices listed are \$/Mt CO₂ eq and the total quantity of GHGs mitigated is listed as Tg CO₂ eq per year net emissions reduced below baseline, annualized over the time period 2010 to 2110 (EPA 205b).

Activity	\$1	\$5	\$15	\$30	\$50
Afforestation	0	2.3	137.3	434.8	823.2
Forest management	24.8	105.1	219.1	314.2	384.8
Agricultural soil carbon sequestration	62	122.7	168	162.4	130.6
Fossil fuel mitigation from crop production	20.5	31.9	53.1	77.6	95.7
Agricultural CH ₄ and N ₂ O mitigation	9.4	15.2	32	66.8	110.2
Biofuel offsets	0	0.1	57.2	374.6	560.9
All activities combined	116.8	277.3	666.7	1430.4	2105.4

3.3. Forestry Carbon Offsets

3.3.1. Forestry Methods Used to Sequester Additional Carbon

There are a number of forestry activities that can enhance the ability of lands to sequester carbon. Afforestation, which involves the establishment of a forest on land that has traditionally been in an unforested state, is one practice. Reforestation, which involves the re-establishment of forest in an area currently unforested but historically forested, is another method. A third technique is through improved forest management which may include but is not limited to: increased tree rotation length, stimulated tree growth, and establishment of fast growing trees. Finally, avoided deforestation, or the prevention of forest land from being converted to an unforested state, is another method.

3.3.2. Forest Management Carbon Offsets

Increasing sequestration ability by improving **forest management** practices is one method of offsetting carbon emissions that shows much promise for the immediate term (US EPA 2005). In the fourth IPCC report, forest management was cited as the mitigation strategy able to generate the largest sustained benefit by increasing forest carbon stocks, while producing a sustainable yield of timber or energy from biomass (Nabuurs et al. 2007). Managed forest carbon credits are generated by managing a forest such that its growth rate and/or the total carbon stored in trees increases. The increase in carbon sequestration rates due to changes in forest management practices vary from 2.1 to 3.1 t CO₂/acre/year depending on the site (e.g. tree species, age, size class, climate, topography, and soil productivity) and specific protocol undertaken (Row 1996).

Traditional silvicultural practices aimed at increasing the volume of wood produced can also increase the carbon storage capacity of trees. Therefore, managed stands are able to sequester carbon at a faster rate than stands of the same species left to “business-as-usual” growth (Birdsey 1992). Many scholars feel that one of the most effective ways to sequester forest carbon is by letting the forest continue to grow older and so delayed rotations are often prescribed (Skog and Nicholson 1998; Carey et al. 2001; Paw et al. 2004; Luysaert et al. 2008).

However, others feel that if carbon stored in products is counted as sequestration, a managed forest can periodically add carbon to products while allowing a forest to continue to regenerate and grow following harvest (Van Deusen 2010). Regardless of the carbon management plan chosen, a forest carbon offset project must be specifically designed to measurably improve the sequestration ability of the forest in question.

3.3.3. Co-benefits Associated with Forest Carbon Offset Projects

An advantage of forest carbon offset projects is that they provide benefits that other alternative carbon storage/reduction methods (i.e. underground sequestration, methane capture and storage) do not provide.

Additional Benefits provided by forest carbon offsets:

Alongside carbon sequestration, forests can provide other ecosystem services such as:

- Wildlife habitat.
- Recreation.
- Improved water quality.
- Esthetics.
- Protection from soil erosion.
- Buffer zones.
- Forest products: **timber** for long-lived wood products (LLWP), biomass for energy, firewood, mushrooms, nuts, medicinal herbs, syrup, basketry and floral supplies.

3.3.4. Quantification of the Sequestration Potential of Forestry Activities

While much of the United States is heavily forested and is storing vast quantities of carbon, there is still an opportunity to increase these amounts (Rhemtulla et al. 2009). Studies estimate that while United States forests annually sequester the equivalent of 10 percent of United States carbon emissions from the burning of fossil fuels, various forestry activities could sequester another 100 to 200 Tg C/year (1 Teragram = 1 million metric tons) (Smith and Heath 2004, US EPA 2005, Birdsey et al. 2006). If this metric is then applied to family forest lands in particular, the physical sequestration supply boundary⁹ for private forest lands, which provide 59 percent of the nation's forest carbon sequestration potential, is equal to 59 to 118 TgC/yr (USDA Forest Service 2010).

3.4. "Typical" Forest Offset Project Requirements

As carbon credit trading is an emerging industry, and the United States is not a signatory to the Kyoto Protocol, several differing carbon registries and protocols (both at the federal and state level) are currently in development and no specific carbon offset standard has been settled upon. However, an extensive literature review of the various carbon registries and protocols currently in existence, or being considered, reveals several consistencies such that a listing of the "typical carbon offset project" requirements can be given. To enroll forest land in a carbon credit program, a landowner may be required to:

1. *Sign a contract and commit to participating for a specific period of time.* Current carbon protocols list contract length requirements that vary from 15 to 100 years. We chose to vary the contract length from 15 to 50 years.
2. *Obtain an initial forest inventory by a professional forester.* This would include a detailed list of the types, size, and quality of trees on the land.
3. *Obtain and follow a forest management plan.* Work with a professional forester to develop and implement a plan.
4. *Certify their forest.* Several forest certification programs are accepted depending upon the particular registry.

⁹ Physical Sequestration Supply Boundary: the total potential for sequestration that the laws of nature will allow. (i.e. the natural boundary of sequestration potential).

5. *Manage land consistent with carbon storage principles.* For example, delay harvest to allow more carbon to be stored in trees, carry out certain forest management practices, and reduce removal of dead biomass.
6. *Keep a written record of the land management activities undertaken.*
7. *Allow verification and periodic monitoring by an independent third party.* These would be conducted generally every 2 to 5 years.
8. *Convey a conservation easement.* The landowner may be required to record a covenant with the property deed. This is a legal transfer of the land's development rights to a third party.

In studies of other landowner decisions, payment and contract length were important predictors of participation (Stevens et al. 2002, Kilgore et al. 2008, Layton and Siikamaki 2009, Levert et al. 2009, Matta et al. 2009, Lin 2010). Therefore, based on these studies, the willingness to accept valuation question focused on carbon credit payment amount and contract length. Landowner attitudes toward other potential requirements were assessed using a different question format.

3.5. Family Forest Landowners

3.5.1. Previous Research on Family Forest Owner Interest in Forest Carbon Markets

An examination of previously published studies revealed a paucity of literature related to private family forest owners' willingness to participate in forest carbon offset projects. As this group of forest landowners could have a significant impact on the future supply of carbon offsets, especially in the immediate term, information related to landowner attitudes and opinions on this topic is especially necessary and relevant. To our knowledge, only two such studies have been conducted to date—both in Massachusetts.

An initial pilot study was conducted with 17 landowners using a focus group format (Fletcher et al. 2009). Researchers asked landowners to reveal their preference for carbon credit program attributes by rating various potential programs. The attributes included whether a management plan was required, whether withdrawal penalties were enforced, contract length, and compensation amount. Results of this study found that landowners favored having no management plan requirement, higher carbon credit payments, and no early withdrawal penalty. Somewhat surprising, the study found that landowners favored longer contract lengths. However, the 10-year commitment considered in the study as a long commitment period is at the short end of many carbon credit programs in operation today.

An extension of the Fletcher et al. study was carried out in Massachusetts with a much larger sample and using a mail survey format (Dickenson et al. 2011). This study also asked family forest owners to reveal their preference for certain forest carbon credit program attributes by rating different hypothetical programs. The attributes varied were the same as those varied in the earlier Fletcher et al. (2009) study. Each landowner was asked to rate (on a scale of 1 to 10) three different "bundled" programs with a total of 12 program variations being included in the study. Results were analyzed using an ordered logit discrete choice model. Consistent with the Fletcher et al. study, this study found that landowners favored those programs that did not require a management plan, had higher carbon credit payments and did not have early

withdrawal penalties. Contrary to the Fletcher et al. study, landowners in the larger study did not favor longer contract periods. This study investigates the attitudes of landowners towards carbon credit programs with a much larger geographic audience (family forest owners in the Lake States) and incorporates more payment and contract length options as well as additional variables.

3.5.2. Family Forest Landowners—General Attitudes and Opinions

While very few studies have explored the attitudes and opinions of family forest owners toward projects that increase the carbon sequestration ability of their forests, there is a relative abundance of studies exploring family forest owner attitudes towards ownership in general. The consensus reached by a majority of studies is that, contrary to previous (“traditional”) owners of forest land, the new breed of forest owner generally does not purchase timberland in order to make a profit from it (Butler & Leatherberry 2004, Majumdar et al.2007, Kendra & Hull 2005, Kilgore 2008a, Bengston 2008). Studies have shown that while traditional owners were motivated by income from timber or other resource extraction, current forest landowners cite wildlife and other recreation, scenery, protection of nature, privacy, and peacefulness, as important or more important than any financial gains from ownership (Bliss and Martin 1989, Erickson et al. 2002, Haymond 1988, Kendra & Hull 2005, Jacob 1997).

While not directly focused on carbon offset projects, the findings of studies aimed at characterizing private forest landowners and understanding their motivations for forest landownership are useful when attempting to discern how well the management changes required for carbon sequestration align with the goals and motivations of the typical private family forest landowner. Researchers are acknowledging that family forest owners are a very heterogeneous group comprised of various motivational types (Bliss and Martin 1989, Butler 2005, Finley et al. 2006, Johnson et al. 1999).

What has stood out amongst all recent studies is the lack of financial motivation by the new breed of forest landowners (Haymond 1988, Bliss and Martin 1989, Erickson et al. 2001). Nationwide, only 14 percent of private forest landowners consider land investment to be either a primary or a secondary reason for owning land (Birch 1996; Bengston et al. 2008). Rather than being economically motivated, many new landowners associate other goals (such as recreation and nature conservation) with their timberland (Baughman et al. 1998, DuPlissis 2004, Majumdar 2008).

When analyzing a nationwide closed-ended survey, family forest owners listed beauty and scenery, the protection of nature and biodiversity, ability to pass on land to heirs, and privacy as the top reasons for owning forestland (Butler 2008). A study using an open-ended question design, where respondents asked the question “What is the main reason that you own woodland in [your state]?” revealed an even broader range of motives with six main categories and 30 subcategories (Bengston et al.2008). Yet again, the above reasons for owning timberland repeatedly appeared.

Several studies have sought to cluster private forest landowners into motivational types. A study by Kendra and Hull (2005) attempted to identify subgroups within the larger population of forest

landowners and cluster them with other owners that exhibited similar management goals and objectives. The study found that, except for absentee owners, all other landowner groups listed financial goals as their least important reason for owning forest land. The findings suggest that lifestyle and amenity goals motivate ownership much more than timber production or other economic concerns. Another study, also using a closed-ended question design, clustered the motivational types of family forest owners into three groups: multiple-objective (49.1%), timber (29.4%), and nontimber (21.5%) (Majumdar et al. 2008). Within this study as well, aesthetics, biodiversity, recreation and privacy were the most important reasons for owning timberland. The study concluded that when these motivational types are clustered into subgroups and examined across a multistate region, financial benefits **still** are not a significant factor for a large number of forest owners (Majumdar 2007).

3.5.3. Descriptive Demographics of Family Forest Owners in the United States

When further limiting private forest land to nonindustrial private forests (NIPF) that are owned by families, individuals, trusts, estates, family partnerships, and similar unincorporated groups, family forests comprise 35 percent of forest land in the United States (Butler 2008). For holdings larger than 10 acres (92% of forest land) the average parcel size is 58 acres (Butler 2008, Butterfield et al. 2005). Butler's (2008) National Woodland Owner Survey produces some nationwide statistics regarding family forest owners. Nationally, 73 percent of family forest owners live on or near (within 1 mile) their land. The general census of forest landowner demographics showed that more than 60 percent of current private landowners are age 55 and older and own a total of 170 million acres of private forest. Further breaking down the holdings by age group, more than 15 percent are 75 years and older and collectively own about 52 million acres of forest. One in four family forest owners has commercially harvested trees and one in twenty has a written management plan. The percent of family forest owners who have commercially harvested trees on their land dramatically increases with the size of land holding. Fourteen percent of family forest landowners plan to transfer their land to heirs or sell their land within the next five years. While the number of forest owners is increasing, the average parcel size is decreasing (indicating parcelization), and land uses surrounding forests are urbanizing (increased rural development) (Kendra & Hull 2005).

3.5.4. Incentivizing Family Forest Landowners

Various policy tools are being considered to encourage carbon oriented management. Financial incentives are a policy tool of primary interest as they can induce landowners to adopt certain behaviors by providing direct payment for efforts (Engel et al. 2008). However, several studies investigating the reaction of family forest owners to financial incentives meant to encourage the production of other nonmarket forest based goods and services have led to conflicting results, possibly representative of the heterogeneity of ownership that exists. Therefore, it is very uncertain how such tools will influence family forest owner behavior towards policy aimed at increasing carbon sequestration—a relatively unresearched area as of yet.

The ability to use incentives to influence behavior is based on the premise that individuals wish to maximize utility and will choose options that lead to tangible benefits if they have adequate information, decision making skill and opportunity. In theory, an incentive will motivate a

desired action if the individual feels that the value of the commitment is worth less than the value of the incentive offered. Incentives for carbon sequestration offset projects can include direct payments from the sale of carbon credits in the open market, grants, favorable tax conditions, cost-share assistance, low-interest loans, and other assistance.

Carbon offset projects face challenges as they involve a forest market commodity that is nontangible. While many landowners site protection of nature as one of the reasons that they own forest land, carbon sequestration is something that they themselves cannot see or measure (nontangible) nor do they obtain a direct benefit from the production of carbon offsets (due to its public good quality). As such, activities geared towards carbon sequestration alone may not provide much incentive other than that obtained through financial gains. Past research has confirmed that this audience is not generally motivated by financial incentives alone therefore, the WTA amounts required to spur participation in an activity offering only nontangible benefits may be higher than markets will support. Our study investigates this supposition.

3.6. Family Forest Owners in the Lake States

3.6.1. Demographics and Landowner Characteristics of Landowners in the Lake States

The amount of forest land in the Lake States region is estimated at 21.1 million acres—59 percent of which is privately owned (Leatherberry 2003). Of this amount, family forest landowners control approximately 90 percent of all privately owned forest land in the Lake States with holdings generally ranging in size from 10 to 5,000 acres (Leatherberry 2003). The total number of family forest owners in the Lake States region is estimated to consist of 488,000 forest landowners owning approximately 10 million ha of forest land (Leatherberry 2003; NWOS 2002). One quarter of forest landowners are age 70 or older, approximately one-half have owned their land for 25 years or more, and approximately 8 percent have a written management plan (Leatherberry 2003, NWOS 2002).

Specific to the Lake States region, Duplissis (2004) found new forest landowners to be primarily interested in purchasing woodland properties for recreational use or aesthetic values. This is unlike previous agricultural or rural owners of the area who owned forest primarily to supplement income. As of 2003, approximately 7 percent of owners own land primarily for timber purposes (NWOS 2002). New family forest owners tend to be more cautious about harvesting timber, less knowledgeable about the rural area and forest they have relocated to, of a higher financial status than past owners, and more likely to be absentee landowners (Duplissis 2004). The primary concerns voiced, in past studies, by this audience include taxes, trespassing, and being able to leave a legacy (Leatherberry 2003).

4. Study: Data and Methods

4.1 Data Collection

A mail-back questionnaire was the chosen method of obtaining information from forest landowners in the Lake States. In addition to the review of current carbon protocols, survey construction was guided by the literature review of family forest landowners and requested information aimed at understanding the attitudes and opinions of private landowners in the Lake States towards forest carbon offset projects as well as determining their willingness to accept

(WTA) compensation levels. In keeping with the study objectives, the survey contained questions regarding reasons for forest landownership, historical and future planned forest management activities, attitudes toward potential carbon credit program attributes and carbon reduction in general, and owner demographic information (e.g. age, land tenure, location of residence, education level and income).

4.1.1. Sampling

The sampling frame consisted of private forest landowners owning 20 acres or more in heavily forested counties in a three state area (Michigan, Minnesota & Wisconsin) (see Figure 1). This cluster of states shares many similar characteristics (e.g. markets, tree species, landowner demographics) allowing them to be included in a single analysis (Smith et al. 1997; Stearns 1997). Alongside the necessary determination as heavily forested land, those counties chosen for inclusion in the study also were determined to have high percentages of family owned forest land (see Appendix A). A landowner database was created that contained a listing of owners with associated parcel information. The county assessor's office, for each county included in the survey, was the source of information (e.g. name, mailing and parcel address, legal description, tax class) received.



Figure 1: Lake States landowner sampling area (indicated in green area).
Diagram courtesy of Northern Research Station, US Forest Service

4.1.2. Pre-Test

The format and face validity of the final survey version was improved by first administering a pilot test. To do so, a questionnaire addressing the objectives of the project was developed and sent to 400 landowners randomly drawn from the ten most heavily forested and privately owned counties in each of the Lake States (a total of 30 counties) using the tailored design method (Dillman 2000). The first mailing of the pretest surveys was in May of 2010. The time required to complete the pre-test, including the Dillman series of contacts and waiting period for response,

totaled 3.5 months. The overall response rate was 51 percent (198 returned) with a usable response rate of 45 percent (24 returned blank or partially filled).

One objective of the pre-test was to seek information regarding the legitimacy of the payment amounts offered. To that end, half of the surveys sent contained the following open-ended question: “If it cost you nothing to meet these requirements, what is the minimum annual payment per acre you would need to sell carbon credits generated from the forested parcel listed on the front of this questionnaire? \$ ____ per acre per year minimum payment.” (see Appendix B). The time commitments included in this question varied depending upon the survey version sent and ranged from 15 to 50 years (15, 25, 40, 50) (i.e. 4 versions of open-ended surveys). The results from the pre-test caused us to extend the final payment amount offerings (from \$3-\$30 to \$3-\$60). The initial pretest included 24 versions of the survey (payment amount X time commitment). This was adjusted to 32 versions in the full survey.

Many participants noted in the open-ended comment section of the pretest survey that they would like more information regarding carbon credits. Subsequently, an informational brochure was created to be included in the final version of the survey. No problems regarding general survey design (i.e. font size used, types of questions asked, method of delivery/response, overall length) were detected with the pre-test questionnaire. However, because of the revisions made, the results of the pre-test were not included in the final survey.

4.1.3. Survey Instrument and Deployment

The final survey design, Lakes States Forest Landowner Survey—Selling Forest Carbon Credits (University of Minnesota 2010, see Appendix C) was administered according to the mailed survey protocol described by Dillman (2000). From the assembled landowner database, 2,208 landowners were randomly selected, with the sample weighted by the amount of family forest acreage in state relative to the total acreage of all family forest land in the included counties (see Appendix D). Each landowner received a packet containing a personally addressed cover letter, a copy of the revised survey (1 of 32 versions), an informational brochure, and a prepaid business reply mailer (see Appendix E-F). One version of the survey was randomly sent to each of the landowners in the database. It was recorded which survey each landowner received so that if further mailings were necessary, the same version would be sent.

A closed-ended, dichotomous choice questioning method was chosen as the preferred contingent valuation technique to determine willingness to accept values (WTA) based on the literature (Arrow et al. 1993, Hanemann 1994). A referendum-style, discreet choice question varied the price/acre offered from \$3 to \$60 (\$3, \$5, \$10, \$20, \$30, \$40, \$50, \$60) and the time commitment required ranged from 15 to 50 years (15, 25, 40, 50) (see Appendix G). Therefore, 32 versions of the survey were created, each offering a different price for a varying time commitment. The smallest payment offered, \$3 per acre per year, approximated the amounts seen in early carbon market exchange markets. The payment range of \$5 to \$20 approximates the amount carbon credits have traded for on the voluntary market (Delta Carbon 2010). The literature provides little guidance on the largest payment amount to offer and therefore the pre-test was used to give direction to the upper-end value.

According to the method delineated by Dillman (2000), a postcard notifying landowners to the coming delivery of the survey and inviting them to participate was mailed first (August 10, 2010). The first mailing of the questionnaire packet followed a few days later (August 12). This was followed by a wave of reminder cards a few weeks later with a second full questionnaire packet being sent to nonresponders in early September (Sept. 4). Finally, another reminder postcard was sent after two weeks to those who still had not responded. Of the total 2,208 surveys distributed, 105 were returned as undeliverable. We received 1,107 responses (53% response rate). Of the 1,107 survey responses, 187 were returned blank, 35 were unanswered but included some comment (e.g. “sold land”, “I am 92”), and 35 were answered with the exception of the dependent variable question (preventing it from being used in this analysis). Ultimately, 850 surveys were deemed usable for this analysis (40% response rate). The response rate is at the mid-range of the response rates for similar studies previously conducted (32% to 67%) (Rasamoelina 2010, Kendra and Hull 2005, Butler et al. 2005, Potter-Witter 2005, Kilgore 2008).

4.2. Data Analysis

4.2.1. Pre-Analysis Data Inspection

Data from the 850 usable survey responses were entered into a Microsoft Excel spreadsheet containing fields for landowner parcel and contact information and all 75 question responses. The data base was thoroughly checked for any coding errors. Minima and maxima were examined in all question fields and plots, tables and summaries of the responses for each quantitative variable were made. All missing, extreme, or illogical values were cross-checked with the original survey forms to prevent any errors due to coding. Missing data inputs were made only to variables where substituting the mean value would not in any way obscure the respondents’ intent (e.g. age, distance from land, education level, land tenure). The cross-checked and corrected data spreadsheet was then imported into statistical modeling program R version 2.9.2.

4.2.2. Nonresponse Bias

Even though the response rate was well within the response rate necessary for survey analysis, the potential bias of nonresponse was evaluated using three methods. First, the percentage of participant response in each state was compared against the initial percentage sent to each state. The initial surveys sent consisted of 37 percent Michigan, 23 percent Minnesota, and 40 percent Wisconsin. The percentage of usable surveys returned agreed very well to the initial percentages: Michigan 35 percent, Minnesota 24 percent, and Wisconsin 41 percent. Next, the average acreage owned by nonresponders was compared to the percentage owned by responders. Average owned acres for nonresponders were 63.09 as compared to 62.57 acres for responders.

Finally, a comparison was made between those requiring a higher level of contact before responding (no response until all contacts made) to those early responders (returned within one week) with the assumption being made that nonresponders may be more similar to those requiring several contacts before participating. Five demographic characteristics were compared across the two groups: age, distance from land, parcel acres, education, and income (Table 2).

Table 2: General comparison of early responders to late responders

Variable compared	Early responders (After 1 st survey but before reminder— Count: 186)	Late responders (Received after ALL contacts sent— Count: 146)
Acres (noted for Parcel:	61.53 acres	55.75 acres
Age	61.87 years	57.59 years
Income	3.30 (Scale 1 – 5)	3.13 (Scale 1-5)
Education	4.35 (Scale 1-7)	4.32 (Scale 1-7)
Distance from forest land	172.63 miles	334.98 miles (267.09 miles with outliers removed—3 over 1500)
<i>Categories for F & t Tests:</i>	<i>Group 1</i>	<i>Group 2</i>

When conducting independent t tests to compare means (Groves et al. 2002), it was found that three of the five demographic characteristics chosen were not significantly different ($p > 0.05$): parcel acres, education and income. Two significant differences were found: the age of late responders was younger than early responders and they lived farther from their land. It is felt that this most likely represents the fact that a higher percentage of early responders tend to be older (retired) and live on or closer to their land. It follows that younger participants may lead busier lives, resulting in a later return rate. Also, living an increased distance from their forest land may result in mail system delays. Taking the comparisons of early vs. late respondents into account, as well as considering the earlier tests of nonbias showing no significant difference in acreage owned by nonresponders vs. responders and a similar state by state return rate, nonresponse bias was considered to be minimal and no further tests were conducted.

Table 3: F Test and t test comparisons for early responders and late responders.

Group 1 vs. Group 2	Age	Distance	Acres	Education	Income
F test for equal variance	0.572947	1.03738E-07	0.977810392	0.58155289	0.50775
Variance	Equal	Unequal	Equal	Equal	Equal
t test	0.003557	0.027576224	0.371546904	0.88456688	0.331791
Significant?	YES – p value <0.05	YES – p value <0.05	NO- p value >0.05	NO- p value >0.05	NO- p value >0.05

4.2.3. Estimation

This study considered the factors that would cause a landowner to indicate a desire to participate in a forest carbon credit program. A random utility model (Hanemann 1984) was used to estimate WTA in a dichotomous choice format (Loomis 1987, Kilgore et al. 2008). Landowners were asked whether or not they would sell carbon credits at the stated price for the contract term specified. The dependent variable PARTICIPATE had two responses, “1” if a landowner indicated that they would sell forest carbon credits at the price offered and “0” if a landowner indicated that they would not participate at the payment amount offered. Logistic regression analysis was used to relate probable participation in a forest carbon offset project to landowner and carbon credit program characteristics that were used as independent variables in the regression model.

4.2.4. Checking Logistic Regression Model Assumptions

In preparation for the building of a logistic regression model, an extensive pre-analysis evaluation was conducted to ensure that the basic assumptions necessary to a logistic regression analysis were not violated and, further, to ensure that logistic regression was the correct approach. The initial linearity assumption, necessary to logistic regression modeling, was checked at the outset by “binning¹⁰” the entire database into workable subsets (by survey version). The proportions of each binned groups’ Y variable was plotted to ensure that all independent variables did indeed express a linear relationship to the response variable. Testing for needed transformations (independent variables only) and the presence of interactions was also completed during this phase. The statistical modeling program used was R version 2.9.2. All tests validated the linearity assumption and indicated that logistic regression was the correct analysis method.

4.2.5. Logistic Regression

In *logistic regression*, the **log odds** of the outcome are modeled as a linear combination of the predictor variables (χ 's):

$$\text{Log odds} = \text{Log} \frac{P}{1-P} = \beta^0 + \beta^1 X + \beta^2 X + \dots \beta^k X \quad (1)$$

where: P = probability a landowner will enroll in a carbon offset project; β^0 = intercept; β^j = vector of regression coefficients; X_i = vector of predictor variables (e.g., payment, time commitment, total acreage, etc.)

Logistic regression is based on the cumulative logistic probability function and is able to estimate to probability of a certain event occurring given a set of categorical characteristics (Pindyck/Rubinfeld 1981).

Eq. (1) can be written so as to enable one to estimate the probability of occurrence of a specified outcome (Peng et al. 2002; Hanemann/Kanninen 1998).

$$P \{\text{participation is “yes”}\} = \frac{1}{1+e^{-[\beta^0 + \beta^j X_i]}} \quad (2)$$

Estimates for the parameters were obtained using maximum likelihood estimation (MLE) procedures.

4.2.6. Predictor Variable Selection

Directed by the literature and other factors we intuitively felt would influence a landowner’s decision to participate in a carbon credit program, a number of potential predictor variables were

¹⁰ Binning is a technique that allows one to better determine the relationship (linear, nonlinear or other) between variables. Without binning, a standard plot of Y~X for a **dichotomous** dependent variable (as in this study) leads to a plot with all responses at 0 or 1. It is almost impossible to check linearity by reviewing such a plot. Data is “**binned**” into groups and the proportions of each groups’ Y variable is plotted.

identified (see Table 4). Three major categories of independent variables were hypothesized to influence a landowner’s decision to sell forest carbon credits: carbon program characteristics, owner characteristics and parcel characteristics. A codebook displaying how the predictor variables were formulated from survey questions can be found in the Appendix (see Appendix I).

Table 4: Variables hypothesized to have an influence on family forest owner participation in carbon credit projects.

Variable Interest	Description	Hypothesized Effect on Selling Carbon Credits
<i>Carbon Offset Program Characteristics</i>		
PAYMENT	A categorical variable indicating the payment amount offered (\$/ac/yr).	Positive
YEAR	A categorical variable indicating the contract length required	Negative
<i>Landowner Characteristics</i>		
GENDER	A binary variable indicating the gender of the participant (male=1)	Variable
EDUC	A categorical variable indicating level of education (proxy for income)	Negative
TENURE	A continuous variable indicating the length of ownership	Negative
RESIDE	A binary variable indicating whether the owner lives on their land	Indeterminate
CO2.COMP	A continuous variable (composite score) indicating landowner attitude towards carbon reduction	Positive
FAMILIARITY	A categorical variable indicating the owner’s familiarity with carbon credits	Positive
NON.MARKET	A continuous variable (composite score) indicating the importance of other nonmarket forest amenities (aside from carbon reduction)	Positive
MGMT.CHGS	A categorical variable indicating the importance placed on requiring management changes	Negative
ADD.INCOME	A continuous variable (composite score) indicating the importance of other forest income	Positive
ASSIST.PROG	A binary variable indicating past participation in an educational or forest assistance program	Positive
BARRIERS	A continuous variable (composite score) indicating the rating of barriers posed by participation	Negative
<i>Forest Parcel Characteristics</i>		
TOT.ACRES	A continuous variable indicating the size of the parcel	Positive
PAST.HAR	A binary variable indicating whether or not the owner has harvested in the past	Positive

Two variables denoting carbon credit program characteristics were used in the model. As previous studies have demonstrated a positive relationship between a landowners decision to participate in a forestry activity and the payment amount offered, payment (PAYMENT) is included in the model and hypothesized to be positively related to participation (Sullivan et al. 2005; Engel et al. 2008). Contract length (YEAR) are expected to be an important determinant with longer contract lengths having a negative effect on the decision to participate (Layton & Siikamaki 2009, Lin 2010).

Fourteen variables related to a landowner’s decision to participate in activities similar to selling forestry carbon credits were found in the literature: age (AGE) is included in the model and hypothesized to be negatively related to participation in a carbon program based on a decreasing participation seen in studies of other forest activity (Romm et al. 1987). Gender (GENDER) is included in the model but the expected effect is uncertain. Previous research has shown that males tend to be more interested in participating in certain forest management activities (Sullivan

2003) yet other research has shown that women are more apt to participate in activities similar to carbon offsetting (Bliss et al. 1996). Education (EDUC) is included in the model and hypothesized to be negatively related to participate. Demographic information regarding income was also obtained but, as respondents are often reluctant to share such information, education level was used as a proxy for income. Previous studies have shown that higher educated individuals (and higher income households) are less likely to engage in management activities (<1% of income from forest) (Kendra and Hull 2005, Rasamoelina et al. 2010). The length of parcel ownership (TENURE) is included and expected to have a negative relationship to participation as (Lin 2010). It is expected that a landowner's residential status (i.e. whether the landowner resides on their forest parcel) will affect participation. However, previous studies have demonstrated conflicting results for similar activities (Kendra/Hull 2005, Kilgore 2008). Therefore, residential status (RESIDE) is included in the model but the hypothesized effect is uncertain. It is intuitively felt that landowners who agree that climate change is an issue of concern will be more apt to participate in a carbon-offset project. A composite score representing a landowner's attitude toward climate change (CO₂_COMP) is included in the model and hypothesized to have a positive effect on participation. A similar effect is hypothesized for those landowners who highly value other nonmarket forest amenities (e.g., soil, water, wildlife) that could potentially be enhanced by activities that manage for carbon. A composite score for nonmarket forest amenities (NON.MARKET) is included in the model and expected to be positively related to the desire to participate.

Previous studies have shown that the more familiar a landowner is with a particular program, the more likely they are to participate (Kilgore et al. 2008). The level of familiarity with carbon credits (FAMILIARITY) has been included in the model and is expected to be positively related to participation. Related to this variable, if landowners are actively involved in the local forestry assistance network, through past participation with other landowner educational, technical, or tax assistance programs, it is hypothesized that they would be more likely to participate. Variables to indicate past tax program (TAX.PROG) or other landowner assistance (ASSIST.PROG) has been included in the model (Butler and Leatherberry 2004; Salmon et al. 2006; Roper 2007; Rasamoelina et al. 2010). Landowners who indicate that they would be very concerned about making necessary changes in the way they manage their forest are included in the model (MGMT.CHANGES) and expected to have a negative relationship to participation.

Based on the literature as well as intuition, it is hypothesized that those landowners' who value timber income will be less likely to want to sell carbon credits as *extending rotation length* is one of the primary means of sequestering additional carbon. Therefore, a variable for timber income (TIMBER.INC) has been included in the model and is expected to be negatively related to participation (Kline 1999; Sullivan 2003). Related to this variable, landowners who indicate that implementing **other** activities that could increase carbon sequestration would present a considerable barrier to participation are hypothesized to be less likely to want to participate. A composite score (BARRIERS) has been included in the model to represent the cumulative rating landowners place on the barriers presented by each of these other potential sequestration methods. Also hypothesized to be determinant of future participation was the importance placed on obtaining additional income from their forest. Private family forest owners have been shown to be a very diverse group whose initial forest purchase is not particularly motivated by expected financial returns (Baughman et al. 1996, Rickenbach et al. 2005, Butler et al. 2008). Therefore,

those landowners who indicate that they **did** purchase their forest expecting to receive some financial return are expected to be more likely to participate—(ADD.INCOME) has been included in the model.

Four characteristics related to the *forest parcel* are hypothesized to have an effect on participation. Other studies have shown that landowners with larger parcels are more likely to want to participate in similar programs (Kilgore 2008, Butler 2008). A variable (TOT.ACRES) representing the total amount of contiguous acres owned has been included in the model and is expected to be positively related to a landowners desire to participate. It is intuitively felt that those landowners who have already completed some of the activities required to participate in a carbon-offset program will be more likely to participate. Therefore, variables to indicate the previous completion of a written management plan (MGMT.PLAN) and forest certification (CERTIFY) have been included in the model and each are hypothesized to be positively related to participation (Rasamoelina et al. 2010). As land that has been previously harvested is often considered to be owned by active forest owners, (PAST.HARVEST) has been included in the model and hypothesized to be positively related to participation (Butler et al. 2007).

5. Results

5.1. Profile of Lake States Family Forest Landowners

Similar to studies of other forest owners across the nation (Butler & Leatherberry 2004, Sullivan et al. 2005, Butler 2008), the typical Lake States family forest owner who responded to our survey is nearing retirement (59 years old, on average), owns a modest amount of forest land (an average of 135 acres), has completed some post-secondary schooling, and has an above-average household income (\$75,000) (Table 5). Landowners in the Lake States do not sell their land frequently. On average, survey respondents have owned their land for 22 years. This is similar to findings of studies in other parts of the nation (Sullivan et al. 2005). Forty-five percent of respondents have previously harvested trees (compared to 50 % [Butler & Leatherberry 2004] and 44% [Feinburg et al. 2007]); while 21% have enrolled in a forest property tax program (Table 2).

A previous nationwide study of family forest owners found that the primary reason for owning forest land is to enjoy the beauty of nature (Butler/Leatherberry 2004). Our results agree with this finding. Landowners in the Lake States indicated that their primary motivation for owning forest land is to enjoy nature, followed by a place to hunt (see Figure 2).

Our sample included a high percent of absentee forest landowners (76%), compared to national survey results where Butler and Leatherberry (2004) found that 23 percent of forest landowners are absentee owners (Table 5)¹¹. The average distance that absentee owners live from their

¹¹The higher number of absentee owners found in Michigan is related to the tax system used in the state. In Michigan, the type of land cover is not designated within certain tax classes and all land (farmland as well as forest land and other) is combined to form the residential tax class. Therefore, in order to ensure that our survey reached a high percentage of owners owning forest land and not farmland owners or other recreational property owners, a large percentage of landowners within the “Timber Cut-Over” tax class were used to develop the Michigan address database. In most cases, the timber cut-over classification in Michigan does not allow residential structures, hence the high percentage of absentee owners. This did not affect our response rates which coincided very well with the initial “send” rates nor did it affect interest in participating in a carbon credit project.

Table 5: Descriptive statistics of Lake States survey respondents (units of the variable are shown in parentheses)

Variable	Mean	S.D.
<u>Respondent characteristics</u>		
Age (years):	59.2	11.97
Gender (% male)	89	
Education level (years)	14	1.73
Average income: (dollars per household)	75,000	
Reside on land—overall (%)	24	
State analysis (% of each state’s respondents)		
Michigan	8	
Minnesota	34	
Wisconsin	32	
Miles from land (absentee owners)	207	452.74
Dwell in rural area/small rural town (%)	64	
<u>Land characteristics/tenure</u>		
Average total parcels owned (acres)	135.25	414.09
Years owned	22	16.26
Percentage of land forested (%)	79	
Previously harvested trees (%)	45	
Enrolled in tax program (%)	21	
Have a written management plan (%)	23	

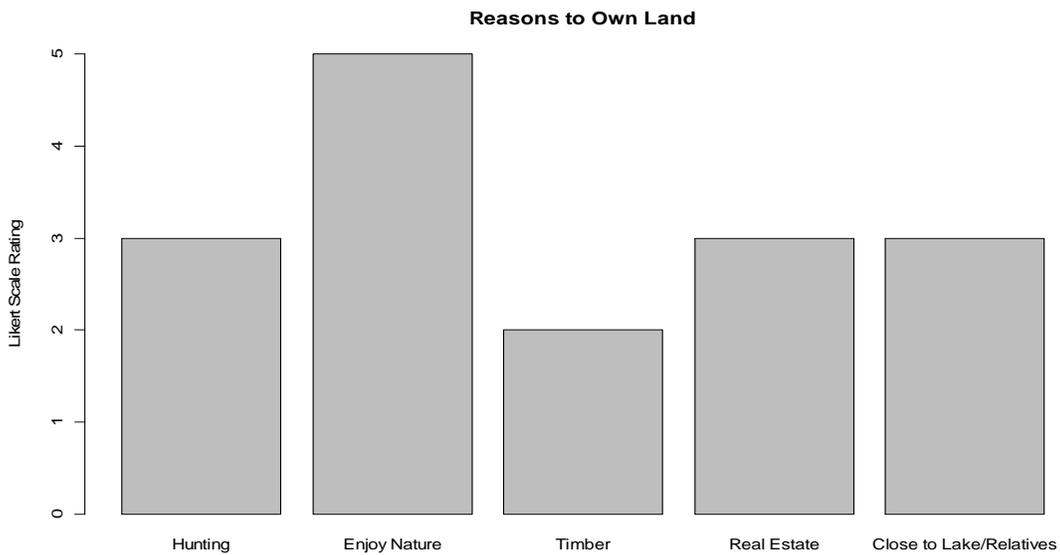


Figure 2: Ownership motivations of landowners in the Lake States.

property is 207 miles. Another distinct contrast to nationwide averages concerns the percentage of Lake State's owners who have a written management plan for their forest land (Butler 2008). While past studies have found that approximately 3 percent of family forest landowners have a written management plan (Butler & Leatherberry 2004) and 1 percent (Butler 2008) have certified their forest our survey revealed much higher percentages: 23 percent have a written management plan (32% in MI; 17% in MN; 22% in WI) and 16 percent have previously certified their forest (23% in MI%; 10% in MN; 15% in WI.). It is assumed these findings are related to the fact that both Michigan and Wisconsin have developed a group certification system for nonindustrial forest land enrolled in certain tax programs (WI-MFL; MI-cite) and written management plans are required for certification.

5.2. Familiarity with Forest Carbon Credits

Lake States family forest owners are very unfamiliar with forest carbon offset projects. Respondents were asked to indicate how familiar they are with forest carbon credits by choosing from the following: never heard of them, minimal familiarity, some familiarity, extensive familiarity. Forty-two percent of our respondents indicated that they had never heard of forest carbon credits prior to our survey, with only 2 percent indicating they had extensive familiarity with the forest carbon market (37% indicated minimal familiarity, 19% some familiarity) (see Figure 3).

5.3. Potential Requirements That May Be Barriers

Survey participants were asked to indicate whether or not they had already carried out certain actions on their forest land commonly associated with selling forest carbon credits. The eight potential actions were identified by reviewing the program requirements contained within current and prospective carbon offset standards (see Background section). If a participant had not already completed the action, he/she was asked to indicate the extent to which doing so would be a deterrent from participating in a forest carbon offset project using a 5-point Likert scale (1=No Barrier, 5=Considerable Barrier). Carbon credit projects that would require a conservation easement posed the greatest barrier to landowner participation, with 53% of our respondents indicating such a requirement would be a significant barrier (Likert scale rating of 5) and 11% stated the requirement would not be a barrier (Likert scale rating of 1). Among all respondents, the mean response to this question was 4.0. Respondents expressed the least resistance towards the requirement to have a detailed inventory of their forest land (See Figure 4).

The survey asked respondents to rate their overall interest in selling carbon credits. When all respondents were considered, the average interest rating on a scale of 1 to 10 (1="Not interested", 10="Very interested") was 5.5. When only those respondents who wished to participate were considered, the mean interest in selling carbon credits was 7.31. Ten percent of respondents who did not wish to participate at the payment amount and contract length offered still expressed a high interest in selling carbon credits (score ≥ 7). Finally, the open-ended question was well received and survey participants shared a wealth of additional information that will be qualitatively analyzed in the future and used to give direction to follow-up focus group sessions.

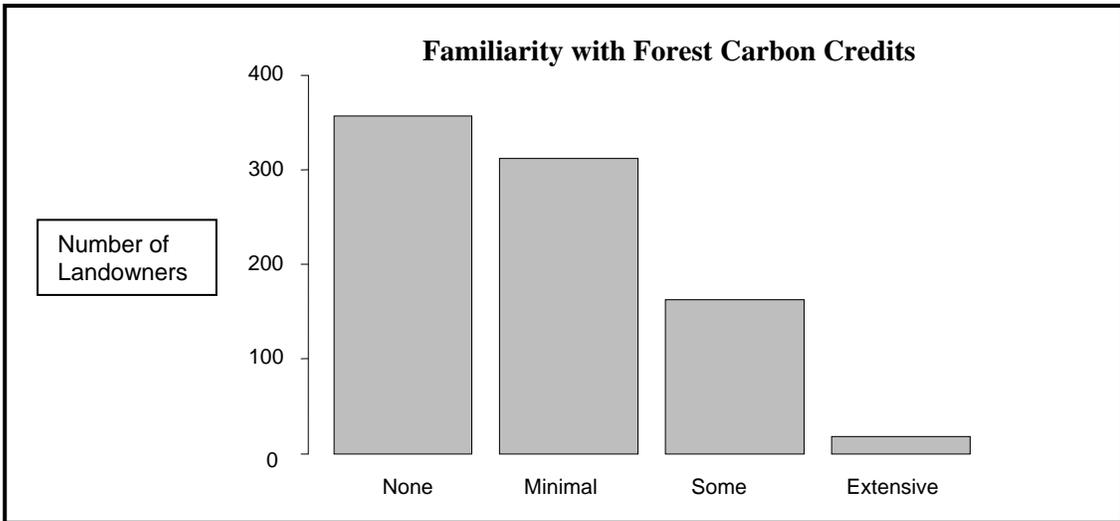


Figure 3: Familiarity with forest carbon offsets expressed by landowners in the Lake States.

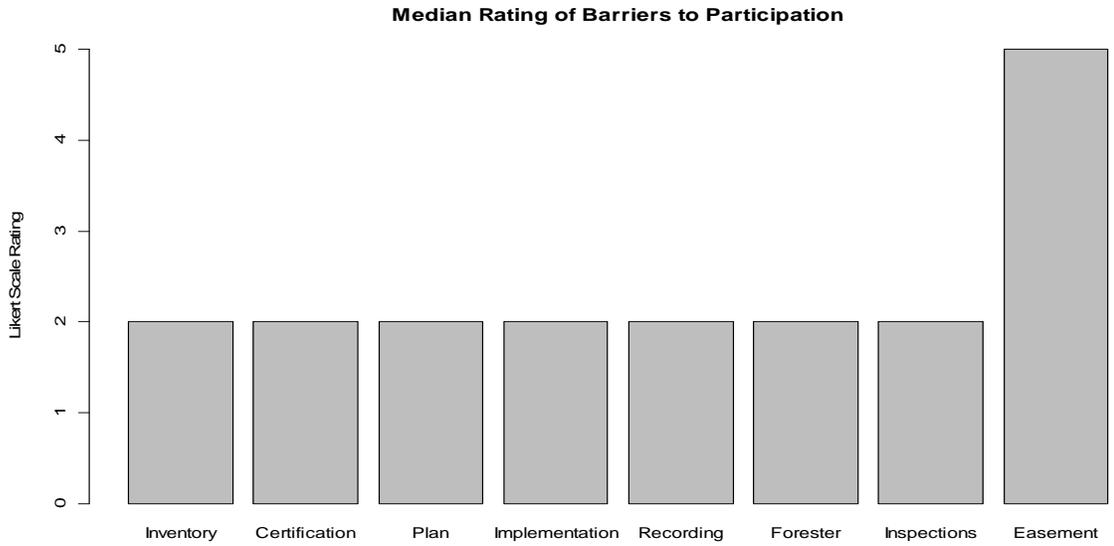


Figure 4: Landowners' in the Lake States rating of potential barriers.

5.4. Correlated Variables

Among the variables identified in Table 1, several were found to be correlated and therefore were removed from the list of potential predictors to be included in the logistic regression model. Guidelines used to determine the cut-off value of correlations were taken from: Cohen (1988) *Statistical power analysis for the behavioral sciences* (2d ed). Using the stated guidelines, the mid-range for a medium correlation was chosen as the cutoff value (0.4). One variable was removed from consideration from all pairings having a correlation score over 0.4. Correlations were shown for (Age/ Tenure, Certification/Tax program, Certification/Written Management Plan, Tax Program/Educational Assistance Program, Timber Income/Need for Additional Income, Education/ Income). As shown above, several variables correlated with more than one other variable and were removed. The number of initial predictors (20) was subsequently reduced to 15, with the highest correlation among predictor variables being 0.354 (landowner value on nonmarket forest amenities and attitudes regarding climate change). Eighty percent of the pair-wise correlations are less than 0.1 in absolute value. A total of 15 variables were ultimately included in the initial model: payment, contract length, gender, total acres owned, familiarity with carbon credits, value placed on other nonmarket forest amenities, attitude towards carbon, need for additional income, education level, attitude toward management changes, past harvest status, past participation in a forest assistance program, absentee status, length of ownership, and estimation of program barriers.

5.5. Logistic Estimation Results

The probability that a family forest landowner who responded to our survey would choose to enrol in a carbon credit program (Eq. 2) was estimated using binomial logistic regression (Statistical program: R version 2.9.2), which is a maximum likelihood estimation technique. Table 2 summarizes the results of this estimation. **Model 1** represents the logistic regression model output with all respondents included (n=850), with missing values causing a survey to be deleted from the analysis resulting in a reduction of 77 surveys (n=773). **Model 2** represents the logistic regression equation modelled only with those respondents who indicated a high degree of certainty in their response (Certainty Rating > 7) (see section 4.1.4). Several tests for *goodness of fit* (GOF) were conducted: Cox and Snell, Nagelkerke R², and Hosmer Lemeshow. All test results indicated that the model fit the data well (see Table 6 for GOF results).

Table 8: Logistic regression analysis of factors affecting Lake States family forest owners' willingness to sell carbon credits by the statistical program R version 2.9.2.

	Model 1 All Respondents included (n = 773)						Model 2 Only High Certainty respondents (n = 494)					
Predictor	Coef. β	S.E.	Wald's X^2	P Value	Marginal Effects	e^β (Odds Ratio)	Coef. β	S.E.	Wald's X^2	P Value	Marginal Effects	e^β (Odds Ratio)
<i>Program Characteristics</i>												
Payment	0.0329	0.005	6.712	0.0000***	0.00802	1.034	0.0484	0.007	6.507	0.0000***	0.0119	1.050
Year	-0.0267	0.007	-4.059	0.0005***	-0.0065	0.974	-0.0388	0.010	-3.963	0.0001***	-0.0095	0.962
<i>Owner Characteristics</i>												
Gender (1=male/0=female)	0.8380	0.245	3.426	0.0006***	0.2042	2.312	0.9879	0.378	2.613	0.0090**	0.2421	2.686
Familiarity	-0.0949	0.114	-0.832	0.4055	-0.0231	0.909	-0.0660	0.165	-0.400	0.6892	-0.0162	0.936
Non-Market Composite	0.1255	0.037	3.431	0.0006***	0.0306	1.134	0.1284	0.051	2.500	0.0109*	0.0315	1.137
CO2 Attitude Composite	0.0664	0.027	2.453	0.0142*	0.0162	1.069	0.1418	0.041	3.495	0.0005***	0.0347	1.152
Additional Income	0.4581	0.075	6.135	0.0000***	0.1117	1.581	0.7431	0.118	6.309	0.0000***	0.1821	2.103
Education	-0.0886	0.053	-1.686	0.0919	-0.0216	0.915	-0.0549	0.077	-0.710	0.4778	-0.0134	0.947
Mgmt. Changes	-0.0183	0.082	-0.225	0.8223	-0.0045	0.982	-0.0926	0.120	-0.777	0.4375	-0.0227	0.912
Assist.Program	0.1757	0.268	0.655	0.5122	0.0428	1.192	0.5430	0.396	1.371	0.1704	0.1330	1.721
Reside	-0.5405	0.207	-2.617	0.0089**	-0.1258	0.582	-0.7795	0.315	-2.477	0.0132*	-0.1938	0.459
Tenure	-0.0046	0.006	-0.802	0.4228	-0.0011	0.995	-0.0250	0.009	-2.862	0.0042**	-0.0061	0.975
Barriers	-0.0650	0.011	-5.871	0.0000***	-0.015	0.937	-0.0941	0.017	-5.580	0.0000***	-0.0234	0.910
<i>Land Characteristics</i>												
Total Acres/40	0.0934	0.053	1.760	0.0785	0.0228	1.0978	0.1244	0.051	2.430	0.0151*	0.0305	1.132
Past Harvest	-0.0034	0.194	-0.017	0.9861	-0.0011	0.9966	-0.0037	0.293	-0.013	0.9899	-0.0010	0.996
Significance codes: ***significant at $\alpha=0.001$ level, ** significant at $\alpha=0.01$ level, * significant at $\alpha=0.05$ level												
<u>Goodness of Fit Tests (Model 1):</u> AIC: 811.16 Cox and Snell: 0.40 Nagelgerke R2: 0.51 Hosmer Lemeshow: 0.284						<u>Goodness of Fit Tests (Model 2):</u> AIC: 404.82 Cox and Snell: 0.53 Nagelgerke R2: 0.68 Hosmer Lemeshow: 0.804						

5.6. Significant Predictors of Enrolment

Eight of the 15 variables are significant predictors of a landowner's interest in enrolling in a carbon credit program at $p < 0.05$, as shown in Model 1 (Table 6). Both carbon program characteristics were found to be significant. The carbon credit payment amount (\$/acre/year) was positively related to the response. Conversely, contract length was found to be negatively related to the participation. Alongside carbon program attributes, model results showed that the characteristics of the landowner, as well as the forest land owned, also were important predictors of program participation. Those landowner characteristics found to have a significant **positive** effect on participation were: gender (for males), value placed on nonmarket forest amenities, the need for additional income, and attitude towards climate change. Landowner characteristics found to have a significant **negative** effect on participation included: residing on land and the estimation of the barriers caused by program requirements. When only those landowners expressing a high certainty in their response are considered (Model 2), an additional landowner characteristic is found to have a significant negative effect on participation: land tenure. It is with high certainty respondents that the only significant land characteristic is observed: total acreage owned. Total acreage owned has a positive relationship to the response variable.

6. Discussion

6.1. Carbon Program Characteristics

The primary trading program characteristic family forest owners in the Lake States are **amenable to** is a **higher price** for carbon credits. As the price offered for carbon credits increases, so does the WTP in an offset program. The results of the logistic regression model found payment amounts to be a very significant (p value=0) predictor of participation when modeled both with all respondents and with only those who indicated they were “very certain” of their answer. The question of whether to participate was also tied to a contract length so within each price point, the landowner considered various contract lengths as well. This was a very interesting pairing as survey/model results found that family forest landowners in the Lake States are **averse to long contract lengths**—the longer the contract required, the less landowners want to participate. The logistic model found contract length to be a very significant (p value = 0.00001) **negative** predictor of participation. The dampening effect an increasing contract length has on participation at the various payment amounts is demonstrated in the following graph (see Figure 6). The model prediction when all contract lengths are considered is shown (middle blue line) as compared to participation at 15 years (top line) and at 50-year contract length requirements (bottom line).

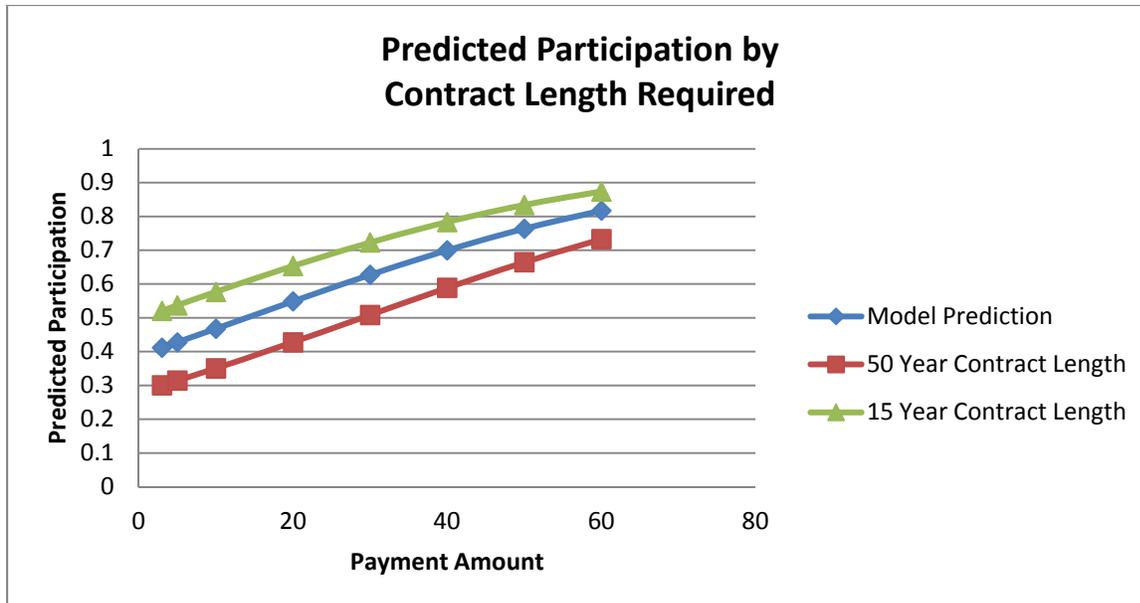


Figure 5: Willingness to participate based on contract length.

6.2. Owner Characteristics

Model results found that several characteristics of the landowner were significant predictors of participation. Landowner attitudes towards both nonmarket forest amenities and climate change were positively related to the willingness to participate. Owners in the Lake States who place a high value on forest amenities that may result from the sale of carbon credits (e.g., improved water and soil quality, forest esthetics, wildlife habitat) are significantly more likely to indicate a desire to participate in an offset project than those who do not value them. Not surprisingly, landowners who feel that climate change is a real environmental concern are much more likely to participate than those who do not feel that climate change is a problem. The amount of importance landowners place on receiving additional income from their forest land is also a significant predictor of participation—the more landowners value additional income, the more likely they are to agree to the program terms offered. While the initial hypothesis was uncertain, model results show that males are significantly more interested in participating in a carbon offset project than female respondents, even when controlling for age. This could indicate that, similar to the findings by Bliss et al. (1997) and Sullivan et al. (2003), males are more interested in engaging in certain types of forest management activities.

Those landowners that reside on their land are significantly less likely than absentee owners to participate in carbon offset programs. This could indicate that absentee owners are less attached to their land and therefore may be more willing to comply with certain requirements such as allowing third-party inspections and the conveyance of conservation easements. Of the 18 respondents already having conservation easements on their land, all but one is an absentee owner. Also, landowners who do not live on their land may be more desirous of a means of reducing ownership costs given their less frequent use of the land. For those that do reside on

their land, the importance that they place on the necessity for additional income seemed to be a key factor in the decision to participate.

The composite score for *barriers* (the extent a potential requirement would prevent participation) was very significant (p value = 0.001) with a negative coefficient—the higher the composite score, the less likely the respondent was to participate. Conversely, if a landowner had already completed a required activity, it posed no barrier (individual score of 0). The compiling of a composite score for barriers allowed the comparison of landowners who had already completed many requirements (Scoring of 0 to 5) to those landowners without any requirements fulfilled and a high estimation of the barriers presented by requirements (Score of 30 to 35). Those landowners who already had completed several requirements (e.g., forest inventory, written management plan, forest certification) were much more apt to indicate a desire to participate in a carbon-trading program.

6.3. Land Characteristics

The one land characteristic that showed a positive relationship to participation was the total acreage owned. While not a significant predictor in Model 1, the forest land characteristic of total parcel size becomes an important predictor of participation with landowners who indicate that they are very certain of their decision whether or not to sell forest carbon credits for the terms offered. Those landowners having large parcels of forest land (200 acres shown in Figure 7) are more likely to participate than those owning smaller parcels (40 acres).

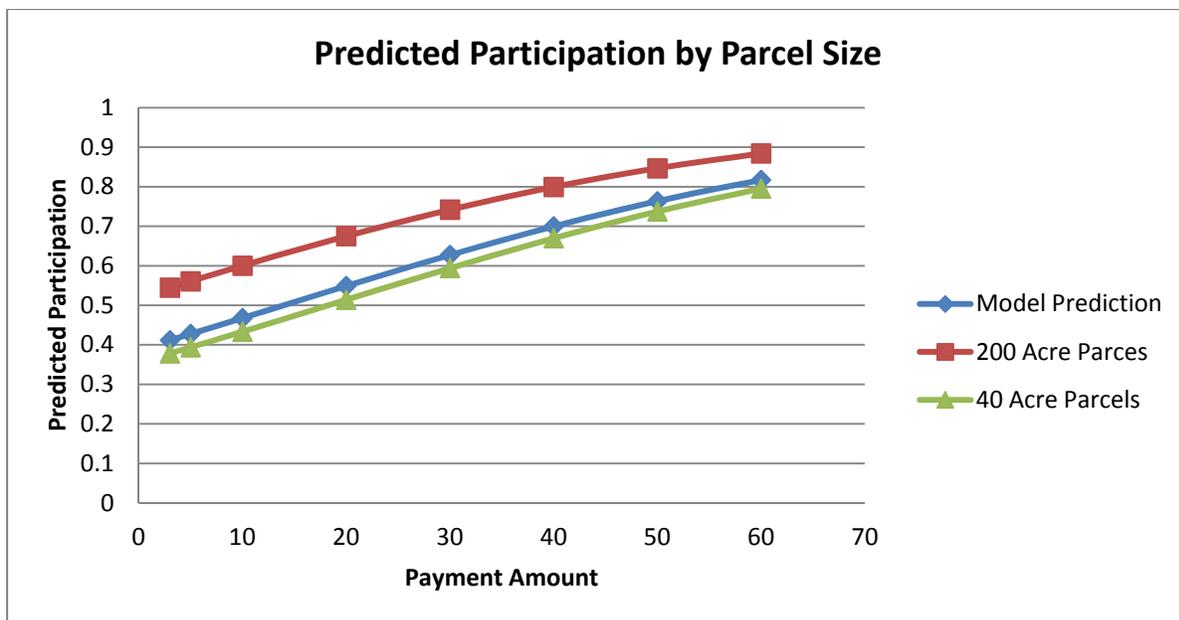


Figure 6: Difference in expected participation based on parcel size owned by Lake States family forest owners.

6.4. Unexpected Findings

Familiarity with carbon-offset programs was not shown to affect the decision to participate. Those family forest owners who were not familiar with the concept of selling carbon credits prior to receiving our survey were no less likely to consider participating than those who were extensively familiar with carbon credit programs. This finding is counter to other studies that found that interest in enrolling in similar type programs is influenced by familiarity with the program (Kilgore et al. 2008).

7. Policy Implications

According to analysis using Model 1, a payment of approximately \$18/acre/year would be required to generate a 50 percent participation rate. The payment amount required to generate a 50 percent participation rate rises to \$28/acre/year when estimated using only those respondents who express a high certainty in their response to the valuation question (Model 2). These amounts are higher than the amount currently being offered for carbon credits through voluntary markets operating within the region (\$8.00/metric ton [Delta Carbon 2010]). However, both model estimates reveal that some portion of landowners would participate for payments within the range currently offered. If the probability estimates are extended towards the axis, both models estimate that a certain portion of Lake States family forest owners would be willing to participate without receiving payment. This finding agrees with other research on incentive payments to family forest owners for similar programs (Kline et al. 2000; Kilgore et al. 2007).

Comments provided by survey respondents to the open-ended question are consistent with our model results, namely that some landowners would require very little or no compensation for their efforts:

“We use our property for deer and grouse hunting. Our son-in-law has a Forestry Degree- UW Stevens Point. He advises me on when to harvest trees, etc. It really makes no difference if carbon credits or not. I like trees. Every year we plant more and different kinds like oaks for wildlife.” Landowner #P8

“I know forests help the carbon problem and voluntarily would keep my forest property in good environmentally favorable condition.” Landowner #2131

“I am not interested in carbon credits but would want as much forest land to remain forest land because that is the most environmentally necessary - not because there is financial gain. Do the right thing for the environment.” Landowner #915

It is possible that for a certain segment of family forest landowners, the value derived from making a positive contribution to an issue they are concerned about (climate change) alongside the ability to improve other valued forest amenities (by fulfilling offset requirements) may provide enough incentive for participation (Gottfried et al. 1996). Methods of reaching and assisting this group of landowners should be further investigated.

The majority of forest landowners who participated in this study indicated that requiring a conservation easement before selling carbon credits is a major deterrent. It is likely that if carbon offset standards contained this requirement, the resulting participation rate would be much lower than that modeled. Also, the Lake States landowners surveyed were very resistant to long contract periods. Rather than developing projects that extend for 50 to 100 years (beyond the lifespan of many participants), carbon-offset projects that can be completed within a 15 to 25 year time span would have a greater chance of success with family forest owners in the Lake States. In order to interest project participation within this audience, it would be important to consider methods of ensuring genuine carbon sequestration within shorter time frames.

Forest landowners in the Lake States appear to be ahead of the national average when considering the requisite actions needed in order to sell carbon credits: having a written management plans and certifying their forest land. While the model indicates each requirement is not significant when viewed separately, the cumulative effect of having several needed prerequisites in place is significant. Policy makers could direct family forest owner assistance towards those programs and activities that allow a landowner to put in place the necessary requirements of a forest carbon offset project. These activities include forest inventories (including baseline carbon determinations), written management plans (geared toward carbon sequestration) and forest certification.

8. Conclusion: Carbon Program Potential in the Lake States

Family forest landowners in the Lake States region appear to be better positioned to participate in carbon offset projects than many others in the nation. For example, the percent of forest landowners who already have a written forest management plan is much higher than the national average (Butler 2008). While survey results show that owners in the Lake States currently are very unfamiliar with forest carbon credits (42% indicated they had never heard of them prior to our survey), they also suggest that a majority of forest landowners feel climate change is an issue of concern. Even though Lake States family forest owners are very unfamiliar with carbon trading, a large percent of respondents indicated that they would be willing to participate in an offset project under certain conditions. One interpretation of this finding is that carbon sequestration projects can provide benefits (both monetary and nonmonetary) to forest owners in the Lake States and can help mitigate a problem that they are concerned about.

If future forest offset project standards could address the perceived barriers to market entry expressed by the Lake States owners we surveyed (e.g., long contract lengths, conservation easement requirements), yet make real and quantifiable carbon sequestration improvements, increased participation is likely. Additionally, making carbon credit options more visible within the information and assistance forest network that apparently already exists within the Lake States could increase the interest in carbon trading. Based on survey results, the best audience to begin directing such information towards would be large parcel absentee owners. Further investigation into the network of information, assistance and incentives (applicable to carbon management) that exists within this region will enable a better prediction of future carbon credit program success.

The results of this regional study indicate that family forest owners in the Lake States are interested in participating in carbon markets under certain financial and contractual conditions. Our study only looked at one geographic area of the United States. It would be important to replicate this study with family forest owners in other regions of the United States. Such comparative studies would facilitate a more complete understanding of the potential supply of carbon credits provided by the nation's family forest owners. Having such information will assist in determining whether or not forest carbon sequestration programs may be a viable response to the problem of global climate change.

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Appendix A

Lake States Counties included in study

Michigan Counties Included in Survey:

County	Acres Privately Owned ¹	Tax Classification Included ²
Chippewa	227,900	Commercial Forest Classification
Delta	220,000	Qualified Forest Program
Houghton	150,100	Timber Cut-Over parcels
Iron	162,800	Timber Cut-Over
Mackinac	168,600	Timber Cut-Over
Menominee	303,800	Commercial Forest Classification
Newaygo	208,500	Qualified Forest
Ontonagon	133,400	Timber Cut-Over

Minnesota Counties Included In Survey:

County	Acres Privately Owned ³	Tax Classification Included
Aitkin	228,800 acres	111/Rural Vacant Land & 151/Seasonal Recreational
Becker	185,300 acres	111/Rural Vacant Land
Beltrami	183,300 acres	111/Rural Vacant Land
Cass	193,800 acres	Multiple Tax Classes
Crow Wing	231,500 acres	111/Rural Vacant Land & 151/Seasonal Recreational
Hubbard	196,100 acres	999 Tax Class
Itasca	303,00 acres	Predominately 111/Rural Vacant Land
Otter Tail	196,200 acres	111/Rural Vacant Land & 151/Seasonal Recreational
Pine	310,700 acres	Mostly 111/Rural Vacant Land & small percentage in Managed Forest Land
St. Louis	678,500 acres	Mostly 111/Rural Vacant Land & small percentage in Managed Forest Land

¹From: Leatherberry & Spencer (1996) Michigan Forest Statistics, 1993. North Central Forest Experiment Station, Resource Bulletin NC-170.

² The Michigan property tax system does not specify the type of land owned by private individuals – most privately owned acreage is placed in the *Residential* tax class, no notation is recorded as to whether land is agricultural, grassland or forest. To best ensure our database contained addresses of private owners in Michigan who owned forest, we primarily included the Timber Cut-Over and Commercial Forest tax classifications. These tax classifications are the only parcels notated as forest land and include the highest percentage of privately held forests in Michigan (per recommendation of a Michigan Tax assessor – Marquette County Michigan).

³ From: Miles et al. (1995). Minnesota Forest Statistics, 1990, Revised. USDA Forest Service, North Central Forest Experiment Station, Resource Bulletin NC-158.

Wisconsin Counties included in Survey:

County	Acres Privately Owned⁴	Tax Classification Included
Bayfield	252,700 acres	All tax classifications
Douglas	253,600 acres	G5M, G5, G6
Lincoln	240,000 acres	G6/Productive Forest
Marinette	313,200 acres	G6/Productive Forest
Price	285,200 acres	G6/Productive Forest
Rusk	212,700 acres	G5M/ Agricultural Forest & G6/Productive Forest
Sawyer	218,300 acres	G5M/Agricultural forest & G6/Productive Forest & Managed Forest Lands
Washburn	192,900 acres	All tax classifications

⁴ From: Schmidt (1997). Wisconsin Forest Statistics, 1996. USDA Forest Service, North Central Forest Experiment Station, Resource Bulletin NC-183

Appendix B:

Pre-Test Open-Ended Contingent Valuation (WTA) Question

From: SECTION VII. WILLINGNESS TO SELL CARBON CREDITS

8. Assume that selling forest carbon credits would require you to:

- Sign a contract to participate in a carbon credit sale program for 15 years.
- Work with a professional forester to develop an inventory of your forest land.
- Work with a professional forester to develop and implement a forest management plan.
- Have your forest land certified (this verifies you are applying good stewardship practices).
- Manage your land consistent with carbon storage principles (for example, delay a harvest to allow more carbon to be stored in your trees, carry out certain forest management practices, reduce removal of dead biomass, fertilize).
- Allow verification and periodic monitoring by an independent third party.

If it cost you nothing to meet these requirements, what is the minimum annual payment per acre you would need to sell carbon credits generated from the forested parcel listed on the front of this questionnaire? (You would receive an annual payment based on the acreage of your parcel for 15 years, but would be required to participate for 15 years.)

\$ _____ per acre per year minimum payment

**LAKE STATES FOREST LANDOWNER SURVEY:
SELLING FOREST CARBON CREDITS**



State and County where your forest land is located:

Parcel Size:

Property Identification Number (PIN):
(#1)

Survey of Lake States Family Forest Owners -- Selling Forest Carbon Credits --

We want your opinion about emerging new markets that could give you the opportunity to sell carbon credits generated from your forest land. You do not need any prior knowledge of forest carbon credits in order to complete this questionnaire. However, we have enclosed a brochure in case you would like more background information on forest carbon credits. You do not need to read the brochure before completing the questionnaire.

Thinking specifically about the parcel of forest land identified on the cover of this questionnaire, answer all of the questions to the best of your ability. A partially filled out questionnaire cannot be used in the study. All of the information you provide will be kept anonymous and confidential.

I. INFORMATION ON YOUR FOREST LAND:

1. Estimate the percent of your parcel that is forested: _____%

2. Of your parcel's forested acres, estimate what percent is in each of the following tree size classes: *(indicate the percent of your forest land in each of the four tree size class categories)*
 - a) Regenerating size class (trees up to 3 inches in diameter) _____%
 - b) Small tree size class (trees between 3.1-6 inches diameter) _____%
 - c) Medium tree size class (trees between 6.1-9 inches diameter) _____%
 - d) Large tree size class (trees greater than 9 inches diameter) _____%

TOTAL: 100%

3. If the parcel listed on the cover of this questionnaire is adjacent to other forested parcels you own, please enter the total number of acres of all adjoining parcels: _____ total contiguous acres
(For example, if your forest land actually consists of two, 40 acre parcels each with separate PINs that are directly adjacent to each other, you would write in "80 total contiguous acres.")

What are Forest Carbon Credits?

Trees provide an important environmental service by removing carbon from the atmosphere and storing it in aboveground (tree trunk, branches, leaves) and belowground (roots) plant material. By increasing forest growth, landowners can enhance their forest's ability to remove carbon from the atmosphere and store it in trees.

Forest landowners may have the opportunity to benefit financially by selling carbon that is stored in the trees on their forest land. New markets for selling stored carbon are evolving as businesses seeking to offset their carbon emissions are looking to purchase carbon stored in forests in the form of carbon credits. By managing their forest land in certain ways, landowners may be able to sell carbon credits generated from their forest land.

Typical Landowner Requirements

- Sign a contract to participate in a carbon market program for a minimum number of years.
- Manage the forest land in specified ways to enhance carbon storage.
- Work with a professional forester to develop and use a forest management plan.
- Have the forest land certified (shows the landowner is applying good forestry practices).
- Allow periodic monitoring of forestry practices by someone from a carbon market program.

Landowner Financial Benefits

Landowners receive an annual payment based on the additional carbon stored in trees on their forest land.

II. FAMILIARITY WITH FOREST CARBON CREDITS

4. Prior to receiving this questionnaire, which of the following best describes your familiarity with Forest Carbon Credits? (check one)

- Extensive familiarity
 Some familiarity
 Minimal familiarity
 Never heard of them

III. BENEFITS AND COSTS OF SELLING FOREST CARBON CREDITS

5. Listed below are potential outcomes that may result from the sale of forest carbon credits generated from your forest land. Indicate how important each of these would be to you.

(circle one number for EACH reason listed below)

	Not Important			Very Important	
a) Water and soil quality on my forest land may be improved	1	2	3	4	5
b) The look of my forest land may be improved	1	2	3	4	5
c) Wildlife habitat on my forest land may be improved	1	2	3	4	5
d) I can generate additional income from my forest land	1	2	3	4	5
e) My forest will contribute to reducing atmospheric carbon	1	2	3	4	5
f) I may need to change the way my forest land is managed	1	2	3	4	5
g) I might lose some timber revenue by changing the way my forest is managed	1	2	3	4	5
h) I may have to commit to selling carbon credits for a minimum number of years	1	2	3	4	5

IV. REASONS FOR OWNING FOREST LAND

6. Listed below are several potential reasons for owning forest land. Indicate how important each reason is to you. (circle one number for EACH reason listed below)

	Not Important			Very Important	
a) Place to hunt	1	2	3	4	5
b) Place to enjoy nature	1	2	3	4	5
c) Grow timber to produce income	1	2	3	4	5
d) Real estate investment	1	2	3	4	5
e) Is close to areas of personal interest (e.g. near favorite lake, relatives or friends)	1	2	3	4	5
f) Other. Please specify: _____	1	2	3	4	5

V. POTENTIAL ACTIONS NEEDED TO SELL FOREST CARBON CREDIT

7. For each action listed below, indicate whether you have already carried out the action. If you **have not**, indicate the extent each would keep you from participating in a program that allows you to sell carbon credits generated from your forest land. **Assume each activity could be undertaken at no cost to you.**

[For EACH statement, answer whether you already do/ have this (Yes or No). If NO, please rate from 1 to 5 (1 being low – 5 being high) how much of a barrier obtaining or doing would be to your participating in selling forest carbon credits.]

	Do you already have or do this?		Barrier to participating in a program allowing you to sell forest carbon credits?				
	Yes	No	Outcome is-----				
			Not a Barrier			Considerable Barrier	
a) Obtain a detailed inventory of the types, size, and quality of trees on your forest land	Yes	No	1	2	3	4	5
b) Certify your forest land (shows you are applying good forestry practices)	Yes	No	1	2	3	4	5
c) Obtain a written plan for managing your forest land	Yes	No	1	2	3	4	5
d) Implement one or more actions identified in the forest management plan	Yes	No	1	2	3	4	5
e) Keep a written record of the land management activities you undertake	Yes	No	1	2	3	4	5
f) Use a professional forester in carrying out your land management activities	Yes	No	1	2	3	4	5
g) Allow periodic inspections of your forest land (every 2-5 years)	Yes	No	1	2	3	4	5
h) Convey a conservation easement on your land (a legal transfer of the property's development rights to a third party)	Yes	No	1	2	3	4	5

VI. WILLINGNESS TO SELL CARBON CREDITS

Assume that selling forest carbon credits would require you to:

- Sign a contract to participate in a carbon credit sale program for 15 years.
- Work with a professional forester to inventory your forest land.
- Work with a professional forester to develop and implement a forest management plan.
- Have your forest land certified (this verifies you are applying good stewardship practices).
- Manage your land consistent with carbon storage principles (for example, delay a harvest to allow more carbon to be stored in your trees, carry out certain forest management practices, reduce removal of dead biomass).
- Allow verification and periodic monitoring by an independent third party.

8. If it did not cost you anything to meet these requirements, would you sell carbon credits generated from the forested parcel listed on the front of this questionnaire if you were annually paid \$3 for each parcel acre? (For example, if your parcel is 40 acres, you would receive \$120 each year for 15 years, but would be required to participate for 15 years.) *(circle one)*

YES

NO

9. Indicate how certain you are of your response to question 8 above on a scale of 1 to 10, with 1 being completely uncertain and 10 being completely certain of your response. *(circle one)*

Completely
Uncertain

Completely
Certain

1 2 3 4 5 6 7 8 9 10

10. In formulating your response to question 8 above, please indicate how important the following were to you.

	Not Important			Very Important	
a) Length of contract	1	2	3	4	5
b) Payment amount offered	1	2	3	4	5
c) Actions you would be required to take (e.g., develop a management plan, allow periodic monitoring)	1	2	3	4	5

VII. HISTORICAL / PLANNED ACTIONS

11. Indicate which of the following actions/activities you have already undertaken and/or plan to undertake in the future on your forest land listed on the front of this questionnaire.

	(I've done this since owning the property)		(I plan to do this)	
	----Past----		---Future---	
	Yes	No	Yes	No
a) Harvest trees (other than for firewood)	Yes	No	Yes	No
b) Seek assistance from a professional forester	Yes	No	Yes	No
c) Participate in an educational, technical assistance, or financial program for forest landowners	Yes	No	Yes	No
d) Enroll in a special property tax program for forest landowners	Yes	No	Yes	No
e) Join a forest landowner association	Yes	No	Yes	No

VIII. LANDOWNER ATTITUDES

12. Listed below are some statements regarding the sale of forest carbon credits and climate change. Please indicate the degree to which you agree with each of these statements. (circle one number for EACH statement listed below)

	Strong Disagree			Strongly Agree	
	1	2	3	4	5
a) Climate change is real.	1	2	3	4	5
b) Human activities are contributing to climate change.	1	2	3	4	5
c) Forests can play an important role in mitigating climate change.	1	2	3	4	5
d) Selling carbon credits is a good way to reduce climate change.	1	2	3	4	5
e) I own enough forestland to make it worthwhile/feasible to sell carbon credits.	1	2	3	4	5
f) I know where to obtain the information or assistance I need in order to sell forest carbon credits.	1	2	3	4	5

13. Indicate how comfortable you would be with each of the organizations listed below that might assist you with selling forest carbon credits. (circle one number for EACH statement listed below)

	Not Comfortable			Very Comfortable	
	1	2	3	4	5
a) Professional forester	1	2	3	4	5
b) Nonprofit organization	1	2	3	4	5
c) Forest landowner association	1	2	3	4	5
d) Public forestry agency	1	2	3	4	5

IX. OVERALL INTEREST IN SELLING CARBON CREDITS

14. Based on what you know about carbon credits, how interested are you in selling carbon credits generated from your forest land? (circle one)

Not Interested										Very Interested	
1	2	3	4	5	6	7	8	9	10		

X. LANDOWNER INFORMATION

15. How long have you owned your forest land? _____ years

16. Is your permanent home located on your forest land? (check only one)

_____ YES, my home is located on my forest land.
_____ NO, I live _____ miles from my forest land.

17. Which best describes where you currently live? (check only one)

_____ Rural area
_____ Small rural town (less than 5,000 people)
_____ Large rural town (more than 5,000 people)
_____ Suburb of a metropolitan area
_____ Metropolitan area

18. Are you? (check one) _____ Male _____ Female

19. Your age: _____ Years old

20. What is the highest level of formal education you have completed? (check only one)

_____ Some High School or less	_____ Bachelor's Degree
_____ High School/GED	_____ Some Graduate School
_____ Some College	_____ Graduate Degree
_____ Technical/Community College Degree	

21. Annual household income: (Check one)

_____ less than \$25,000	_____ \$75,001 - \$100,000
_____ \$25,001 - \$50,000	_____ more than \$100,000
_____ \$50,001 - \$75,000	

22. Is there anything else you would like to share with us regarding opportunities to generate carbon credits from your forest land?

XI. INTERESTED IN TALKING MORE ABOUT FOREST CARBON CREDITS?

23. We will be organizing meetings with a small number of landowners to discuss how the sale of forest carbon credits could meet some of the needs of today’s private forest landowners. These meetings will be held in the evening, last approximately 1-2 hours, and involve approximately 10 – 15 forest landowners. Would you be interested in participating in one of these meetings?

_____ Yes _____ No _____ Maybe

If you answered “YES” or “MAYBE”, please indicate a phone number and/or email address where you can be reached.

Phone: (_____) _____

E-mail: _____

Thank you for taking time to complete this questionnaire! Please return this form using the pre-paid, self-addressed envelope provided. If you have any questions regarding the study we are conducting, please feel free to contact us:

**Dr. Mike Kilgore, Dept. of Forest Resources, University of Minnesota
1530 Cleveland Avenue North, St. Paul, MN 55108-6112
mkilgore@umn.edu 612-624-3400**

Appendix D

Random Selection of Lake States Landowners

- A sample size of 2,000 was desired for study purposes. The number 2,208 was decided upon as it allowed for expected undeliverables (conservatively estimated at 200) and also allowed for an even selection of survey combinations (i.e. 69 selection rounds of the 32 survey versions – $69 \times 32 = 2,208$)
- The number of landowners randomly drawn from the assemble database was weighted by the amount of family forest acreage in state relative to the total acreage of all family forest land in the included counties.

Michigan: 8,448.5 Thousand acres = $8,448.5/22,575.6 = 37\%$

For Pretest: $400 * .37 = 148$ surveys

For Survey: $2,208 * .37 = 817$ surveys

Minnesota: 5,291.1 Thousand acres = $5,291.1/22,757.6 = 23\%$

For Pretest: $400 * .23 = 92$ surveys

For Survey: $2,208 * .23 = 508$ surveys

Wisconsin: 9,018.0 Thousand acres = $9,018.0/22,575.6 = 40\%$

For Pretest: $400 * .40 = 160$ surveys

For Survey: $2,208 * .40 = 883$ surveys

Appendix E

Survey Accompaniments:

Survey Deployment according to Dillman (2000):

1.) Pre-Notice Postcard

A few days from now you will receive in the mail a brief questionnaire about forest ownership and carbon credits. This information is being collected as part of a research project being conducted by the University of Minnesota's Department of Forest Resources.

Completing the questionnaire should take no more than 10-15 minutes of your time and is entirely voluntary. All responses will be kept confidential. Please contact me if you have any questions about the survey. Thank you for your time and consideration.

Michael A. Kilgore, Ph.D.
Associate Professor
Director, Center for Environmental and Natural Resources Policy
612-624-3400
mkilgore@umn.edu

2.) Survey Cover Letter

April 15, 2011 March 7, 2012

FIRST NAME LAST NAME
STREET ADDRESS
CITY, STATE, ZIP CODE

Dear Sir or Madam,

We are requesting your help in a study of forest landowners being conducted by the University of Minnesota. This study is part of an effort to better understand forest landowner opinions about forest carbon credits. **Even if you don't know much about forest carbon credits, we'd like your opinion. Answering the questions does not require any previous knowledge about forest carbon credits.**

County property tax records show that you own forest land in COUNTY, STATE. To help us better understand forest landowner perspectives on forest carbon credits, we are asking that you complete the enclosed questionnaire. The questionnaire should not take more than 10 - 15 minutes of your time and is completely voluntary.

Some landowners think because they don't actively manage their land, they shouldn't fill out the questionnaire. That is not the case! Even if you haven't planted trees or harvested timber from your property, we would like your opinion. Because the questionnaire has been sent to a small number of landowners, it is extremely important that your input be included in the study.

We are very concerned about your privacy. Your answers will be completely confidential. Only summaries of our questionnaire data will be reported. We will not report individual responses.

Please feel free to contact us if you have any questions or comments about this study. We would be happy to talk with you.

It would greatly assist us if you could return the enclosed questionnaire within one week. Thank you very much for helping us with this important study.

Sincerely,



Michael A. Kilgore, Ph.D.
Associate Professor
Director, Center for Environmental and Natural Resources Policy
Phone: 612-624-3400
E-mail: mkilgore@umn.edu



Kristell Miller
Graduate Research Assistant
Phone: 612-625-8216
E-mail: mill4662@umn.edu

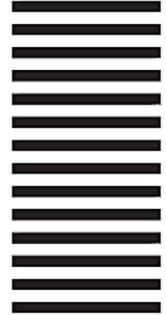
3.) Postage Paid Business Reply Envelopes:

UNIVERSITY OF MINNESOTA

6005.02
Department of Forest Resources
Kristell Miller - Graduate Research Assistant
Biosystems and Agricultural Engineering Bldg.
1390 Eckles Ave. Room #309
St. Paul, MN 55108



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UNITED STATES



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100 CHURCH ST SE
MINNEAPOLIS MN 55455-9819





Why Forests?

One advantage of using forests as a way to remove carbon from the air is that they provide benefits that other alternative carbon storage methods do not provide - such as clean air and water, wildlife habitat, and protection from soil erosion. Also, the potential to generate carbon credits from forests provides forest landowners with increased revenue opportunities for their forest land and keep local economies strong.³

Links to further Forest Carbon Credit Info.:

A Landowner's Guide to Carbon Sequestration Credits

- www.fas.org/sgp/crs/misc/RL34560.pdf

Michigan Forest Carbon Program

- www.michigan.gov/documents/dnr/CarbonSequestrationInMi_275110_7.pdf

My Minnesota Woods/ University of Minnesota

- www.myminnesotawoods.umn.edu/2009/04/carbon-credits-on-minnesota-woodlands/

Wisconsin Council on Forestry

- www.council.wisconsinforestry.org/pdf/CarbonMarkets.pdf

References:

1. Mountain Association for Community Economic Development. Online: <http://www.maced.org/foi/carbon.htm>
2. www.ForestryCarbon.com
3. Alabama Forestry Commission www.forestry.alabama.gov

OPTIONAL READING FOR SURVEY PARTICIPANTS

Forest Carbon Credits Frequently Asked Questions

Prepared by the Dept. of Forest Resources
University of Minnesota
Forest Carbon Credit Survey July 2010



What is a Carbon Credit?

Trees remove carbon dioxide (CO₂) from the air through a process called photosynthesis. Trees break down CO₂, store the carbon in all parts of the tree, and release oxygen back into the atmosphere. The process of removing carbon from the air and storing it (e.g. in trees) is called carbon sequestration.

The term "carbon credit" is a market term. It refers to a quantity of carbon removed from the air that can be purchased by an entity (e.g., power plant) wishing to offset its carbon emissions. Participation in a carbon credit market is **completely voluntary.**

Why are carbon credit markets developing?

Carbon credit markets are emerging as many companies (such as power plants) are seeking to voluntarily offset their total carbon emissions. Forest landowners who have earned carbon credits by implementing improved forest management practices can sell those credits through a carbon credit market. Carbon emission reduction (by companies) is currently voluntary but may become regulated in the future. A landowner's decision to participate in forest carbon trading is **completely voluntary**.

How can forests generate carbon credits?

Managed Forest Carbon Credits are generated by managing a forest such that its growth and the total carbon stored increases. By enhancing the growth of your forest to accumulate carbon more quickly, you may be able to generate carbon credits which can be offered for sale. It is important to note that carbon credits are typically earned for activities that are undertaken in addition to current 'business as usual' forest management.

How is the amount of carbon stored in a forest determined?

A professional forester conducts an initial inventory of the trees on your forest land. This data establishes a baseline for determining the increase in net carbon that will be stored over the term of a carbon credit contract through the landowner's implementation of certain management activities.¹



What types of management activities might a landowner need to apply?

Delaying harvesting, partial harvesting, planting fast growing trees, controlling competing vegetation, and fertilizing are some of the ways a landowner can influence the amount of carbon stored in a forest. Such activities are also important for the health and vitality of a growing forest. Forest landowners must consider the ability to continue such types of management activities before entering long-term contracts to sequester carbon.

What is required to sell carbon credits?

A landowner would typically be required to:

1. Sign a contract to participate in a carbon market program for a minimum number of years, typically several decades.
2. Manage his/her forest land in specified ways to enhance carbon storage.
3. Work with a professional forester to develop and use a forest management plan.
4. Have his/her forest land certified (shows you are applying good forestry practices).
5. Allow periodic monitoring of forestry practices by someone from a carbon market program.

How much money can I expect?

The amount of money a forest landowner can receive for carbon credits depends on combination of factors that include the amount of forest land owned, types/condition of trees, potential to increase forest growth with management practices as well as the current market price of carbon and demand from purchasing entities. For every 1 metric ton of carbon (measured in CO₂ equivalents) that your land is sequestering annually, one carbon credit is earned.

Appendix G

Contingent Valuation Question

VI. WILLINGNESS TO SELL CARBON CREDITS

Assume that selling forest carbon credits would require you to:

- Sign a contract to participate in a carbon credit sale program for 15 years.
- Work with a professional forester to inventory your forest land.
- Work with a professional forester to develop and implement a forest management plan.
- Have your forest land certified (this verifies you are applying good stewardship practices).
- Manage your land consistent with carbon storage principles (for example, delay a harvest to allow more carbon to be stored in your trees, carry out certain forest management practices, reduce removal of dead biomass).
- Allow verification and periodic monitoring by an independent third party.

8. If it did not cost you anything to meet these requirements, would you sell carbon credits generated from the forested parcel listed on the front of this questionnaire if you were annually paid \$ X¹ for each parcel acre?

(For example, if your parcel is 40 acres, you would receive \$ Y² each year for Z³ years, but would be required to participate for Z years.) (*circle one*)

YES

NO

¹ One of the following payment options was inserted here: \$3, \$5, \$10, \$20, \$30, \$40, \$50, \$60

² Payment amount X Contract Length

³ One of the following contract lengths was inserted here: 15, 25, 40, 50

Appendix H

Certainty and Three-Part “Weighting of Factors” Question:

9. Indicate how certain you are of your response to question 8 above on a scale of 1 to 10, with 1 being completely uncertain and 10 being completely certain of your response.
(circle one)

Completely
Uncertain

Completely
Certain

1 2 3 4 5 6 7 8 9 10

10. In formulating your response to question 8 above, please indicate how important the following were to you.

	Not Important		Very Important		
a) Length of contract	1	2	3	4	5
b) Payment amount offered	1	2	3	4	5
c) Actions you would be required to take (e.g., develop a management plan, allow periodic monitoring)	1	2	3	4	5

Appendix I

Code Book showing how variables were selected

Lake States Forest Landowner Survey: Selling Forest Carbon Credits		
CODE BOOK		
of		
EXPLANATORY VARIABLES		
Variable	Description	Survey Question Number
<i>Carbon Offset Program Characteristics</i>		
PAYMENT	A categorical variable indicating the payment amount offered (\$/ac/yr).	8
YEAR	A categorical variable indicating the contract length required	8
<i>Landowner Characteristics</i>		
GENDER	A binary variable indicating the gender of the participant (male=1)	19
EDUC	A categorical variable indicating level of education (proxy for income)	20
TENURE	A continuous variable indicating the length of ownership	15
RESIDE	A binary variable indicating whether the owner lives on their land	16
CO2.COMP	A continuous variable (composite score) indicating landowner attitude towards carbon reduction	Composite: 12a + 12b + 12c + 12d
FAMILIARITY	A categorical variable indicating the owner's familiarity with carbon credits	4
NON.MARKET	A continuous variable (composite score) indicating the importance of other non-market forest amenities (aside from carbon reduction)	Composite: 5a + 5b + 5c
MGMT.CHGS	A categorical variable indicating the importance placed on requiring management changes	5f
ADD.INCOME	A continuous variable (composite score) indicating the importance of other forest Income	5d
ASSIST.PROG	A binary variable indicating past participation in an educational or forest assistance program	11c (past)
BARRIERS	A continuous variable (composite score) indicating the rating of barriers posed by participation	Composite: Barrier scores for 7a + 7b + 7c + 7d + 7e + 7f + 7g + 7h
<i>Forest Parcel Characteristics</i>		
TOT.ACRES	A continuous variable indicating the size of the parcel	3
PAST.HAR	A binary variable indicating whether or not the owner has harvested in the past	11