An Assessment of Norwegian Family Forest Owner Interest in Carbon Offset Programs and Comparisons to the Lake States

by

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Abstract

In many countries, family forest owners own a significant share of the forest land and can, therefore, make important contributions to climate change mitigation by undertaking management measures that increase the amount of carbon sequestered in their forests. As more opportunities for forest carbon offsetting emerge, it becomes increasingly important to understand the factors that motivate family forest owners to participate in these types of programs. So far, only a limited number of studies have examined this question, all of which have been conducted in the United States. A mail survey of 1,500 Norwegian family forest owners was used to investigate the factors that influenced their interest in participating in a hypothetical carbon program. Results indicated that there is a considerable amount of interest among Norwegian landowners and that the most important predictors of participation were payment amount offered, perceived barriers posed by management actions, importance of nonmarket forest amenities, and attitudes toward climate change. These results were compared to an earlier study conducted in the United States' Lake States, which surveyed 2,208 family forest owners in Minnesota, Wisconsin, and Michigan. The comparative analysis found that there are many similarities between the two regions, both in terms of the most important predictors and overall estimated participation, and suggests that it may be possible to apply some of the common findings to other regions as well.

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1. Introduction

In its Fifth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) describes the warming of the Earth's climate as "unequivocal," and there is overwhelming evidence that climate change is driven by anthropogenic greenhouse gas emissions. If left unchecked, climate change poses serious risks to both human and natural systems (IPCC 2014).

As climate change has risen on the political agenda in many countries, there has been an increasing interest in emissions trading, or cap-and-trade, as a potential approach to reducing greenhouse gas emissions. Several emissions trading schemes have come into force during the past decade in various parts of the world, including the European Union, New Zealand, and California. In an emissions trading scheme, the central authority sets a cap on the total amount of emissions that can be emitted and allocates emissions permits (not exceeding the cap) to firms included under the scheme. Firms must hold permits equivalent to their own emissions, but are free to trade the permits among each other. In theory, emission in the market will be reduced at the lowest cost to society, as the firms who can reduce their own emissions cheaply will do so and sell their excess permits to firms who have a high cost of emissions abatement.

With the development of emissions trading, there has also been an increased interest in carbon offsetting as a component of emissions trading schemes. A carbon offset is a reduction in greenhouse gas emissions that can be used to compensate for emissions elsewhere. While emissions trading schemes generally only cover emissions from large-scale industrial facilities and power plants, carbon offsetting creates incentives for a variety of other activities that reduce greenhouse gas emissions. These activities can include renewable energy, energy efficiency, methane capture, and forestry. If approved under the framework of the emissions trading scheme, offset projects can generate carbon credits that can be sold in market. Firms then have the option to offset some of their emissions (usually a limited percentage) by purchasing these carbon credits.

Forestry activities have a particularly large potential for generating carbon offsets. Forests naturally sequester carbon dioxide from the atmosphere through the process of photosynthesis, and the amount of carbon dioxide that is sequestered can be increased through certain forest management practices (Nunery and Keeton 2010; Ruddell et al. 2007). These forest management practices can include changing harvesting levels, thinning, tree planting, and fertilization.

In many countries, family forest owners[1] own a significant share of the forest land and, therefore, play an important role in undertaking these management practices. Although opportunities for family forest owners to generate carbon offsets are beginning to emerge, relatively little is known about the factors that would affect these landowners to participate in these types of programs. So far, only a handful of studies have quantitatively examined this question (Dickinson et al. 2012; Fletcher et al. 2009; Markowski-Lindsay et al. 2011; Miller et al. 2012; Thompson and Hansen 2012), and no such study has yet been conducted outside the United States.

[1] Family forest owners are a subset of nonindustrial private forest owners and include families, individuals, trusts, estates, family partnerships, and other unincorporated groups of individuals that own forest land (Butler 2008).

This study contributes to the existing literature by examining the factors that influence family forest owner interest in carbon offset programs in Norway, and providing a comparative analysis of the results in Norway to a study by Miller et al. (2012) in the United States' Lake States. The study will address the following research questions:

1) How do various landowner characteristics, forest land characteristics, and program characteristics affect Norwegian family forest owner interest in carbon offset programs?
2) What are the implications of these findings for a potential carbon offset program in Norway?
3) In what ways are these results similar or different to those found in the Lake States, and what is the significance of these similarities or differences?

The next section presents the analysis of Norwegian family forest owner interest in carbon offset programs, the third section compares the findings of that analysis to the findings of the Lake States study, and the conclusion summarizes the key points of the sections.

2. Norwegian Family Forest Owner Interest in Carbon Programs

2.1 Introduction

Forests act as carbon sinks and, therefore, play an important role in mitigating climate change, removing carbon from the atmosphere equivalent to about a third of the world's combined annual greenhouse gas emissions (Pan et al. 2011). Certain forest management practices can increase the amount of carbon stored in forests (Nunery and Keeton 2010; Ruddell et al. 2007) and potentially provide one of the lowest-cost and highest-volume opportunities for climate change mitigation (Galik et al. 2009; Gorte and Ramseur 2008). If policy mechanisms are in place, private forest owners can get compensated for undertaking management practices that increase the amount of carbon stored on their land. For instance, in California's cap-and-trade system, forest management projects that increase carbon sequestration can generate credits that can be sold to offset emissions elsewhere in the market (CARB 2014).

In Norway, a quarter of the land area is covered in productive forest land, and overall about 40 percent of the country is forested (Rognstad and Steinset 2011). In 2005, Norwegian forests sequestered 29.9 Mt CO_2e, which was equivalent to 55 percent of the country's anthropogenic greenhouse gas emissions that year (Norwegian Ministry of the Environment 2008), and there is potential for carbon sequestration to be increased substantially. It has been estimated that over the next 100 years, forest management measures could increase sequestration of CO_2 by up to 12.3 million tons per year (Norwegian Climate and Pollution Agency 2010).

Family forest owners own 80 percent of productive forest land in Norway (Rognstad and Steinset 2011) and play a central role in the management of the country's forests. Thus, they also play an important role in Norway's efforts to reduce its net greenhouse gas emissions. Family forest owners are a diverse group with a wide range of objectives, values, and attitudes that have been found to affect their management decisions (Becker et al. 2013; Bolkesjø et al. 2007; Butler et al. 2007; Finley and Kittredge 2006; Ingemarson et al. 2006; Karppinen 1998; Kline et al. 2000). If

policymakers wish to implement programs aimed at increasing the amount of carbon sequestered in Norwegian forests, it is important to recognize the heterogeneity of Norwegian forest owners and the factors that influence their willingness to participate in such programs (Finley and Kittredge 2006).

So far, only a handful of studies have quantitatively examined the factors that influence family forest owner interest in participating in carbon programs (Dickinson et al. 2012; Fletcher et al. 2009; Markowski-Lindsay et al. 2011; Miller et al. 2012; Thompson and Hansen 2012), and no such study has yet been conducted outside the United States. This section investigates the factors that affect whether Norwegian family forest owners would be willing to manage their forests for increased carbon sequestration and estimates the potential supply of forest carbon offsets from family forestlands in Norway.

2.2 Background

2.2.1 Policy situation in Norway

There is currently no policy mechanism in place to encourage increased carbon sequestration on private Norwegian forest land or to allow Norwegian family forest owners to sell carbon credits. However, the topic is high on the political agenda, with several public reports and white papers discussing how Norwegian forests may contribute to climate change mitigation published during the past six years (Norwegian Climate and Pollution Agency 2010; Norwegian Ministry of Agriculture and Food 2009; Norwegian Ministry of the Environment 2012; Ministry of Climate and Environment 2015). While more intensive management and improved carbon efficiency in the use of forest products are clearly stated as proposed measures, the question of changing the harvest level has been much more controversial and subject of much public debate also outside the forestry sector. In the Report No. 21 (2011–2012) to the Storting (the Norwegian parliament), examining collaboration systems with private forest owners to establish "climate forests" was explicitly mentioned as one of several measures that the government would undertake in Norway to mitigate climate change (Norwegian Ministry of the Environment 2012).

The standing volume in Norway's forests is currently at a high due to improved forest management practices, intensive planting and afforestation between 1950 and 1990, and relatively stable harvest levels. However, due to a decline in planting investments, the forests are growing older and growth will be reduced in the future (Trømborg et al. 2011).

The most important policy mechanism that ensures sustainable forest management in Norway is the Forestry Act of 2005. The Forestry Act defines the responsibilities of all forest owners and aims to promote economic development, secure biological diversity, and protect the recreational and cultural values associated with the forest. According to the Act, forest owners "shall have an overall view of the environmental values in his own forest and pay regard to them when carrying out all activities in the forest" (Norwegian Forestry Act 2005).

Guidelines for sustainable forest management are outlined in the national "Living Forest" standard, which is accepted under the Programme for the Endorsement of Forest Certification (PEFC). The standard has 25 sections, covering topics such as harvesting methods, areas of ecological importance, riparian buffer zones, and species composition (Living Forests 2007). Norwegian forest owner associations have made certification based on this standard mandatory

for forest owners wanting to sell commercial timber through the associations. Group certification through the forest owner associations has reduced the cost of certifying small forest properties and has led to practically all commercial timber in Norway being certified (Norwegian Forestry Society 2011).

The Forestry Act also requires forest owners to reinvest a voluntary share of between 4 and 40 percent of their timber revenue in the government administered Forest Trust Fund, with the default share, if the owner does not take any active decision, being 10 percent. The tax exemption share is 185 percent, thus offering substantial tax reductions depending on the owner's marginal tax rate. The funds can be used to finance activities such as tree planting, management planning, road construction and maintenance, and protecting important environmental values (Norwegian Forestry Act 2005; Norwegian Forestry Society 2011).

2.2.2 Existing literature

Only a handful of studies have quantitatively examined factors that influence family forest owner interest in participating in carbon offset programs. The first such study was a pilot study conducted by Fletcher et al. (2009), which surveyed 17 private forest owners in Massachusetts. Participants were asked to rate six hypothetical carbon credit programs on a scale of 1 to 10 according to how likely they would be to enroll in the program. The programs varied according to whether a management plan was required, time commitment, expected payment, and whether there was a penalty for early withdrawal. Tobit and logit models were used to analyze the results. The study found that the highest rated programs were those that had a higher expected payment, did not have an early withdrawal penalty, did not require a management plan, and had a longer time commitment. Socioeconomic factors were not found to be significant, however, the authors point out that this was likely due to their limited sample size.

Dickinson (2010) expanded on the findings of Fletcher et al. (2009), using mail survey data of approximately 1,400 Massachusetts family forest owners. The results were summarized by Dickinson et al. (2012). Respondents were asked to rate three hypothetical carbon sequestration programs that varied according to the same four attributes as the Fletcher et al. (2009) study. An ordered logit discrete choice model was used to predict likelihood of enrollment for each program. As in the Fletcher et al. (2009) study, respondents similarly preferred programs that had a higher expected payment, no early withdrawal penalty, and no management plan requirement. However, in this study respondents favored shorter time commitments.

Building on the preliminary findings of Dickinson (2010), another study was conducted in Massachusetts by Markowski-Lindsay et al. (2011) using survey data from 930 landowners. The survey asked respondents to rate three carbon programs, which varied according to the amount of required enrolled acreage, the contract length, whether the program included an additionality requirement, whether the program had an early withdrawal penalty, and whether the program was implemented by the public sector or the private sector. Results from a random effects ordered probit suggested that longer contract lengths, additionality requirements, and early withdrawal penalties reduced the probability of participation. The study also found that certain landowner characteristics, such as having higher education and believing that forests can reduce climate change, increased the probability of participation. Overall, the three Massachusetts studies found that family forest owner participation would be quite low given program

characteristics similar to those in existing carbon sequestration programs, and that nonmonetary factors played an important role in landowner decision-making.

Another study was conducted by Thompson and Hansen (2012) using data from a nationwide mail survey of 429 U.S. family forest owners. The survey asked questions gauging respondents' attitudes toward potential economic and environmental impacts of participating in carbon sequestration and trading, as well as questions about the respondent's land characteristics, land-use planning, and demographic information. A cluster analysis revealed two distinct clusters of positive and negative attitudes among respondents about managing their forest for carbon sequestration and trading. Respondents in the positive attitude cluster tended to own smaller parcels and actively manage their forest.

Miller et al. (2012) conducted a study examining the factors influencing landowner participation in forest carbon offset programs in Michigan, Wisconsin, and Minnesota. The study used a mail-back questionnaire that posed a dichotomous choice question about whether respondents would enroll in the program given a specified per acre payment and contract length. Combinations of eight different payment amounts ($3, $5, $10, $20, $30, $40, $50, $60) and four different contract lengths (15, 25, 40, 50 years) were used, giving 32 different survey versions. The questionnaire also included questions about ownership objectives and practices, forest land characteristics, attitudes toward climate change, familiarity with carbon markets, and landowner demographics. The data were then used to estimate participation rates of potential carbon offset programs given various payment amounts and contract lengths, as well as identify the factors that significantly affect participation. Overall, Miller et al. (2012) found that many landowners would be interested in participating given favorable financial conditions and short contract periods, particularly absentee owners who owned larger parcels and had already completed some of the carbon program requirements. Landowners were also more likely to participate if they had positive attitudes toward using forests to mitigate climate change and if they greatly valued the nonmarket amenities of their forest.

In general, these previous studies show that landowners are sensitive to program requirements and conditions. As one might expect, they prefer programs with higher compensation amounts and less stringent requirements regarding the time commitment, early withdrawal, and management plans. However, the studies also suggest that landowner interest in carbon programs is motivated by nonmonetary factors. Although there is no clear consensus on the most important factors, the previous studies suggest that active forest managers with a high level of education and who believe that forestry can play an important role in mitigating climate change are more likely to be interested in participating in carbon programs.

As only a small number of studies on family forest owner interest in participating in carbon programs have been conducted, there are important information gaps that need to be addressed. All of the studies so far have been conducted in the United States, several in Massachusetts, and as Markowski-Lindsay et al. (2011) point out, forest ownership trends and behavior are likely to vary by region. More studies need to be conducted in other parts of the United States, as well as the world, to better understand how regional differences affect landowner decision-making, particularly as emissions trading and carbon offsetting opportunities continue to develop.

The studies that have been conducted so far have also had samples dominated by relatively small landowner holdings. For instance, Markowski-Lindsay et al. (2011) and Miller et al. (2012) had mean parcel sizes of 48 acres (19 ha) and 63 acres (25 ha) respectively. While small acreage landowners make up the largest number of family forest owners in the respective study regions, they do not necessarily account for the largest share of the total forest land or those landowners who might be most inclined to participate. To estimate the total potential increase in carbon sequestration from a national carbon program in Norway, it is important to understand what influences the behavior of large acreage landowners as well. This study attempts to address both of these information gaps.

2.3 Data and methods

2.3.1 Survey development

In collaboration with Statistics Norway, a mail survey was developed based on the one used by Miller et al. (2012) to investigate Norwegian family forest owners' interest in participating in carbon offset programs. The survey was mailed to a random sample of 1,500 landowners who owned at least eight hectares of forest land in Norway. The sample was stratified by property size, using three size classes: 8.0 to 49.9 ha, 50.0 to 99.9 ha, and >99.9 ha. The sample in each size class was drawn proportional to the total forest area in each size class. This was done to generate an overrepresentation of large acreage forest owners. A total of three mailings were sent beginning in April 2013, following the Total Design Method (Dillman 1978). Each mailing included a personally addressed cover letter, the full survey, and a prepaid return envelope. Surveys returned by August 1, 2013 were considered for analysis.

The survey presented respondents with a hypothetical carbon program that varied in terms of the number of years a respondent would be required to participate (10, 25, or 50 years) and the payment amount they would receive per hectare per year (50, 200, 400, or 600 NOK).[2] Twelve versions of the survey were created using combinations of the three different contract lengths and the four different payment amounts. Respondents were provided information about several management actions they would need to undertake in order to participate, such as having a forest management plan prepared, having the forest certified by an independent third party, and carrying out management actions that increase carbon sequestration in the forest. It was made clear that these management actions would depend on the specific conditions of the landowner's forest and could include harvesting more or less timber, increasing tree planting, or increasing fertilization. Respondents were then presented with a dichotomous choice question asking whether they would participate in the program given the conditions outlined above.

Several studies have found that contingent valuation studies exhibit hypothetical bias both when estimating willingness to pay (WTP) and willingness to accept (WTA) (Blumenschein et al. 1998; Champ and Bishop 2001; Champ et al. 1997; List and Gallet 2001; Murphy et al. 2005). Although studies tend to find that contingent valuation studies overestimate WTP, there is no consensus on the direction of hypothetical bias in WTA studies (List and Gallet 2001). Some studies have found that explicitly asking respondents about the certainty of their response can

[2] These payments correspond to approximately 6, 26, 51, and 77 USD per hectare per year, given an exchange rate of 7.8 NOK/USD.

allow researchers to better estimate actual behavior (Champ and Bishop 2001; Champ et al. 1997).

In this study, the payment amount offered may have been very close to the respondent's reservation price, i.e. the lowest amount of compensation they would have been willing to accept, and/or they may have needed more information about the carbon program to be able to make a decision. Therefore, following the dichotomous choice question, respondents were asked two questions about how confident they felt in their answer using a five-point rating scale. The first question asked how certain they were given the conditions in the contract, and the second question asked how certain they were given the information they had received about the carbon program.

The survey also asked several questions about the respondent's objectives (e.g. reasons for owning forest land, past and planned management actions) and attitudes (e.g. importance of various forest characteristics, perceived barriers to participation, attitudes towards climate change and using forests to mitigate climate change). Finally, the survey included several questions about the respondent's demographic information (e.g. age, gender, education, residential information). The full survey translated survey can be found in Appendix A.

2.3.2 Model development

A random utility model (Hanemann 1984) provides the theoretical basis for estimating Norwegian family forest owner interest in participating in carbon programs. The underlying assumption is that a landowner will make choices that maximize their own utility. A landowner's utility function is made up of observed factors (v), which includes carbon program attributes and sociodemographic characteristics, and unobserved factors (ε) (Train 2009). The utility function can be written as:

$$u_i = v_i + \varepsilon_i \quad (1)$$

If u_1 is the utility a landowner receives from participating in the carbon program and u_0 is the utility a landowner receives from not participating, they would only participate if $u_1 > u_0$.

Several discrete choice models can be used to predict a landowner's decision, depending on how the unobserved error term (ε) is specified. The logistic regression model, which assumes that each error term is independently and identically distributed following the Gumbel distribution, is the most widely used discrete choice model (Train 2009).

The survey data were analyzed using a binary logistic regression model, and all computations were done using the statistical software R version 3.1.0. The dependent variable was the respondent's answer to the dichotomous choice question, which took on the value of "1" if the respondent was willing to accept the conditions and participate in the carbon program and "0" if the respondent was not willing to participate. The model takes the general form:

$$\text{logit}(Y_i) = \ln\left(\frac{p_i}{1-p_i}\right) = \alpha + \beta' X_i \quad (2)$$

Where:

Y_i outcome of interest (whether a landowner will participate in the carbon program)

p_i probability of outcome
A intercept
β' vector of regression coefficients
X_i vector of predictor variables (e.g. payment amount, parcel size, past harvesting, etc.)

Eq. (2) can be rewritten to allow us to estimate the probability of occurrence of the outcome of interest (Peng et al. 2002):

$$\mathrm{P}(Y_i = 1|X_i) = \frac{e^{\alpha+\beta' X_i}}{1 + e^{\alpha+\beta' X_i}} = \frac{1}{1 + e^{-(\alpha+\beta' X_i)}} \quad (3)$$

Existing literature on family forest owners was used to inform the decision about which predictor variables to include in the model and their hypothesized effect on participation in carbon programs. These variables can be grouped into three categories: carbon program characteristics, forest land characteristics, and landowner characteristics (Table 1).

Previous studies suggest that payment amount and contract length are important carbon program characteristics and were included in the model. Several studies have demonstrated a positive relationship between the payment amount offered and participation in carbon programs (Fletcher et al. 2009; Markowski-Lindsay et al. 2011; Dickinson et al. 2012; Miller et al. 2012) as well as in incentive programs for conservation or other ecosystem services (Kline et al. 2000; Sullivan et al. 2005; Kilgore et al. 2008a; Layton and Siikamäki 2009; Rabotyagov and Lin 2013). Payment amount (PAYMENT) was therefore hypothesized to have a positive effect on participation.

Although the length of the time commitment was found to positively impact participation in Fletcher et al. (2009) pilot study, most studies on carbon programs (Dickinson et al. 2012; Markowski-Lindsay et al. 2011; Miller et al. 2012) and other incentive programs (Layton and Siikamäki 2009; Rabotyagov and Lin 2013) have found that landowners prefer shorter contract lengths. Contract length (YEARS) was therefore hypothesized to have a negative effect on participation.

Two forest land characteristics were hypothesized to affect participation: total amount of forest land owned and whether the landowner had harvested timber in the past. The literature suggests that the impact of forest size is somewhat mixed, with most studies on carbon programs finding forest size to have no effect, or a marginally significant positive effect (Dickinson et al. 2012; Markowski-Lindsay et al. 2011; Miller et al. 2012). Thompson and Hansen (2012) found that larger landowners tend to have more negative attitudes toward carbon sequestration and trading. For other types of incentive programs, some studies found total forest size to positively affect participation (Kilgore et al. 2008b; Lindhjem and Mitani 2012; Mäntymaa et al. 2009; Sullivan et al. 2005), while others found it to have a negative effect (Kline et al. 2000; Rabotyagov and Lin 2013). Total forest land owned (HECTARES) was therefore included in the model with an uncertain hypothesized effect. Whether the landowner had harvested in the past (HARVEST) was included as an indicator of whether the forest was being actively managed (Butler et al. 2007). The hypothesized effect on participation was positive, as it has been suggested that landowners already actively managing their forests are more willing to take the management actions required to participate in carbon programs (Markowski-Lindsay et al. 2011).

Several landowner characteristics were also included in the model. Gender (MALE) was included, although the literature suggests the role of gender is mixed. While Miller et al. (2012) found that men were more likely to participate in carbon programs, Dickinson et al. (2012) found that women were more likely to participate. The hypothesized effect of gender was therefore uncertain. Several studies suggest that landowner education level has a positive effect on participation in carbon markets (Dickinson et al. 2012; Markowski-Lindsay et al. 2011; Thompson and Hansen 2012). A variable indicating whether the landowner has education beyond the high school level (HIGHER.ED) was included and hypothesized to have a positive effect on participation. Length of ownership, in years, (TENURE) was also included in the model with a negative hypothesized effect, as some studies have found evidence suggesting that land tenure may have a negative effect on participation in carbon programs (Miller et al. 2012) and conservation programs (Rabotyagov and Lin 2013). Residing on the forest land (RESIDE) was also thought to affect participation, though the hypothesized effect was uncertain. Miller et al. (2012) found that absentee owners were more interested in participating in carbon programs, while Thompson and Hansen (2012) found that absentee owners were less likely to participate. Kilgore et al. (2008a) found that landowners were more likely to participate in a program if they were familiar with it prior to receiving the survey, so a categorical variable indicating level of familiarity with managing forests for carbon sequestration (FAMILIARITY) was included and hypothesized to have a positive effect on participation.

Family forest owners have diverse motivations for owning forest land, many of which involve nontimber values (Butler et al. 2007; Kline et al. 2000). Miller et al. (2012) found that landowners who place importance on generating nontimber income from their land were more interested in selling carbon credits. A categorical variable indicating the importance of generating nontimber income (e.g. hunting and fishing licenses, rent from cabins) from the forest land (OTHER.INCOME) was therefore included and hypothesized to positively affect participation. Managing forests for carbon sequestration has the potential to enhance other nonmarket amenities in a forest such as soil and water quality and biodiversity compared to traditional timber management. Miller et al. (2012) found that landowners who place a high level of importance on these nonmarket amenities are more likely to participate in carbon programs. A composite score indicating the importance of nonmarket forest amenities (NON.MARKET) was therefore included and hypothesized to positively affect participation.

Participating in a carbon program would require a landowner to take specific management actions to increase carbon sequestration on their land (establishing additionality), which may be a barrier to participation. Respondents rated the extent to which a variety of potential management actions would present barriers to participation, and a composite score (BARRIERS) was included in the model and hypothesized to negatively affect participation, as was found by Miller et al. (2012). Other studies have found that landowners are less interested in participating in carbon programs that require management plans and establishing additionality, which would also support this hypothesis (Dickinson et al. 2012; Markowski-Lindsay et al. 2011).

Finally, it was hypothesized that landowners who believe climate change is an important concern and that forests can play an important role in mitigating climate change would be more interested in participating (Markowski-Lindsay et al. 2011; Miller et al. 2012). Respondents were asked to rate their level of agreement with statements claiming that humans have contributed to climate

change, that forests can play an important role in mitigating climate change, and that they own enough forest for it to be worthwhile to manage for carbon. A composite score (CO2.COMP) was included with a positive hypothesized effect.

Two other variables were also considered for inclusion: whether a respondent was a member of a forest management association and their income level. After testing for correlation between the independent variables, however, these variables were found to be highly correlated with past harvesting and higher education respectively and were excluded.

Table 1: Description of variables hypothesized to have an effect on participation in carbon programs

Variable	Description	Hypothesized effect on participation
Carbon program characteristics		
PAYMENT	Categorical variable indicating the payment amount offered (50, 200, 400, or 600 NOK/hectare/year)	Positive
YEARS	Categorical variable indicating the contract length required (10, 25, or 50 years)	Negative
Forest land characteristics		
HECTARES	Continuous variable indicating the total amount of forest land owned in hectares	Uncertain
HARVEST	Binary variable indicating whether the respondent has harvested timber in the past	Positive
Landowner characteristics		
MALE	Binary variable indicating the gender of the respondent (1 = male)	Uncertain
HIGHER.ED	Binary variable indicating whether the respondent has attained education beyond a high school diploma	Positive
TENURE	Continuous variable indicating length of ownership	Negative
RESIDE	Binary variable indicating whether the respondent resides on or within 10 km of their forest land	Uncertain
FAMILIARITY	Categorical variable indicating the respondent's level of familiarity with managing forests for carbon sequestration	Positive
OTHER.INCOME	Categorical variable indicating importance of generating nontimber income from the forest land	Positive
NON.MARKET	Continuous (composite) variable indicating the importance of nonmarket forest amenities (e.g. soil and water quality, aesthetics, biodiversity)	Positive
BARRIERS	Continuous (composite) variable indicating the extent to which various required actions are perceived as barriers to participation	Negative
CO2.COMP	Continuous (composite) variable indicating the respondents attitudes toward climate change and using forests to mitigate climate change	Positive

2.3.3 Data inspection

Before conducting the analysis, the suitability of logistic regression as an analysis method was assessed. As shown in Eq. (2), logistic regression assumes that the log odds ratio is linearly related to the predictor variables. To check this linearity assumption, each continuous and categorical predictor variable was binned, and the log odds ratio was plotted for each bin. All but two variables were found to adequately meet the linearity assumption without needing transformations. The variables PAYMENT and HECTARES were found to meet the linearity assumption when transformed by taking the natural log of the variable, so the transformed variables lnPAYMENT and lnHECTARES were included in the model instead.

As is common with voluntary surveys, many respondents did not fill out responses to every item. About two-thirds of respondents answered all items that were included as variables in the model. Overall, about 5 percent of the items for the model variables were missing. Although a common method for dealing with missing data is listwise deletion, which involves eliminating an entire observation if any entries are missing, this method results in the loss of valuable information and a potential selection bias, as it assumes data is missing completely at random (MCAR) (King et al. 2001). To test, a Little's MCAR test was run, giving a Chi-squared of 3,439.742 on 3,240 degrees of freedom, and a p-value of 0.007. The null hypothesis that the data is MCAR was therefore rejected, suggesting that listwise deletion could indeed lead to biased results.

One of the most highly recommended methods for dealing with missing data in the social sciences is multiple imputation (King et al. 2001; Little et al. 2014; Manly and Wells 2012; Schafer and Graham 2002). Multiple imputation uses the distribution of the observed data to estimate plausible estimates for the missing values. Multiple datasets are created, each of which is slightly different due to random components that reflect the uncertainty in the values (White et al. 2011). Each dataset is analyzed individually and the results are combined using the rules outlined by Rubin (1987) to obtain overall coefficients and standard errors.

The R package Amelia II (Honaker et al. 2011) was used to create ten multiple imputed datasets. All variables were included in the imputation model, including the dependent variable and skewed variables, without modification, as is recommended (Honaker et al. 2011; Schafer and Graham 2002; von Hippel 2012). The R package Zelig (Owen et al. 2013) was used to analyze the datasets and combine results.

2.4 Results

2.4.1 Survey response rate

Of the 1,500 surveys mailed to Norwegian family forest owners, seven were undeliverable and 15 were incorrectly sampled (e.g. recipient was deceased or no longer owned forest property), giving an adjusted sample size of 1,478. A total of 841 surveys were returned, of which 831 were considered usable for the analysis. Only surveys returned completely blank or where the respondent indicated they did not own forest land were removed before conducting the analysis. In addition, there were 25 responses from landowners who did not wish to participate. This gave an overall response rate of 59 percent, and a usable response rate of 56 percent.

This response rate is high compared to other surveys of family forest owners, which tend to be in the range of 32 percent to 67 percent (Butler et al. 2007; Dickinson et al. 2012; Kendra and Hull 2005; Kilgore et al. 2008b; Markowski-Lindsay et al. 2011; Miller et al. 2012; Rasamoelina et al. 2010). Few surveys of Norwegian family forest owners have been conducted previously; however, a survey examining their WTA compensation for voluntary conservation achieved an overall response rate of 38.5 percent (Lindhjem and Mitani 2012).

2.4.2 Sample description

The mean respondent was 55 years old and owned 319 hectares of forest land (median forest size was 150 ha), and had owned their forest property for 22 years. About 83 percent of respondents were male, 43 percent had completed some higher education, and 82 percent resided on or within

10 km of their forest land. Respondents tended to be active forest managers, with about 73 percent being members of forest owner associations and 78 percent having harvested timber for sale since owning the property. The most important reasons for forest ownership were "Heritage/family tradition," "Part of farm or other property," and "Timber income" (receiving mean scores of 3.93, 3.69, and 3.48 on a 5-point rating scale respectively).

Overall, 48 percent of respondents indicated that they would be interested in participating in a carbon program, given the contract conditions offered. Respondents indicated a moderate level of previous knowledge regarding managing forests for carbon sequestration (10 percent stating they had very good knowledge and 12 percent saying they had no previous knowledge, with the rest somewhere in between). Respondents cited fertilizing more and changing harvesting practices as the largest barriers to participation in carbon programs. On the other hand, getting their forest certified, having an inventory and management plan prepared, and implementing measures in the management plan were not seen as particularly large barriers. This is likely due to the fact that the sample consisted largely of active landowners, and each of these three measures had already been completed by between 60 percent and 67 percent of respondents during the past 10 years.

With regards to their attitudes about using forests to mitigate climate change, 41 percent of respondents said they completely agree (5 on a 5-point rating scale) that humans have contributed to climate change, 42 percent completely agree that forestry can play an important role in mitigating climate change, while only 15 percent completely agree that they own enough forest for it to be worthwhile to implement measures to mitigate climate change on their land.

2.4.3 Checking for nonresponse bias

In order to check for potential nonresponse bias, respondents were compared to those who did not return the survey. Statistics Norway provided data on selected variables for the entire population of family forest owners, the gross sample (i.e. all the landowners in the sample), and the net sample (i.e. all landowners who returned the survey) (Table 2). These data show that respondents were more likely to be male, have harvested timber, and own more forest land than nonrespondents. As this study purposefully oversampled large acreage landowners and thereby also more active landowners, this means these landowners are even more overrepresented in the net sample. Respondents were very similar to nonrespondents, and the population, in terms of age and living on the forest property.

Table 2: Mean values for population, gross sample, and net sample

Variable	Population	Gross sample	Net sample
Age (years)	56.0	55.4	55.2
Male	77%	78%	81%
Harvested timber in 2011	15%	29%	34%
Live on forest property	63.6%	64.1%	63.5%
Total forest area (ha)	85.3	221.9	265.7

2.4.4 Logistic regression models

The logistic regression model was run on six different subsets of respondents. Model 1 included all respondents and modeled factors that were hypothesized to affect overall interest in participating in carbon programs in the sample. Guided by studies that examined the potential for

hypothetical bias in contingent valuation studies (Champ and Bishop 2001; Champ et al. 1997), Model 2 includes only respondents who indicated they were certain about their response to the dichotomous choice question (i.e. whether or not they would participate in the carbon program given the contract conditions they were offered). Responses to the two certainty questions were averaged, and a cutoff of >=4 on the 5-point rating scale was used to determine whether the respondent was certain of their response. The choice for the cutoff was informed by Champ and Bishop (2001), who found that stated behavior was most similar to actual behavior when only responses with eight or more on a 10-point certainty scale were considered valid.

Because the sample was stratified to give an overrepresentation of large forest owners, this allowed us to run a separate model on their responses, something that has not been done in previous studies on family forest owner participation in carbon programs. Model 3 included only landowners who own more than 150 hectares of forest land, and Model 4 included only landowners who own 150 hectares or less of forest land.

Also of interest was examining the influence of the explanatory variables for landowners who actively manage their land compared to landowners who do not actively manage their land. As landowners who are members of a forest owner association tend to be more actively managing their land, the sample was divided into respondents who were members of forest owner associations and those who were not. The interest of forest owner association members in participating in carbon programs is modeled in Model 5, while nonmembers are modeled in Model 6. Descriptive statistics for the sample subsets used in Models 1, 3, 4, 5, and 6 are shown in Table 3.

Table 3: Mean values and standard deviations (in brackets) for sample subsets

	All respondents (n=831)	Large acreage landowners (>150 ha) (n=385)	Small acreage landowners (<=150 ha) (n=387)	Members of forest owner associations (n=596)	Nonmembers (n=224)
Would accept contract conditions	48%	56%	43%	52%	38%
Age (years)	55.4	54.4	55.7	55.0	56.6
	(12.2)	(11.5)	(12.9)	(11.9)	(12.8)
Male	83%	85%	81%	83%	87%
Have education beyond high school	43%	47%	41%	47%	35%
Length of ownership (years)	22.0	22.3	21.4	22.5	20.8
	(13.3)	(12.3)	(14.2)	(13.2)	(13.6)
Reside on or within 10 km of forest property	82%	84%	81%	84%	76%
Member of forest owner association	73%	86%	62%	100%	0%
Forest land owned (hectares)	319.3	564.8	75.0	384.8	138.7
	(1694.5)	(2379.7)	(45.1)	(1974.0)	(185.4)
Previously harvested timber for sale	78%	90%	69%	91%	43%
Forest certified during the past 10 years	66%	81%	57%	81%	27%
Prepared a management plan during the past 10 years	61%	75%	50%	73%	30%
Implemented management measures during the past 10 years	65%	80%	53%	79%	26%

2.4.5 Significant predictors of participation

Table 4 reports the coefficients and standard errors of the logistic regression analyses. The payment amount offered (PAYMENT) is highly significant in all but one of the models and has a positive coefficient as expected. The contract length required (YEARS) has a negative coefficient as expected; however, it is not statistically significant in most of the models. The amount of forest land owned (HECTARES) only has a marginally significant positive affect on participation in Model 1, while having harvested previously (HARVEST) is significant in Model 3, but with a negative coefficient, opposite of what was hypothesized.

Table 4: Regression coefficients and standard errors (in brackets) of factors influencing Norwegian family forest owner participation in carbon programs

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	All respondents (n=831)	Only certain respondents (n=394)	Large acreage landowners (>150 ha) (n=385)	Small acreage landowners (<=150 ha) (n=387)	Members of forest owner associations (n=596)	Nonmembers (n=224)
Intercept	0.4212	-2.3100	5.0047*	-0.5189	0.7458	-0.7515
Carbon program characteristics						
lnPAYMENT	0.4442***	0.8477***	0.5187***	0.4346***	0.5077***	0.3020
	(0.0957)	(0.1664)	(0.1458)	(0.1477)	(0.1103)	(0.2012)
YEARS	-0.0049	-0.0111	-0.0110	-0.0080	-0.0112*	0.0184
	(0.0054)	(0.0093)	(0.0085)	(0.0084)	(0.0064)	(0.0113)
Forest land characteristics						
lnHECTARES	0.1600*	0.1652	0.0285	0.1815	0.1201	0.2216
	(0.0900)	(0.1575)	(0.2223)	(0.1770)	(0.1233)	(0.1809)
HARVEST	-0.3299	-0.5771	-0.9869**	-0.1906	-0.2771	-0.0515
	(0.2603)	(0.4387)	(0.5001)	(0.3417)	(0.4067)	(0.3926)
Landowner characteristics						
MALE	-0.1692	-0.0042	-0.4291	0.1447	-0.2056	0.0492
	(0.2530)	(0.4272)	(0.3913)	(0.3957)	(0.2790)	(0.6200)
HIGHER.ED	0.4841**	0.7348**	0.2199	0.6367**	0.7345***	-0.2495
	(0.1881)	(0.3288)	(0.2937)	(0.2893)	(0.2260)	(0.4150)
TENURE	-0.0045	0.0104	-0.0071	0.0004	-0.0083	0.0017
	(0.0069)	(0.0124)	(0.0111)	(0.0104)	(0.0082)	(0.0137)
RESIDE	-0.1714	0.6058	-0.6496	0.0240	-0.1001	-0.3863
	(0.2520)	(0.4246)	(0.4082)	(0.3763)	(0.3156)	(0.4537)
FAMILIARITY	0.0064	0.0108	0.0101	0.0234	-0.0779	0.1874
	(0.0925)	(0.1541)	(0.1500)	(0.1473)	(0.1187)	(0.1678)
OTHER.INCOME	0.0315	0.0000	-0.0306	0.0944	0.0721	-0.0179
	(0.0728)	(0.1164)	(0.1129)	(0.1176)	(0.0816)	(0.1682)
NON.MARKET	-0.2603**	-0.3835*	-0.6040***	-0.2788	-0.3212**	-0.1068
	(0.1233)	(0.2162)	(0.2139)	(0.1979)	(0.1537)	(0.2429)
BARRIERS	-1.4724***	-1.9347***	-2.0113***	-1.5249***	-1.5772***	-1.2993***
	(0.1398)	(0.2383)	(0.2585)	(0.2081)	(0.1773)	(0.2409)
CO2.COMP	0.3890***	0.6836***	0.4500**	0.4859***	0.4414***	0.3034
	(0.1148)	(0.1931)	(0.1839)	(0.1705)	(0.1394)	(0.2044)
Goodness-of-fit statistics						
Null deviance	1150.82	545.86	527.41	528.76	825.49	298.57
Residual deviance	831.50	300.42	345.83	376.49	591.03	212.18
AIC	859.50	328.42	373.83	404.49	619.03	240.18

Significance levels: ***1%, **5%, *10%

Of the landowner characteristics, only four were found to be significant in any of the models. Having higher education (HIGHER.ED) has a positive impact on participation in four of the models. Placing importance on nonmarket values (NON.MARKET) negatively influences participation in four of the models, contrary to the hypothesized effect. Perceived barriers to participation (BARRIERS) is statistically significant in all six models and attitudes towards using forests to mitigate climate change (CO2.COMP) is significant in all but one of the models, both with the hypothesized effect on participation.

Table 5 reports the marginal effects of each variable in the six models. Marginal effects indicate the change in probability of participation associated with a one unit increase in a continuous explanatory variable or a change from 0 to 1 in a binary explanatory variable. For instance, marginal effects on BARRIERS in Model 1 indicates that a 1 point increase in the composite score would decrease the probability of participation by about 37 percent. The marginal effects on HIGHER.ED in Model 1 indicates that a respondent with higher education is about 12 percent more likely to participate than a respondent without higher education. For the log-transformed variables lnPAYMENT and lnHECTARES, the marginal effects indicate the change in probability of participation associated with the variable increasing by a factor of the base of the log, in this case by a factor of *e*. In other words, based on Model 1, increasing the payment amount offered by a factor of 2.718 increases the probability of participation by about 11 percent. All marginal effects are estimated using the means of each explanatory variable for that sample subset.

Table 5: Marginal effects of factors influencing Norwegian family forest owner participation in carbon programs

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	All respondents (n=831)	Only certain respondents (n=394)	Large acreage landowners (>150 ha) (n=385)	Small acreage landowners (<=150 ha) (n=387)	Members of forest owner associations (n=596)	Nonmembers (n=224)
Carbon program characteristics						
lnPAYMENT	0.1102***	0.2117***	0.1249***	0.1026***	0.1267***	0.0668
YEARS	-0.0012	-0.0028	-0.0026	-0.0019	-0.0028*	0.0041
Forest land characteristics						
lnHECTARES	0.0397*	0.0412	0.0069	0.0428	0.0300	0.0490
HARVEST	-0.0819	-0.1441	-0.2376**	-0.0450	-0.0692	-0.0114
Landowner characteristics						
MALE	-0.0420	-0.0010	-0.1033	0.0342	-0.0513	0.0109
HIGHER.ED	0.1201**	0.1835**	0.0529	0.1503**	0.1834***	-0.0551
TENURE	-0.0011	0.0026	-0.0017	0.0001	-0.0021	0.0004
RESIDE	-0.0425	0.1513	-0.1564	0.0057	-0.0250	-0.0854
FAMILIARITY	0.0016	0.0027	0.0024	0.0055	-0.0194	0.0414
OTHER.INCOME	0.0078	0.0000	-0.0074	0.0223	0.0180	-0.0040
NON.MARKET	-0.0646**	-0.0957*	-0.1454***	-0.0658	-0.0802**	-0.0236
BARRIERS	-0.3654***	-0.4830***	-0.4842***	-0.3599***	-0.3937***	-0.2872***
CO2.COMP	0.0965***	0.1707***	0.1083**	0.1147***	0.1102***	0.0671

Significance levels: ***1%, **5%, *10%

2.5 Discussion

2.5.1 Comparing models

The models presented in Table 4 and Table 5 examine six important dimensions of Norwegian family forest owners. Generally, the results of the logistic regression analysis are quite consistent across the different models. Several variables are significant in most or all of the models, and the signs of the coefficients of the significant variables are consistent across all models. A couple variables, however, are only significant in one or two of the models.

Comparing Model 1 and Model 2 illustrates the difference between all respondents and those who are certain of their participation in a carbon program. The main difference is that the amount of forest land owned is a marginally significant predictor in Model 1, but is not significant in Model 2. Additionally, all the significant coefficients have a greater magnitude in Model 2, meaning the variables have a greater impact on participation when looking only at respondents certain of their participation.

The coefficient on forest size was only marginally significant in Model 1 and not significant in Model 2, suggesting there is not much difference between large and small acreage landowners in terms of their overall interest in participating in carbon programs. However, by comparing Model 3 and Model 4 it is clear there are some differences in the factors that influence interest in participation between the two groups. If a large acreage landowner has harvested timber in the past and greatly values nonmarket forest amenities, they are significantly less likely to participate. This is not true for small acreage landowners, where these variables are insignificant in Model 4. On the other hand, having higher education increases the probability of participation for small acreage landowners but not large acreage landowners.

Model 5 and Model 6 compare members of forest owner associations to nonmembers. Although the coefficient on past harvesting, which is positively correlated with being a member of a forest owner association, was not significant in Model 1 or Model 2, Model 5 and Model 6 do show some differences between these two groups. Members are less likely to participate if they greatly value nonmarket forest amenities, but are more likely to participate if they have higher education and are positive toward using forests to mitigate climate change, while these variables are not significant for nonmembers. Nonmembers seem to be primarily concerned about the management measures they may be required to take and the extent to which they present a barrier, as this is the only significant variable in the model. Notably, not even payment amount offered, which is highly significant in all other models, has a significant effect on whether a nonmember would be interested in participating in carbon programs.

2.5.2 Unexpected findings

Several of the model variables were found to have a different effect on participation than hypothesized. The required contract length only found to be marginally significant in one model, suggesting that Norwegian landowners are not particularly averse to long time commitments. This contrasts earlier studies that have generally found that longer time commitments have a significant negative effect on participation in carbon programs and other incentive programs. This might be because Norwegian landowners have longer planning horizons than landowners in

previous study areas. It may be that whether or not there is a time commitment is a greater concern to Norwegian landowners than the length of the time commitment.

Another unexpected finding was that large acreage landowners who had harvested timber for sale in the past were less likely to participate than those who had not. Although the hypothesis was that landowners who were already actively managing their land and selling timber would be more willing to take the actions necessary to participate in carbon programs, it appears that some groups of Norwegian landowners see carbon sequestration and timber production as conflicting goals. This finding may be a result of the sample, which oversampled large acreage landowners and has a high proportion of landowners actively harvesting timber.

The importance placed on nonmarket forest amenities also had an effect opposite of what was hypothesized. It was expected that landowners who greatly valued nonmarket forest amenities to be more interested in managing for carbon, however, the results show the opposite effect. Norwegian landowners seem to see carbon management and the protection or enhancement of nonmarket amenities as competing objectives. This could be due to a belief among Norwegian landowners that participation in carbon programs still requires active management and that nonmarket amenities are best protected when the forest is left untouched.

Additionally, several landowner characteristics were found not to be significant predictors of participation. Although landowners with long land tenure were not found to be significantly less interested in participating as hypothesized, some other studies have also found length of ownership to not influence participation in carbon programs (Fletcher et al. 2009; Thompson and Hansen 2012). Familiarity with managing forests for carbon was also not found to be a significant predictor of participation. While this was somewhat unexpected, Miller et al. (2012) also found that familiarity with carbon offsets did not influence probability of participation. Finally, the importance placed on nontimber income from their forest land was not found to be a significant variable. Positive effect on participation was expected, however, the results suggest that Norwegian landowners may not view income from carbon offsets as an additional source of income in the same way as rent from hunting, fishing, or cabins, but rather as an alternative to timber income.

2.5.3 Estimated participation

When Model 1 is evaluated at the sample mean for each explanatory variable it predicts an overall level of participation of 46 percent. A payment amount of 324 NOK (42 USD) per hectare per year would be required to achieve 50 percent participation. Model 2, using only respondents that were highly certain of their response, predicts an overall level of participation of 37 percent. In Model 2, a payment of 411 NOK (53 USD) per hectare per year would be required to achieve 50 percent participation. Figure 1 shows the estimated participation at each of the four payment amounts offered for Model 1 and Model 2. All other explanatory variables are held at their mean values. Participation ranges from about 30 percent at the lowest payment amount to about 57 percent for the highest payment amount in Model 1, and from about 14 percent to 58 percent in Model 2.

The overall estimated participation is relatively high compared to that found in earlier studies. Fletcher et al. (2009) estimated a participation rate of 5 percent at a payment of 15 USD per acre

(37 USD per ha) per year and 33 percent at a payment of 50 USD per acre (123 USD per ha) per year. Markowski-Lindsay et al. (2011) estimated participation to be between 2 percent and 4 percent for a program with strict requirements and offering 10 USD per acre (25 USD per ha) per year and between 36 percent and 38 percent for a program with lenient requirements and offering 1,000 USD per acre (2471 USD per ha) per year. Dickinson et al. (2012) estimated participation to be about 7.5 percent for with strict requirements and offering 8 USD per acre per year (20 USD per ha) and 43 percent for a program with lenient requirements and offering 30 USD per acre (74 USD per ha). These participation rates are all significantly lower than those found in this study. Miller et al. (2012) estimated that 18 USD per acre (44 USD per ha) per year would be required to achieve a 50 percent participation rate using a model with all respondents, and 28 USD per acre (69 USD per ha) for a model using only certain respondents. These values are very similar to the ones found in this study.

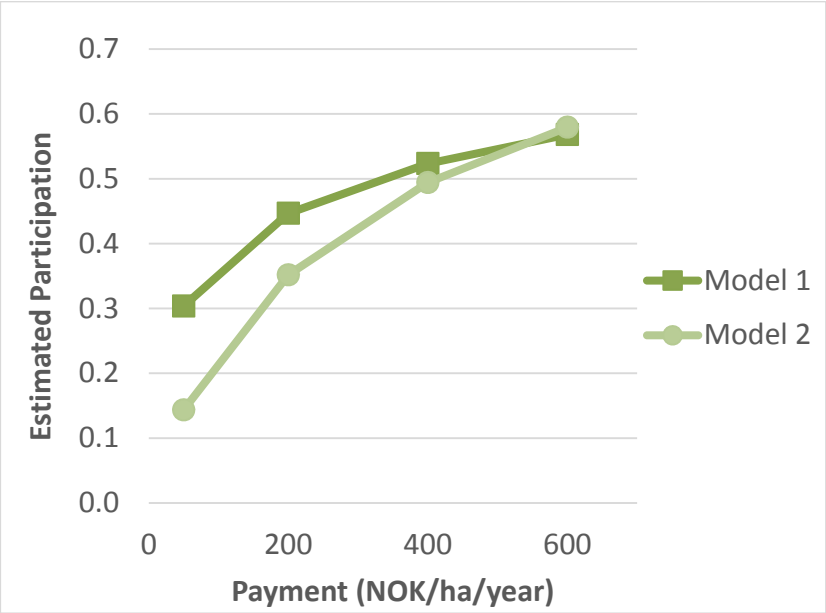

Figure 1: Estimated participation by payment amount for Model 1 and Model 2

In addition to payment amount offered, perceived barriers and attitudes toward climate change were found to be the most significant predictors of participation. Figure 2 shows the estimated participation by payment amount offered for various levels of the composite variable BARRIERS, using coefficients from Model 1 and mean values for all other explanatory variables. The dashed line using the mean value of BARRIERS is equivalent to the model prediction from Figure 1. This figure clearly illustrates the highly significant effect perceived barriers has on participation. Respondents who view every potential measure they might be required to take as posing a "large barrier" (mean composite score of five on a 5-point rating scale), would only have a 3 percent participation rate at the highest payment level of 600 NOK per hectare per year. In contrast, respondents who view every potential measure as posing "no barrier" (mean composite score of 1) would have an 80 percent participation rate at the lowest payment level offered of 50 NOK per hectare per year.

Figure 3 shows the estimated participation by payment amount offered for various levels of the composite variable CO2.COMP, using coefficients from Model 1 and mean values for all other

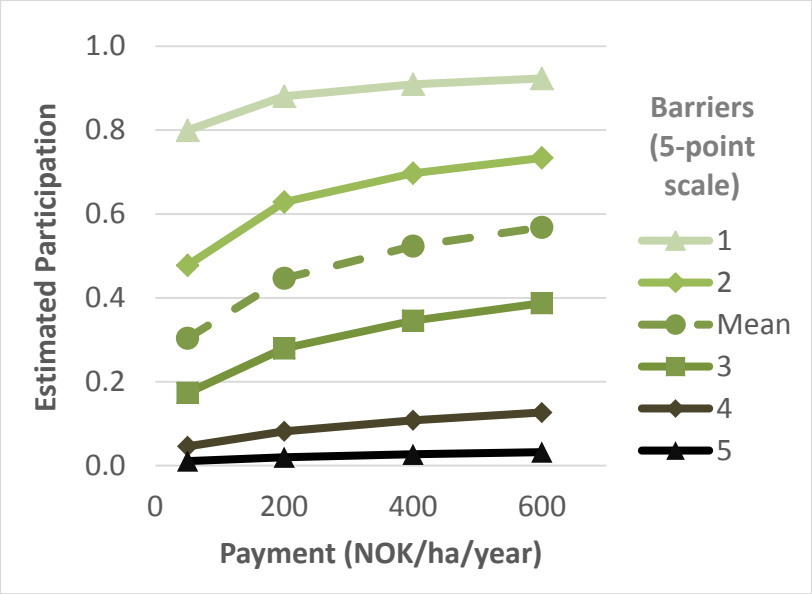

Figure 2: Estimated participation by payment amount and level of barriers to participation for Model 1

explanatory variables. This figure illustrates that landowner attitudes towards using forests to mitigate climate change has a significant impact on participation as well, although not as extreme as that of the variable BARRIERS. Respondents who "completely agree" (mean composite score of five on a 5-point rating scale) with the statements that humans have contributed to climate change, that forests can help mitigate climate change, and that they own enough forest land for carbon sequestration efforts to be worthwhile, have estimated participation rates ranging from 44 percent to 70 percent depending on the payment amount offered. In contrast, respondents who "completely disagree" (mean composite score of 1) with the statements have estimated participation rates between 14 percent and 33 percent.

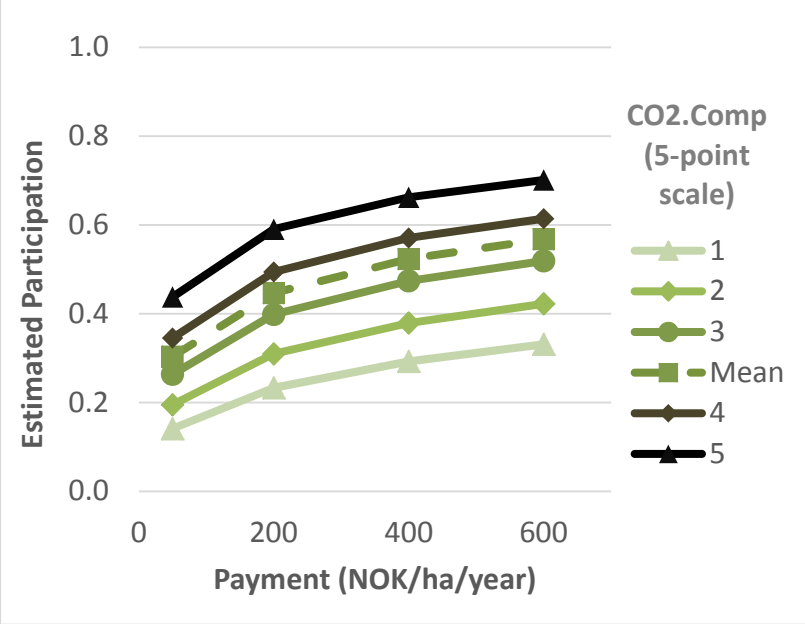

Figure 3: Estimated participation by payment amount and level of attitudes toward climate change for Model 1

2.6 Conclusion

Family forest land in Norway has the potential to provide a significant reduction in the country's net greenhouse emissions. However, if a policy aimed at increasing carbon sequestration in these forests is to be implemented, it is important to understand the factors that influence whether landowners would be interested in participating.

The findings of this study suggest that there is a considerable amount of interest among Norwegian family forest owners to participate in carbon programs, more so than has been shown in earlier studies. In the sample, 48 percent of respondents indicated they would be interested in participating given the contract conditions they were offered. The actual level of participation in a carbon program would depend greatly on the characteristics of the program, in particular the payment amount offered and management actions landowners may need to take in order to participate. Of these potential management actions, Norwegian landowners seem to be the most reluctant to fertilizing and changing their harvesting practices. On the other hand, it does not appear that long contract periods would significantly discourage participation.

The results of the preceding analysis have important implications for policymakers and others interested in developing carbon offset programs in Norway. If the goal is to generate substantial participation and a resulting supply of carbon offsets, prices will need to be sufficiently high and a balance will need to be found such that contract requirements ensure that the program is effective and credible in establishing additionality, while not imposing too great of a barrier to landowners. In particular, policymakers may wish to allow for flexibility in terms of the silvicultural measures landowners can take to increase carbon sequestration on their land, while stricter requirements regarding certification, management plans, and long contract lengths would likely not be seen as significant barriers for Norwegian landowners. This study also found that the extent to which landowners believe humans are contributing to climate change and that forestry can help mitigate climate change significantly influences their interest in participating. Because this is such a strong motivating factor for participation, is important that any carbon program is marketed to landowners in terms of its ability to contribute to mitigating climate change.

The negative coefficients on the variables HARVEST and NON.MARKET suggest that some Norwegian landowners see managing their forest for carbon as conflicting both with goals of timber harvesting and protecting nonmarket amenities. If policymakers wish to encourage participation in a potential carbon offset program, it may be important to communicate to landowners ways in which carbon management can be compatible with both these goals and market the carbon program to appeal to landowners who view these as important objectives. There are different ways to increase carbon sequestration on forest land depending on the existing forest conditions, and landowners may see some of these as less conflicting with their management objectives than others. Once again, giving landowners some flexibility in terms of the management actions they can take as a part of the program could encourage participation significantly.

While the perception of barriers was an important predictor of participation, not much is known about why respondents viewed certain management actions as barriers. These measures may pose a financial burden to the landowner, they may conflict with other management objectives,

or they may have cited the measures as barriers out of protest to the notion of participating in such a program. For this reason it is difficult to know for certain how these perceived barriers can be overcome and whether additional financial or technical assistance would make landowners more likely to participate. More research is needed to fully understand how specific program requirements are perceived by landowners and how programs can be designed to encourage participation.

This study contributes to the existing literature on family forest owner interest in carbon programs by looking at a geographic area outside the United States, where all previous studies of this type have been conducted. More studies from other regions are needed to fully understand the potential for carbon sequestration from family forest lands and the factors that influence landowner participation. There is also a need for comparisons between regions to better understand important similarities and differences in landowner interest in carbon programs, the factors driving those similarities and differences, and the implications for policymakers in the respective regions.

3. Norway and Lake States Comparative Analysis

3.1 Introduction

Improved forest management practices have the potential to increase the amount of carbon sequestered in the world's forests significantly if implemented on a large scale (Sohngen 2009). In many countries, family forest owners own a significant share of the forest land and therefore play an important role in undertaking these management practices. Studies have found that family forest owners are a diverse group with a wide range of objectives, values, and attitudes that affect their management decisions (Becker et al. 2013; Bolkesjø et al. 2007; Butler et al. 2007; Finley and Kittredge 2006; Ingemarson et al. 2006; Karppinen 1998; Kline et al. 2000). If policymakers wish to implement programs that incentivize increased carbon sequestration on private forest land, it is important to understand how these factors affect whether family forest owners would be interested in participating.

Only a handful of studies have examined factors that influence family forest owner interest in participating in carbon programs (Dickinson et al. 2012; Fletcher et al. 2009; Markowski-Lindsay et al. 2011; Miller et al. 2012; Thompson and Hansen 2012). So far, all of these studies have been conducted in the United States. The behavior and objectives of family forest owners is likely affected by structural, institutional, cultural, and economic factors of a particular region (Ingemarson et al. 2006; Karppinen 1998), and these studies may, therefore, not adequately describe the family forest owners in other countries. There is a need for studies that examine the factors which motivate family forest owners to participate in carbon programs in other parts of the world, and subsequently, comparative studies that attempt to explain similarities and differences between the respective countries. Such comparative studies can highlight some of the considerations that need to be made when applying the findings of these studies to other regions and help policymakers in the respective regions better design carbon programs to encourage participation.

This section provides a comparative analysis of family forest owner interest in carbon offset programs in Norway and the United States' Lake States of Minnesota, Wisconsin, and Michigan. It uses the findings of two separate studies, the Norwegian study presented in the previous section and the Lake States study presented in Miller et al. (2012), with the intention of highlighting important similarities and differences between the two regions and evaluating the implications for potential future programs and estimated levels of participation.

3.2 Background

3.2.1 Forest resources

Forests cover about one third of the land area in both Norway and the United States, but land cover patterns vary greatly. In the United States, the Northeast and Southeast are heavily forested, while the Great Plains and Southwest have relatively little forest cover. The area classified as timberland as a percentage of total land area ranges from 87 percent in Maine to 0.5 percent in Nevada (Oswalt et al. 2014). Overall, the total forest area in the United States has remained stable while the growing stock volume has been steadily growing over the past 50 years (Robertson et al. 2011). In the northern Unites States region, the region where the Lake States study was conducted, the area of timberland has increased slightly and net growth has exceeded removal over the past 50 years (Robertson et al. 2011).

In Norway, large parts of the country are mountainous and not forested. Even in heavily forested areas, the terrain is often too steep and difficult to access for harvesting, and as a result not all forest land in Norway is commercially viable (Rognstad and Steinset, 2011). As in the United States, the amount of productive forest land varies greatly across the country. While 50 percent of the land area in Hedmark County is classified as timberland (capable of producing 1 m^3 per ha per year), only 2 percent is in the northern county of Finnmark (Norwegian Forest and Landscape Institute 2014).

In the Lake States, the two dominant forest types are aspen/birch and maple/beech/birch, each representing about a quarter of the timberland in the region. Aspen is the most commercially important species in the region, used for paper, pulp, and solid wood products. Other significant forest types include oak/hickory, spruce/fir, white/red/jack pine, and elm/ash/cottonwood (Domke et al. 2008).

Norwegian forests are dominated by boreal tree species, in particular Norway spruce, Scots pine, and birch. Norway spruce is the most commercially important species, accounting for about three quarters of the timber volume harvested for sale each year. The remaining timber volume is primarily Scots pine, with broad-leafed tree species only making up about 1 percent of the timber volume sold (Rognstad and Steinset 2011).

The standing volume in Norwegian forests is at its highest since the first national forest inventory in 1933 (Rognstad and Steinset 2011). This is due to improved forest management practices, intensive planting and afforestation between 1950 and 1990, and relatively stable harvest levels (Trømborg et al. 2011). During the past couple decades, harvest levels have been less than half the annual growth. Due to a decline in planting investments since 1990, however, the forests are growing older and the growth will be reduced in the future (Trømborg et al. 2011).

Carbon sinks in the United States, of which 90 percent is forest land, sequester about 200 Tg C per year which is equivalent to about 12 percent of United States greenhouse gas emissions from all sectors of the economy (Birdsey et al. 2006; Murray et al. 2005). It has been estimated that forestry activities can increase carbon sequestration by another 100 to 200 Tg C per year (Birdsey et al. 2006; Murray et al. 2005).

Forests in Norway sequester about 30 Mt CO_2e per year, which is equivalent to about 55 percent of the country's anthropogenic greenhouse gas emissions (Norwegian Ministry of the Environment 2008). It has been estimated that forest management measures could increase sequestration of CO_2 by up to 12.3 million tons per year over the next 100 years (Norwegian Climate and Pollution Agency 2010).

3.2.2 Ownership and management

Forest management is affected by ownership patterns, and the distribution of a country's forest resources is therefore important to understanding the decision of landowners to manage for increased carbon sequestration. In the United States, 10.4 million family forest owners collectively own 35 percent of the forest land (Butler 2008). Ownership patterns vary greatly across the country, but have been documented in detail through the National Woodland Owner Survey (NWOS) (Butler 2008). In the eastern United States, most forest land is owned by family forest owners and other private owners, while in the western United States most forest land is owned by the federal and state governments (Hewes et al. 2014).

The Lake States are a part of the 20 state region defined by the USDA Forest Service as the Northern United States. In this region, 55 percent of forest land is owned by family forest owners. Average holding size is 20 acres, with 61 percent of landowners owning less than 10 acres. In the Lake States of Minnesota, Wisconsin, and Michigan, the average size of family forest owner holdings is 28, 26, and 20 acres respectively (Butler and Ma 2011). The NWOS found that among seven different reasons for owning forest land among family forest owners in the northern United States, the most important are aesthetics, part of home, and recreation, while timber production is the least important (Butler and Ma 2011). Although timber production is not an important ownership objective, nearly one-half of family forest owners have harvested timber (Butler and Ma 2011).

In Norway, there are about 120,000 forest properties with at least 2.5 hectares of forest land. Ninety-seven percent of these properties are owned by individuals, and constitute 80 percent of the total productive forest area in the country (Norwegian Forestry Society 2011; Rognstad and Steinset 2011). A large number of these properties are small-scale farms that combine forestry and agriculture (Norwegian Forestry Society 2011) and the average property has 57 hectares of timberland (Rognstad and Steinset 2011). In the most heavily forested counties of Hedmark and Buskerud, timber has been harvested on about 60 percent of forest properties during the past 10 years, while very few forest owners in the three northern counties of Nordland, Troms, and Finnmark harvest timber commercially (Rognstad and Steinset 2011).

Purchasing land is the most common method for acquiring forest land in the United States with 82 percent of family forest owners purchasing some or all of their land. Twenty percent of owners inherited some or all of their land (Butler 2008). One quarter of family forest owners

own their forest as a part of a farm or ranch and 5 percent of owners report that their primary occupation is a farmer (Butler 2008). In the United States 4 percent of family forest owners, who account for 17 percent of the family forest land, have a written management plan (Butler 2008). Although several forest certification programs have been established in the United States, less than 1 percent of family forest owners, accounting for approximately 4 percent of family forest land owners, are enrolled (Butler 2008).

In Norway, most forest land is part of a farm that is passed down through inheritance from generation to generation. More than 80 percent of properties with productive forest land in Norway also contain farmland (Rognstad and Steinset 2011), and as a result, a long-term perspective and feeling of responsibility to maintain the land for future generations is of great important to forest owners (Nordic Family Forestry 2015). About 40,000 forest owners are members of the Norwegian Forest Owners Association (Norges Skogeierforbund). The organization assists landowners with forest management, negotiates timber prices, buys timber from the members, and sells the timber to the industry. Because forest owners are group certified through the forest owner association, practically all productive forest land and commercial timber in Norway is certified (Nordic Family Forestry 2015; Norwegian Forestry Society 2011). Certification is based on a national set of criteria and indicators known as the "Living Forests Standard," which is accepted under the Programme for the Endorsement of Forest Certification (PEFC) (Living Forests 2007; Nordic Family Forestry 2015). Management plans exist for about 80 percent of productive forest area in Norway (Lindstad 2002).

3.2.3 Carbon offset opportunities

There is currently no federal climate policy in the United States that would allow for trading of carbon offsets. However, several states and regions have developed initiatives to reduce greenhouse gas emissions through market mechanisms.

The Regional Greenhouse Gas Initiative (RGGI) launched in 2008 and was the first mandatory cap-and-trade program for carbon dioxide emissions in the United States. It currently has nine participating states in the Northeastern United States. The RGGI established state-level cap-and-trade programs for greenhouse gas emissions from power plants and allows offsets from a range of projects, including improved forest management, avoided conversion, and reforestation (Sopher et al. 2014).

California's cap-and-trade program is perhaps the most significant regional climate initiative in the United States. The program was developed by California's Air Resources Board and began its compliance period in 2013. The program allows for offsets from four different offset protocols, all of which are developed by the Climate Action Reserve, including one for United States forest projects. This protocol allows for offsets from forestry projects anywhere in the contiguous United States (CARB 2014).

Although Norway has several national greenhouse gas mitigation policies, including a carbon tax and the Greenhouse Gas Emissions Trading Act, there is currently no policy mechanism in place to allow Norwegian forest owners to sell carbon offsets. The Greenhouse Gas Emissions Trading Act established the country's emission trading system (ETS), which became active in 2005. The Norwegian ETS was designed to be compatible with the European Union ETS, and the two

merged in 2007 (Sopher and Mansell 2014). While the EU ETS does allow for offsets through the CDM and JI mechanisms in the Kyoto Protocol, it does not allow for offsets from forestry or other land-use projects, whether in the EU region or internationally (Haskett et al. 2009).

3.2.4 Existing literature

Only a handful of studies have quantitatively examined factors that influence family forest owner interest in participating in carbon sequestration programs. The first such study was a pilot study conducted by Fletcher et al. (2009), which surveyed 17 private forest owners in Massachusetts. Two subsequent studies, Dickinson (2010) and Markowski-Lindsay et al. (2011) expanded on the findings of Fletcher et al. (2009) using a mail survey of Massachusetts family forest owners. In all three studies, respondents were asked to rate hypothetical carbon sequestration programs that varied according to various contract requirements, such as payment amount, time commitment, and whether there was a penalty for early withdrawal. Overall, the three Massachusetts studies found that family forest owner participation would be quite low given program characteristics similar to those in existing carbon sequestration programs, and that nonmonetary factors played an important role in landowner decision making.

3.3 Data and methods

3.3.1 Survey development

The Lake States family forest owner data used by Miller et al. (2012) were collected through a mail survey. The sample included landowners who owned 20 acres or more in the most heavily forested counties in Minnesota, Wisconsin, and Michigan. County assessor's offices were contacted to provide contact information for landowners whose properties fell under the appropriate property tax classes and met the study criteria. Of these, 2,208 landowners were randomly selected, with the sample weighted according to the amount of family forest acreage in each state relative to the aggregate for the Lake States study area. The survey was administered in September 2010.

The survey posed a dichotomous choice question to respondents about whether they would enroll in a hypothetical carbon program given a specified per acre payment and contract length. Combinations of eight different payment amounts ($3, $5, $10, $20, $30, $40, $50, $60 per acre per year) and four different contract lengths (15, 25, 40, 50 years) were used, giving 32 different survey versions. The questionnaire also included questions about ownership objectives and practices, forest land characteristics, attitudes toward climate change, familiarity with carbon markets, and landowner demographics.

The mail survey used to collect data on Norwegian landowner interest in participating in carbon sequestration programs was based on the one used by Miller et al. (2012) and developed in collaboration with Statistics Norway. The sample included landowners who owned at least eight hectares of forest land in Norway. The random sample of 1,500 landowners was stratified by property size, using three size classes: 8.0 to 49.9 ha, 50.0 to 99.9 ha, and >99.9 ha. The sample in each size class was drawn proportional to the total forest area in each size class. This was done to generate an overrepresentation of large acreage forest owners as these landowners account a large share of the total forest area in Norway and have the greatest ability to contribute to increased carbon sequestration. The survey was administered in April 2013.

Similar to the Lake States study, the survey presented respondents with a dichotomous choice question asking whether they would participate in a hypothetical carbon program given a specified contract length and payment amount per hectare. Twelve versions of the survey were created using combinations of three different contract lengths (10, 25, or 50 years) and four different payment amounts (50, 200, 400, or 600 NOK per hectare per year).[3] The survey also asked several questions about the respondent's objectives, attitudes, and demographic information.

3.3.2 Model development

The survey data from both studies were analyzed using logistic regression models. In all the models, the dependent variable was the respondent's answer to the dichotomous choice question, which took on the value of "1" if the respondent was willing to accept the conditions and participate in the carbon program, and "0" if the respondent was not willing to participate. The explanatory variables included in the models used in each study were guided by existing literature on family forest owner participation in carbon programs and other incentive programs. Because of the similarity of the questionnaires used in the Lake States and Norway studies, the model of Norwegian landowners was developed to be easily comparable to the Lake States model. Detailed definitions of the variables are described in Table 6.

The only variables that were not used in the Norway study were MGMT.CHGS and ASSIST.PROG. The variables are grouped into three categories: carbon program characteristics, forest land characteristics, and landowner characteristics. The two carbon program characteristics that were included were payment amount and contract length. The payment amount offered has consistently been found to have a positive effect on participation in carbon programs (Dickinson et al. 2012; Fletcher et al. 2009; Markowski-Lindsay et al. 2011; Miller et al. 2012) as well as in similar incentive programs (Kilgore et al. 2008b; Kline et al. 2000; Layton and Siikamäki 2009; Rabotyagov and Lin 2013; Sullivan et al. 2005). Payment amount was, therefore, hypothesized to have a positive effect on participation in both studies. Studies on participation in carbon programs and other incentive programs have generally found that landowners prefer shorter contract lengths (Dickinson et al. 2012; Layton and Siikamäki 2009; Markowski-Lindsay et al. 2011; Rabotyagov and Lin 2013), and contract length was therefore hypothesized to have a negative effect on participation in both studies.

Two forest land characteristics were hypothesized to affect participation: total amount of forest land owned and whether the landowner had harvested timber in the past. In the Lake States study, forest size was hypothesized to have a positive effect on participation due to the findings of studies on participation in similar programs (Butler 2008; Kilgore et al. 2008b). In other studies on participation in carbon programs and other incentive programs the effect of forest size is somewhat mixed (Dickinson et al. 2012; Lindhjem and Mitani 2012; Mäntymaa et al. 2009; Markowski-Lindsay et al. 2011; Sullivan et al. 2005), and thus the variable was included in the Norwegian model with an uncertain hypothesized effect. Whether the landowner had harvested in the past was included as an indicator of whether the forest was being actively managed (Butler et al. 2007). The hypothesized effect on participation was positive in both studies, as it has been

[3] These payments correspond to approximately 6, 26, 51, and 77 USD per hectare per year, given an exchange rate of 7.8 NOK/USD.

suggested that landowners already actively managing their forests are more willing to take the management actions required to participate in carbon programs (Markowski-Lindsay et al. 2011).

Table 6: Description of variables used in the Lake States and Norway logistic regression models

Lakes States		Norway	
Carbon program characteristics			
PAYMENT	Payment amount offered (USD/acre/year)	PAYMENT	Payment amount offered (NOK/hectare/year)
YEARS	Contract length required (years)	YEARS	Contract length required (years)
Forest land characteristics			
TOT.ACRES	Size of the parcel (acres)	HECTARES	Total amount of forest land owned (hectares)
PAST.HAR	Respondent has harvested timber in the past (1=yes)	HARVEST	Respondent has harvested timber in the past (1=yes)
Landowner characteristics			
GENDER	Respondent's gender (1=male)	MALE	Respondent's gender (1=male)
EDUC	Level of education (1-7)	HIGHER.ED	Respondent has attained education beyond a high school diploma (1=yes)
TENURE	Length of ownership (years)	TENURE	Length of ownership (years)
RESIDE	Respondent resides on their forest land (1=yes)	RESIDE	Respondent resides on or within 10 km of their forest land (1=yes)
FAMILIARITY	Level of familiarity with forest carbon credits (1-4)	FAMILIARITY	Level of familiarity with managing forests for carbon sequestration (1-5)
ADD.INCOME	Importance of ability of carbon credits to generate additional income from the forest land (1-5)	OTHER.INCOME	Importance of generating nontimber income from the forest land (1-5)
NON.MARKET	Importance of nonmarket forest amenities (1-5 composite)	NON.MARKET	Importance of nonmarket forest amenities (1-5 composite)
BARRIERS	Extent to which various required actions are perceived as barriers to participation (1-5 composite)	BARRIERS	Extent to which various required actions are perceived as barriers to participation (1-5 composite)
CO2.COMP	Respondent's attitude towards climate change and using forests to mitigate climate change (1-5 composite)	CO2.COMP	Respondent's attitude towards climate change and using forests to mitigate climate change (1-5 composite)
MGMT.CHGS	Importance of management changes required to sell carbon credits (1-5)		
ASSIST.PROG	Past participation in an educational or forest assistance program (1=yes)		

Several landowner characteristics were included in both models. Gender was included with an uncertain hypothesized effect in both models as the literature suggests the role of gender is mixed (Bliss et al. 1997; Sullivan et al. 2005). Education was included in both models, but with different hypothesized effects. The Lake States study hypothesized that higher education would have a negative effect on participation as some studies have shown that individuals with higher education (and by correlation higher income households) are less likely to engage in management activities (Kendra and Hull 2005; Rasamoelina et al. 2010). However, other studies suggest that landowner education level has a positive effect on participation in carbon markets

(Dickinson et al. 2012; Markowski-Lindsay et al. 2011; Thompson and Hansen 2012), and thus the variable was included in the Norwegian model with a positive hypothesized effect. Length of ownership was included in the models with a negative hypothesized effect, as it has been suggested that long land tenure has a negative effect on participation in conservation programs (Lin 2010). Residing on the forest land was also thought to affect participation, though the hypothesized effect was uncertain as previous studies have conflicting findings about the effect of the variable (Kendra and Hull 2005; Kilgore et al. 2008b). Kilgore et al. (2008a) found that landowners were more likely to participate in a program if they were familiar with it prior to receiving the survey, so a categorical variable indicating level of familiarity with managing forests for carbon sequestration was included and hypothesized to have a positive effect on participation.

It was hypothesized that landowners who place importance on generating nontimber income from their land would be more interested in selling carbon credits, so a variable measuring the importance of nontimber income was included in both models and hypothesized to positively affect participation. As managing forests for carbon sequestration has the potential to enhance other nonmarket amenities in a forest such as soil and water quality and biodiversity compared to traditional timber management, it was hypothesized that landowners who place a high level of importance on these nonmarket amenities would be more likely to participate in carbon programs. A composite score indicating the importance of nonmarket forest amenities was therefore included and hypothesized to positively affect participation. Managing a forest to increase carbon sequestration requires certain management actions, some of which may be seen as barriers to landowners. Respondents rated the extent to which a variety of potential management actions would present barriers to participation, and a composite score was included in both models and was hypothesized to negatively affect participation.

Finally, it was hypothesized that landowners who believe climate change is an important concern and that forests can play an important role in mitigating climate change would be more interested in participating. Respondents were asked to rate their level of agreement with statements claiming that humans have contributed to climate change, that forests can play an important role in mitigating climate change, and that they own enough forest for it to be worthwhile to manage for carbon. A composite score of the responses was included with a positive hypothesized effect in participation. A summary of the variables and their hypothesized effects in each study is presented in Table 7.

Most questions were asked with similar or identical wording in both surveys, however, some questions were changed during the development of the Norwegian survey. A couple of these are significant for the interpretation of the variables and are discussed in more detail.

The variables ADD.INCOME and NON.MARKET in the Lake States study were derived from responses to a question that asked about potential outcomes that could result from the sale of carbon credits. Several potential outcomes were described and respondents were asked to rate each potential outcome on a scale of 1 (Not important) to 5 (Very Important). The variable ADD.INCOME was based on the potential outcome that stated “I can generate additional income from my forest land.” The variable NON.MARKET was a composite (summation) of three

potential outcomes: “Water and soil quality on my forest land may be improved,” “The look of my forest land may be improved,” and “Wildlife habitat on my forest land may be improved.”

Table 7: Hypothesized effect on participation of variables used in the logistic regression models

Lakes States	Hypothesized effect on participation	Norway	Hypothesized effect on participation
Carbon program characteristics			
PAYMENT	Positive	PAYMENT	Positive
YEARS	Negative	YEARS	Negative
Forest land characteristics			
TOT.ACRES	Positive	HECTARES	Uncertain
PAST.HAR	Positive	HARVEST	Positive
Landowner characteristics			
GENDER	Uncertain	MALE	Uncertain
EDUC	Negative	HIGHER.ED	Positive
TENURE	Negative	TENURE	Negative
RESIDE	Uncertain	RESIDE	Uncertain
FAMILIARITY	Positive	FAMILIARITY	Positive
ADD.INCOME	Positive	OTHER.INCOME	Positive
NON.MARKET	Positive	NON.MARKET	Positive
BARRIERS	Negative	BARRIERS	Negative
CO2.COMP	Positive	CO2.COMP	Positive
MGMT.CHGS	Negative		
ASSIST.PROG	Positive		

In the Norway study, the variables OTHER.INCOME and NON.MARKET were derived from a question presenting several statements about their forest land in general. Respondents were asked to rate to what extent they agreed with the statement on a scale of 1 (Completely disagree) to 5 (Completely agree). The variable OTHER.INCOME was based on the statement “Income from hunting, fishing, and cabins is important.” The variable NON.MARKET was a composite (mean) of three statements: “It is important that the quality of the water and soil is good,” “How my forest looks is important,” and “The biodiversity on my property is important.”

The important distinction between the two surveys is that in the Lakes States survey, the benefit of additional income and improved nonmarket amenities was tied directly to the sale of carbon credits. In the Norway survey, the importance of other income and nonmarket amenities was not directly connected to the sale of carbon credits.

3.3.3 Data inspection

In both studies, the survey data were carefully analyzed prior to building the regression models to assess the suitability of the analysis method. The datasets were checked for coding errors, and each independent variable was checked to make sure it met the linearity assumption.

The two studies differed in the way they treated missing data. The Lake States study removed all observations that contained missing values for any questions other than those involving demographic information. The Norway study kept all observations except for surveys returned completely blank. Multiple imputation was selected as the method of dealing with the missing data in order to minimize potential selection bias, as the data was found to not be missing completely at random (MCAR). In the preliminary analysis, the Norway model was also run on a

dataset where all observations with missing values had been removed and the results did not differ significantly from those found using multiple imputation. For this reason, it is unlikely that the difference in method of dealing with missing data between the Lake States and the Norway study has significant implications for the comparison.

3.4 Results

3.4.1 Survey response rate

In the Lake States study, of the 2,208 surveys mailed out, 1,107 responses were received. Of those, 850 were usable for the analysis (i.e. were answered completely with the exception of certain demographic details). 150 surveys were returned as undeliverable. This gave an overall response rate of 53 percent and a usable response rate of 40 percent.

In the Norway study, 841 of the 1,500 surveys were returned and 831 of these were considered usable for the analysis. Only surveys that were returned completely blank or the landowner indicated that they were incorrectly sampled were removed. Twenty-two surveys were undeliverable or incorrectly sampled, and there were an additional 25 responses from landowners who did not wish to participate. This gave an overall response rate of 59 percent and a usable response rate of 56 percent.

3.4.2 Sample description

Because of the difference in sampling method between the Lake States and Norway study, care is needed when comparing descriptive statistics between the two. The sample in the Lake States study was representative of the population of Lake States family forest owners. Nonresponse checks showed the sample modestly undersampled landowners who had harvested timber and substantially oversampled absentee owners and landowners who had a forest management plan. The sample in the Norway study purposefully oversampled large acreage landowners, and nonresponse checks showed that respondents were slightly more likely to have harvested timber and own a larger forest area than nonrespondents.

When comparing the data from the two surveys, it is important to keep in mind that differences could be due to both regional differences as well as differences in the sampling method. In order to control for the oversampling of large acreage landowners in the Norway study, a subset of respondents was drawn from the full sample, representative of the size class distribution in the population based on three size classes: 8 to 49.9 ha, 50 to 99.9 ha, and >99.9 ha (Table 8). Although the representative sample has a relatively low number of observations, it can be helpful in the comparison to the Lake States study as it allows us to compare an average landowner in the Lake States to an average landowner in Norway. It also highlights some of the differences between large acreage landowners and the average landowner in Norway.

Table 8: Number of forest owners by size class in population, gross sample, responses, and representative sample

	Number of forest owners in population	Number of forest owners in gross sample	Responses that provided forest size	Representative sample
8.0-49.9 ha	52,826	370	130	130
50.0-99.9 ha	13,651	297	108	34
>99.9 ha	10,685	833	534	26
Total	77,162	1,500	772	190

Another challenge when comparing the Lake States and Norway data is that several of the questions differed between the two surveys. Direct comparisons can only be made when identical questions were asked in both. Table 9 shows descriptive statistics for a selection of questions that were identical in both surveys for the full Lake States sample, the full Norway sample, and a representative subset of Norwegian respondents.

Table 9: Mean values and percentages for survey questions that were identical in both surveys

Question	Lake States (Full sample)	Norway (Full sample)	Norway (Representative sample)
Forest land owned (hectares)	70	319	71
How long have you owned your forest land? (years)	22.3	21.9	21.8
Place to hunt as reason for owning forest land (1-5)	3.90	3.15	2.88
Timber income as reason for owning forest land (1-5)	2.56	3.48	2.85
Have certified forest land in the past	17%	66%	48%
Implemented management plan measures in the past	23%	65%	42%
Harvested timber in the past	47%	77%	57%
Perceived barrier of certifying forest (1-5)	2.36	2.11	2.55
Perceived barrier of implementing management measures (1-5)	2.50	2.23	2.63
Humans have contributed to climate change (1-5)	3.64	3.86	3.77
Forestry can play an important role in mitigating climate change (1-5)	4.00	4.04	3.95
Live on forest property	24%	73%	79%
Male	83%	83%	80%
Age (years)	59.3	55.5	57.4

Comparing the Lake States sample with the representative sample of Norwegian landowners suggests some generalizations can be made about the population of family forest owners in the two countries. Family forest owners in the two countries are similar in terms of average amount of forest land owned, age, land tenure, gender distribution, perceived barriers, and attitudes toward climate change. However, Norwegian forest owners are much more likely to live on their forest property and be actively managing their forest. Timber income is a more important reason for ownership in Norway than in the Lake States, while hunting is more important reason for ownership in the Lake States than in Norway. Norwegian forest owners are more likely to have certified their forest, implemented management measures, and harvested timber than forest owners in the Lake States.

The representative sample of Norwegian landowners excludes most of the large acreage landowners and as a result is quite different from the full sample of Norwegian respondents in several ways in addition to forest size. Respondents in the full sample tend to be more active, see timber income as a much more important reason for ownership, and are less likely to see the management measures required by carbon sequestration programs as barriers. These differences are important to take into consideration when comparing the Norwegian models with the Lake States model.

3.4.3 Logistic regression models

This study compares three logistic regression models that estimate landowner interest in participating in carbon markets. Model 1 is a model of the Lake State respondents, as presented in Miller et al. (2012). The model uses all 773 usable survey responses. Model 2 is a model of the Norwegian respondents, as presented in section 2, using all 831 usable survey responses.

Because Model 1 uses a representative sample of Lake States family forest owners while the sample used in Model 2 oversampled large acreage landowners, a third model was added to help identify what differences in the two models might be due to the difference in sampling method. Model 3 is a model of a subset of the Norwegian respondents that is representative of the size class distribution of the population of Norwegian family forest owners, as illustrated in Table 8, and has a sample size of 190.

3.4.4 Significant predictors of participation

Table 10 reports the coefficients, standard errors, and marginal effects of the three logistic regression models. The significant predictors of participation that are common across all the models are payment amount, which has a positive effect on participation; perceived barriers to participation, which has a negative effect on participation; and attitudes toward climate change, which has a positive effect on participation. The importance of nonmarket forest amenities is also significant across the three models, however, it has a positive effect on participation in Lake States model and a negative effect on participation in the Norway models.

In the Lake States model, contract length and residing on the forest land are also significant, both with a negative effect on participation. Neither of these variables are significant in the two Norway models. In the Norway models, forest size and higher education have a significant positive effect on participation in Model 2, but not Model 3.

Comparing Model 2 and Model 3 suggests that having oversampled large acreage landowners in Norway has not had a major impact on the significance of the predictor variables. The main differences between the two models are that forest size, while marginally significant in Model 2 is not significant in Model 3, and higher education is significant in Model 2 but not Model 3. It seems fair to assume that Model 2 also provides a reasonable representation of the population of Norwegian family forest owners, and because of the relatively low number of observations in Model 3, only Model 2 will be discussed in detail in the following section.

Coefficients on variables are difficult to directly compare across models as different scales or units were used for most of the variables. Thus, the focus instead was on comparisons of statistically significant versus insignificant variables and the direction of effect of these variables between models.

3.5 Discussion

3.5.1 Comparing models

In general, there are many similarities in the factors that influence family forest owner interest in participating in carbon programs in Norway and the Lake States. Many of the same variables are significant (or insignificant) in both models and have the same directional effect. In both cases, the greatest predictors of participation are payment amount, which has a positive effect on participation, and perceived barriers, which has a negative effect. Additionally, if landowners believe human activities are contributing to climate change and that forestry can help mitigate climate change, they are also significantly more likely to participate in both regions.

Table 10: Regression coefficients, standard errors, and marginal effects for variables influencing Norwegian family forest owner participation in carbon programs

Variable	Model 1 Lake States (n=773)			Variable	Model 2 Norway (full) (n=831)			Model 3 Norway (representative) (n=190)		
	Coefficient	S.E.	Marginal effects		Coefficient	S.E.	Marginal effects	Coefficient	S.E.	Marginal effects
PAYMENT	0.0329***	0.005	0.00802	lnPAYMENT	0.4442***	0.0957	0.1102	0.5570**	0.230	0.1062
YEAR	-0.0267***	0.007	-0.0065	YEARS	-0.0049	0.0054	-0.0012	-0.0010	0.013	-0.0002
TOT.ACRES	0.0934	0.053	0.0228	lnHECTARES	0.1600*	0.0900	0.0397	-0.0623	0.220	-0.0119
PAST.HAR	-0.0034	0.194	-0.0011	HARVEST	-0.3299	0.2603	-0.0819	-0.1983	0.466	-0.0378
GENDER	0.8380	0.245	0.2042	MALE	-0.1692	0.2530	-0.0420	0.0650	0.541	0.0124
EDUC	-0.0886	0.053	-0.0216	HIGHER.ED	0.4841**	0.1881	0.1201	0.4214	0.451	0.0803
TENURE	-0.0046	0.006	-0.0011	TENURE	-0.0045	0.0069	-0.0011	-0.0035	0.016	-0.0007
RESIDE	-0.5405**	0.207	-0.1258	RESIDE	-0.1714	0.2520	-0.0425	0.2658	0.550	0.0507
FAMILIARITY	-0.0949	0.114	-0.0231	FAMILIARITY	0.0064	0.0925	0.0016	0.1689	0.204	0.0322
ADD.INCOME	0.4581	0.075	0.1117	OTHER.INCOME	0.0315	0.0728	0.0078	-0.0283	0.176	-0.0054
NON.MARKET	0.1255***	0.037	0.0306	NON.MARKET	-0.2603**	0.1233	-0.0646	-0.5135*	0.301	-0.0979
BARRIERS	-0.0650***	0.011	-0.015	BARRIERS	-1.4724***	0.1398	-0.3654	-1.4885***	0.324	-0.2838
CO2.COMP	0.0664*	0.027	0.0162	CO2.COMP	0.3890***	0.1148	0.0965	0.7219**	0.285	0.1376
MGMT.CHGS	-0.0183	0.082	-0.0045							
ASSIST.PROG	0.1757	0.268	0.0428							

Significance levels: ***1%, **5%, *10%

Although there are several differences between the two models, some of these are not particularly surprising or meaningful. One difference between the two models is that while Lake States landowners who reside on their forest land were significantly less interested in participating, this variable had no significant effect among Norwegian landowners. Miller et al. (2012) suggest that this may be because landowners who do not live on the land may be more open to requirements such as third-party inspections and conveying conservation easements. Given the large difference in rates of absentee ownership between the two regions, it seems reasonable that there would be a difference in the effect of this variable.

Higher education is another variable that is significant in only one of the models. While landowners with higher education were more likely to participate in Norway, education level did not affect participation in the Lake States. It is difficult to draw any meaningful conclusions from this as educational attainment is often used as a proxy for other variables such as income, and it is difficult to say what factors are influencing participation that may be correlated with education. Thompson and Hansen (2012) also found education to have a positive effect on attitudes toward carbon sequestration and suggest that because higher education is correlated with higher income, it may mean that landowners have more financial freedom to pursue less traditional forest management. However, they also found that income did not have a significant effect on participation, and it could therefore be that there is a positive relationship between education and environmental attitudes or values.

3.5.2 Unexpected findings

The comparison does also highlight a couple of surprising differences between the two regions. The first is that contract length was not found to be a significant predictor of participation in Norway, while it had been found to have a negative effect in the Lake States and most previous studies on landowner participation in incentive programs (Dickinson et al. 2012; Layton and Siikamäki 2009; Markowski-Lindsay et al. 2011; Miller et al. 2012; Rabotyagov and Lin 2013). A possible explanation for this finding relates to the difference in ownership patterns between the two regions. Most forested properties in Norway tend to be a part of a farm that has been passed down from generation to generation and long-term considerations are of great importance for Norwegian forest owners (Nordic Family Forestry 2015; Rognstad and Steinset 2011). In contrast, Lake States landowners have to a greater extent purchased their forest land and do not own it as a part of a farm (Butler 2008) and may be more concerned about the implications of the time commitment if they were to sell the land in the future than Norwegian landowners. It appears that there is not a significant difference between a contract length of 10 years and 50 years for Norwegian landowners, however, it is possible that the variable would have had a greater influence on participation if a wider range of contract lengths had been used in the survey.

Another significant difference between the two models is the importance of nonmarket amenities, while significant in both, has a positive effect on participation in the Lake States but a negative effect in Norway. The hypothesis in both studies was that landowners who greatly valued nonmarket amenities would be more likely to participate, as these amenities could potentially be enhanced by managing for carbon.

There are a couple potential factors influencing the difference in the two results. The first could be that landowners in Norway and the Lake States have different perceptions of the types of

management activities that would be required to increase carbon sequestration. The results suggest that Lake States landowners may see participating in the program as meaning less intensive management (i.e. harvesting less timber, increasing rotation lengths, or leaving the forest untouched). This is consistent with the finding that absentee owners in the Lake States were more interested in participating than landowners residing permanently on their forest land, as requiring active and intensive management would be more difficult and possibly more objectionable for absentee owners.

Norwegian landowners, on the other hand, may see participating in the program as meaning more intensive management (i.e. more planting, increasing planting density, planting faster growing species, or increasing fertilizer use). There has been public discussion in Norway in recent years about planting and managing forests for carbon sequestration as a climate initiative. In a report to the Storting in 2012, the Ministry of the Environment recommended several measures for increasing carbon sequestration from forests, such as increasing planting in new areas, increasing stand density, and targeted fertilization (Norwegian Ministry of the Environment 2012).

Organizations such as Norwegian Biodiversity Network (SABIMA) and the Norwegian Society for the Conservation of Nature have expressed concerns about proposals to increase the planting of Sitka spruce, a faster growing species than the native Norway spruce, particularly in coastal areas where it can threaten biodiversity, as well as using fertilizer to increase forest growth (Norwegian Biodiversity Network 2014; Steel et al. 2013). As a result of the public discussion surrounding the use of forests as a climate initiative, it is understandable that Norwegian family forest owners who are particularly concerned about nonmarket forest amenities may be opposed to managing their forest for carbon sequestration.

Another factor that may have influenced the difference in the direction of the nonmarket variable is how the questions were asked in the two surveys. As explained in Section 3.2, the Lake States survey presented the nonmarket amenities as ones that could be improved as a result of the sale of forest carbon credits. The question relates the nonmarket amenities directly to the sale of carbon credits and implies that these amenities can only be improved as a result, not worsened, and then asks how important this would be to the landowner.

In the Norwegian survey, the questions about nonmarket amenities were not tied directly to the sale of carbon credits. The survey only asked how important these amenities were to the landowner. Because the question in the Lake States survey did not leave room for the possible interpretation that nonmarket amenities might be worsened as a result of the sale of carbon credits, it is not unexpected that the variable had a positive coefficient and the result should therefore be interpreted with some caution.

3.5.3 Estimated participation

Figure 4 shows the estimated participation for the Lake States and Norway models when evaluated at the mean values for each explanatory variable, but varying the payment amount offered. Overall, the estimated participation curves for the two models are very similar. While the Lake States model predicts that a payment of about 44 USD per hectare (18 USD per ac) would be required to achieve a participation rate of 50 percent, the Norway model predicts that a

payment of about 42 USD per hectare would be required. It is, however, difficult to compare the two models directly for a few reasons. Because the sample of Norwegian landowners consists of larger and more active landowners, it is not necessarily representative of the population of Norwegian landowners in the same way the Lake States model is. It may therefore be that the model overestimates the participation of the average Norwegian landowner. Another important consideration is that the overall price level is approximately 30 percent higher in Norway than in the United States, which would suggest that the Norway model may be underestimating participation relative to the Lake States model if they were to be adjusted for purchasing power parity between the two regions.

3.6 Conclusion

The findings of this comparative study suggests there is considerable interest among both Lake States and Norwegian landowners in forest carbon offset programs. This is true even at low payment amounts, suggesting that a portion of landowners are motivated to participate for primarily nonmonetary reasons. Estimated participation in both studies is higher than what was found in the three Massachusetts studies (Dickinson et al. 2012; Fletcher et al. 2009; Markowski-Lindsay et al. 2011). This may, however, be explained in part by the samples of the two studies, as the Lake States study oversampled absentee owners and landowners who had a management plan while the Norway study purposefully oversampled large acreage landowners.

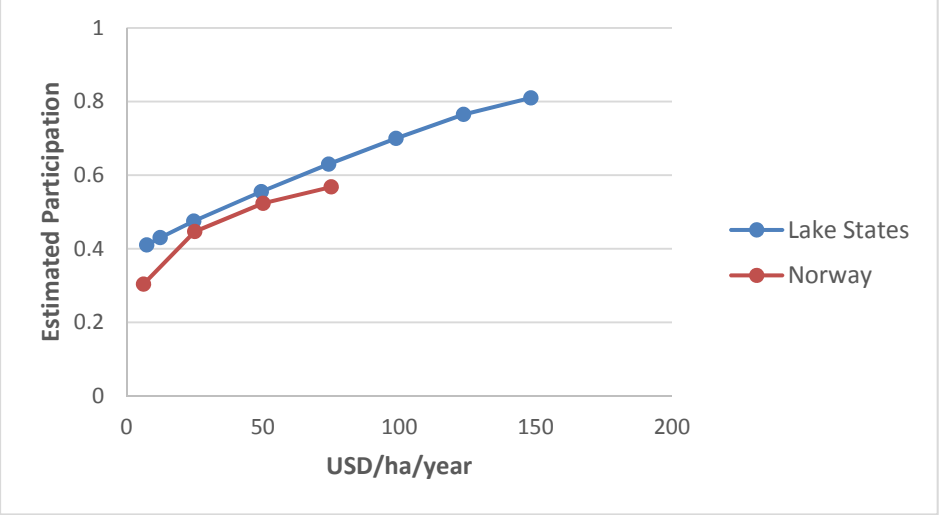

Figure 4: Estimated participation by payment amount for the Lake States and Norway models

In general, WTP to participate seems to be largely driven by environmental values and whether the management actions landowners would need to take are compatible with their ownership objectives. Landowners who are willing to participate even at low payment amounts likely believe that climate change is an important issue and support using forest management as a climate initiative and do not perceive the contract requirement and the necessary management actions as being particularly large barriers. This finding suggests that there is potential for carbon offset programs to achieve a high rate of participation in both the Lake States and Norway, as well as in other similar regions.

The primary difference between landowners in the two regions is that Norwegian landowners reside on their forest land to a much greater extent and are more actively managing their land than Lake States landowners. However, this analysis suggests that although Norwegian landowners may be more engaged with their forest land, it does not necessarily make them likely to participate in carbon offset programs. Consequently, getting landowners in the Lake States or elsewhere more engaged with their land may not be the best way to encourage participation. Instead, participation should be encouraged by appealing to the environmental values of landowners and by reducing the barriers posed by the program requirements.

Whether the management actions required to increase carbon sequestration were perceived as being large barriers was a highly significant predictor of participation in both regions and therefore has important policy implications. In order to encourage participation, policymakers may wish to allow for flexibility in terms of the required management measures needed to be taken so landowners can choose measures that do not conflict with their ownership objectives. This is particularly important in light of the finding that landowners in the Lake States and Norway have very different perceptions about the type of management actions they might have to undertake.

In the Lake States, many landowners seem to perceive carbon programs as requiring a nonintensive form of management, such as limiting timber harvesting or placing a conservation easement on the land. While this type of management may conflict with the landowners who have timber income as an important ownership objective, it may be appealing to many Lake States landowners who do not actively harvest timber, are absentee owners, and value the nonmarket amenities of the forest. Many Norwegian landowners, on the other hand, seem to see carbon programs as requiring more intensive management such as planting fast-growing species and using fertilizer. This type of management may still be compatible with timber harvesting objectives, but may not be appealing to landowners who believe it may have adverse effects on the forest's nonmarket amenities. These findings highlight the need for more research aimed at better understanding how specific management measures affect interest in participation for various groups of landowners, and how carbon offset program can be designed so that they can both lead to significant reductions in atmospheric carbon while also being compatible with the diverse management objectives of family forest owners.

This comparative study highlights some of the structural, institutional, cultural, and economic factors that need to be considered when examining family forest owner interest in carbon offset programs outside the United States, where the previous studies on the topic have been conducted. In particular, ownership and management patterns as well as the state of the public discussion regarding the management of forests for climate change mitigation seem to have contributed to some unexpected differences in the findings of the two studies. Additional studies in other regions are needed to give a more complete picture of the factors driving family forest owner interest in carbon offset programs and to inform policymakers about how to best design these programs in the context of each particular region.

4. Conclusion

Family forest owners have the potential to make a significant contribution to climate change mitigation by enacting management measures that increase carbon sequestration on their land. As emissions trading schemes and carbon offsetting opportunities continue to expand and develop, it is becoming increasingly important to understand what factors motivate family forest owners to participate in carbon offset programs. So far, only a limited number of studies have examined this question, all of which have been conducted in the United States. This study has contributed to this literature by providing an analysis Norwegian family forest owner interest in carbon offset programs and a comparison of the findings of this analysis to an earlier study conducted in the United States' Lake States. The key findings are summarized below.

There appears to be considerable interest in carbon offset programs in both regions, more so than has been estimated by previous studies. While the three Massachusetts studies all suggest that participation would be lower than 10 percent for a program with strict requirements offering 20 USD per hectare per year, the Norway and Lake States studies estimate that participation for a similar program may be somewhere around 40 percent. This difference could be in part due to differences in analysis and sampling methods, however, it does indicate that there may be a greater potential for carbon offsets from family forest lands than had been previously though.

Although the payment amount offered by the carbon offset program is a significant predictor of participation in both studies, family forest owners are largely motivated by nonmonetary factors. In fact, both studies suggest that a portion of landowners may be willing to participate for little to no compensation at all. In particular, whether landowners see the required management actions as posing a barrier, whether they greatly value the nonmarket amenities on their forest land, and their attitudes toward climate change greatly influence a their interest in participating. Thus, in order to encourage participation, carbon offset programs will need to balance contract requirements such that perceived barriers to participation are minimized and landowners are allowed to undertake management activities that do not conflict with their ownership objectives, while still ensuring legitimate and verifiable increases in carbon sequestration. As climate change is a concern and a motivating factor to many landowners, it is also important that the program is marketed in terms of its ability to help mitigate climate change.

In general, there appear to be many similarities between family forest owners in Norway and the Lake States regarding their interest in carbon offset programs. Many of the same variables were significant predictors and the estimated participation in both regions were very similar. This suggests that some of the common findings in this study may hold true in other regions as well. At the same time, some important differences between the two studies highlight regional factors that affect interest in participation. Contract length was not found to be significant in Norway, possibly due to the country's ownership and management patterns while the importance of nonmarket amenities had a different effect in the two regions, possibly due to different understandings of the types of management actions required by the program.

Although perceived barriers to participation was found to be a highly significant variable in both studies, very little is known about how specific program requirements are perceived by landowners and how these perceived barriers can be overcome. This is an important area of

future research. Additionally, while this thesis has provided insight into how family forest owner interest in carbon offset programs may be similar or different outside the United States, more studies in other regions are needed to give a more complete picture of the potential for family forest lands to make a significant contribution to mitigating climate change.

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Appendix A: Translated Norwegian Forest Landowner Survey

NORWEGIAN FOREST LANDOWNER SURVEY:
MANAGING FORESTS TO MITIGATE CLIMATE CHANGE IMPACTS

INSTITUTT FOR NATURFORVALTNING

UNIVERSITETET FOR MILJØ- OG BIOVITENSKAP

2013

We would like to know your opinion on the possibilities for managing your forest to mitigate global climate change. You do not need any prior knowledge beyond what is provided in the textbox below to answer the questions.

We will first ask you some general questions about the management of your forest before we ask about your attitudes towards using your forest to mitigate climate change.

Please answer all the questions to the best of your ability. All of the information you provide will be kept anonymous and confidential.

Please read the information in the textbox before you continue:

Managing forest land to help mitigate climate change

Trees provide an important environmental service by removing CO_2 from the atmosphere and storing it as carbon in plant materials above and below the ground. By changing the management of your forest land, you can increase the forest's potential to absorb and store carbon. The increase of CO_2 in the atmosphere is believed to be the most important cause of global climate change. By changing the management of your forest land to increase forest growth, you can therefore help mitigate global climate.

There are several ways to manage forest land if the goal is to increase carbon storage, and optimal management will depend on the current condition of the forest. Changes in harvesting, regeneration, and fertilization can affect the carbon storage in a forest, but just how these factors will change the carbon storage will vary from forest to forest. For instance:

- If you own a lot of old forest, an increase in harvesting will lead to higher carbon storage in the future, as old forest which grows slowly is replaced by young forest which grows faster.
- If you own a lot of forest with good forest growth, carbon storage can increase by reducing harvesting and thereby better taking advantage of the forest's high growth rate.
- If you don't plant or fertilize much, a greater effort in planting or fertilizing can contribute to increasing growth and thereby carbon storage.

Forest landowners in some countries have the opportunity to benefit financially by managing their forest land specifically to increase carbon storage. They usually receive an annual payment for the additional carbon storage in the forest (compared to the expected carbon storage had they not participated in the program). Internationally there are markets for carbon storage in forests because businesses are seeking to offset their carbon emissions by paying forest landowners to manage their forests to increase carbon storage. Today there exist no such markets in Norway, however there is a possibility that such programs could be established here in the future. The goal of this study is to map Norwegian forest landowners' attitudes towards participating in such carbon programs where they receive payments for increasing carbon storage in their forests.

I. Questions about your forest

1. A) How much forest land do you own in Norway (productive and unproductive forest)?
_____ dekar

B) Do you know how much of the forest is productive?

☐ No, I do not know ⟶ **Go to question 2**
☐ Yes ⟶ _____ dekar

2. Since what year have you been a forest land owner? Since year _____

3. Are you a member of a forest management association?

☐ No
☐ Yes ⟶ Which one(s)?
☐ NORSKOG
☐ Norges Skogeierforbund (includes Havass, Glommen, Mjøsen, Viken, AT Skog, Vestskog, Sogn og Fjordane Skogeigarlag, and Allskog)

4. Given how you believe the condition of a good forest should be, how would you characterize the condition of your forest?

Very bad				Very good
☐	☐	☐	☐	☐

5. Listed below are several potential reasons for owning forest land. Please indicate how important each reason is for you. Check one box for each line.

	Not important				Very important
a) Place with the right to hunt	☐	☐	☐	☐	☐
b) Wish to conserve/protect nature	☐	☐	☐	☐	☐
c) Income from sale of timber	☐	☐	☐	☐	☐
d) Other income (rent from hunting, fishing, or cabins), hydroelectricity	☐	☐	☐	☐	☐
e) Heritage/family traditions	☐	☐	☐	☐	☐
f) Part of a farm or other property	☐	☐	☐	☐	☐
g) Other (please specify) _____ _____	☐	☐	☐	☐	☐

6. Listed below are some statements about the importance of various characteristics of a forest. To what extent do you agree with these statements with regards to your forest? Check one box for each line.

		Completely disagree				Completely agree
a)	Income from the sale of timber is important	☐	☐	☐	☐	☐
b)	Income from hunting, fishing, or cabins is important	☐	☐	☐	☐	☐
c)	It is important that the quality of the water and soil is good	☐	☐	☐	☐	☐
d)	How my forest looks is important	☐	☐	☐	☐	☐
e)	The biodiversity on my property is important	☐	☐	☐	☐	☐
f)	The conditions for huntable wildlife is important	☐	☐	☐	☐	☐
g)	It is important that the qualities of the forest are maintained or improved for the future	☐	☐	☐	☐	☐

7. Listed below are activities forest landowners often undertake or have someone undertake on their forest land. Please answer questions A) and B) in the columns below.

		A) Have you undertaken/had someone undertake the following measures in your forest during the past 10 years? Check one box for each line.		**B) Do you plan to undertake/have someone undertake the following measures in your forest during the next 10 years? Please respond independently of your answer in A).** Check one box for each line.	
a)	Have the forest certified or sell timber via a certified sales organization	Yes ☐	No ☐	Yes ☐	No ☐
b)	Have an inventory of your forest resources and a forest management plan prepared	Yes ☐	No ☐	Yes ☐	No ☐
c)	Implement one or more of the measures in the forest management plan	Yes ☐	No ☐	Yes ☐	No ☐
d)	Document in writing the management measures you implement	Yes ☐	No ☐	Yes ☐	No ☐
e)	Thinning	Yes ☐	No ☐	Yes ☐	No ☐
f)	Fertilization	Yes ☐	No ☐	Yes ☐	No ☐
g)	Planting	Yes ☐	No ☐	Yes ☐	No ☐
h)	Harvesting timber	Yes ☐	No ☐	Yes ☐	No ☐

8. **Have you ever harvested timber for sale?** Ignore harvesting in 2013.

☐ No ⟶ **Go to question 12**

☐ Yes ⟶ **What year did you last harvest for sale?** Year: _____

9. **Approximately how much timber did you harvest for sale that year?** _____ cubic meters

10. **How much did you receive in income from the sale of timber that year?** Please provide either the total gross or net income, or both.

Gross income from timber _____ kr

Net income from timber _____ kr

11. **Do you know what percentage of the timber income that year was placed in the forest fund account?**

☐ No, I do not know ⟶ **Go to question 12**

☐ Yes ⟶ _____ %

II. Questions about willingness to manage forest to help mitigate global climate change

People have different knowledge about climate change. Even if you have little or no knowledge about using forests to help mitigate global climate change, your answers are valuable to us.

12. **How would you describe your knowledge of the possibilities for managing forest to help mitigate global climate change <u>before you received this survey</u>?** Check one box.

No knowledge				Very good knowledge
☐	☐	☐	☐	☐

Participation in carbon programs

As explained in the textbox on page 1, there are carbon programs in some countries where forest landowners receive compensation to increase forest growth and thereby carbon storage in their forests. Forest landowners then receive payment for the carbon storage that comes in addition to the storage one would expect if they had not participated in the carbon program. If you participate in such a program, you are required to sign a contract and agree to participate in the program for *(10, 25, 50)* years. You will for each of these *(10, 25, 50)* years receive a payment of kroner *(5, 20, 40, 60)* per dekar per year. In addition you must do the following:

a. Have an inventory of your forest resources and a forest management plan prepared, and implement the measures in the plan
b. Have your forest certified by an independent third party, and accept that an independent third party verifies and controls the management actions you perform
c. Manage your forest during the contract period so that growth and thereby carbon storage in your forest increases. The changes you should carry out will depend on the condition of your forest. For instance:
    - If you have a lot of forest with good growth, you should possibly reduce harvesting to take advantage of the growth potential in the forest
    - If you have a lot of old forest, you should possibly increase harvest so that the forest that grows slowly can be replaced by young forest that grows better
    - If you have planted or fertilized little, you should possibly increase planting or fertilization to increase growth and thereby carbon storage

Please assume that these conditions apply when you answer questions 13-15

13. Would you accept these conditions for *(10, 25, 50)* years if you were paid kroner *(5, 20, 40, 60)* per dekar per year during the contract period? For instance, if you own 500 dekar you would receive kroner (xxx) every year for (10, 25, 50) years, but you would also have to follow the program for all the (10, 25, 50) years. Check one box.

☐ No

☐ Yes

14. Since the previous question deals with a hypothetical situation, many may feel uncertain about the answer. We would like to know how confident you feel about the answer you gave to question 13. Check one box for each line.

	Completely disagree				Completely agree
a) I feel confident in my answer given the conditions in the contract	☐	☐	☐	☐	☐
b) I feel confident in my answer given the information I have received about the carbon program	☐	☐	☐	☐	☐

15. Assume you receive a compensation of kroner *(5, 20, 40, 60)* per dekar per year for *(10, 25, 50)* years and that each of the measures listed below must be performed in order to participate in a carbon program where you get paid to increase the CO_2 absorption in your forest. For each measure, indicate the extent to which the measure is a barrier to participation in such a carbon program. Check one box for each line.

	Large barrier				No barrier
a) Have the forest certified or sell the timber via a certified sales organization	☐	☐	☐	☐	☐
b) Have an inventory of your forest resources and a forest management plan prepared	☐	☐	☐	☐	☐
c) Implement one or more of the measures in the management plan	☐	☐	☐	☐	☐
d) Document in writing the management measures you implement	☐	☐	☐	☐	☐
e) Accept verification and regular monitoring of the forest by an independent body (every 2-5 years)	☐	☐	☐	☐	☐
f) Harvest more timber than planned	☐	☐	☐	☐	☐
g) Harvest less timber than planned	☐	☐	☐	☐	☐
h) Thin more	☐	☐	☐	☐	☐
i) Fertilize more	☐	☐	☐	☐	☐
j) Plant more	☐	☐	☐	☐	☐

III. Questions about the use of logging residues for bioenergy

The use of bioenergy from forests is increasing in Norway. Previously, logging residues such as branches and tree tops were left on site after the harvest, but now some is used for bioenergy. We would like to know if you have delivered such logging residues for bioenergy and your attitudes towards doing so.

16. Have you ever been asked to deliver logging residues?

☐ No → **Go to question 17**

☐ Yes → **Have you ever delivered forest residues?**

- ☐ No
- ☐ Yes

→ **Go to question 17**

17. Would you consider delivering logging residues if there are buyers at upcoming timber harvests?

☐ No ⟶ **Go to question 20**

☐ Yes ⟶ **Would you require payment for this?**

- ☐ No ⟶ **Go to question 20**
- ☐ Yes ⟶ **Go to question 18**

18. What is the minimum compensation you would require to deliver logging residues for energy purposes? Assume that the buyer covers shipping costs and that you do not receive any subsidies to deliver logging residues. Please give your price per loose cubic meter:

_____ kr/lm^3 (normally there is approx. 0,3 lm^3 per m^3 of harvested timber)

19. How certain are you of the compensation you provided in question 18?

Very uncertain				Completely certain
☐	☐	☐	☐	☐

20. Now follow some statements about removing logging residues. Check one box for each line.

		Completely disagree				Completely agree
a)	Removing logging residues will simplify planting after harvesting	☐	☐	☐	☐	☐
b)	Removing logging residues makes the harvesting site prettier	☐	☐	☐	☐	☐
c)	Removing logging residues is bad for biodiversity in the forest	☐	☐	☐	☐	☐
d)	Removing logging residues will reduce the risk for disease in the forest	☐	☐	☐	☐	☐
e)	Removing logging residues will reduce future growth in the forest because of degradation of nutrients in the soil	☐	☐	☐	☐	☐
f)	Removing logging residues will require replacement fertilization	☐	☐	☐	☐	☐
g)	Removing logging residues is good for local value-added and job creation	☐	☐	☐	☐	☐
h)	Using bioenergy from logging residues is a good greenhouse gas initiative	☐	☐	☐	☐	☐
i)	I know who to contact to sell logging residues	☐	☐	☐	☐	☐
j)	I know how much I should charge for logging residues	☐	☐	☐	☐	☐
k)	Family and friends are against me removing logging residues	☐	☐	☐	☐	☐

IV. Attitudes towards climate change and the use of forests

21. Below are listed some statements about climate change and forest management. Please indicate to what extent you agree with each statement. Check one box for each line.

		Completely disagree				Completely agree
a)	Humans have contributed to changing the Earth's climate	☐	☐	☐	☐	☐
b)	Forestry can play an important role in reducing global warming	☐	☐	☐	☐	☐
c)	I own enough forest for it to be worthwhile to implement measures to counteract global warming	☐	☐	☐	☐	☐
d)	Increased use of bioenergy from forests in Norway is a useful contribution to reducing the climate problem	☐	☐	☐	☐	☐
e)	I know where I can get the information or help I need to implement such measures in my forest	☐	☐	☐	☐	☐

V. Information about the forest owner

22. Do you live on your forest property? Check one box.

☐ No ⟶ I live _____ km from my forest property

☐ Yes, I live on my forest property

23. Which municipality and county do you live in?

Municipality _____

County _____

24. How would you describe the area where you live? Check one box.

☐ Rural

☐ Town (200 - 1 999 inhabitants)

☐ Small city (2 000 - 19 999 inhabitants)

☐ Mid-sized city (20 000 - 99 999 inhabitants)

☐ Large city (more than 100 000 inhabitants)

25. Gender. Check one box.

Male	Female
☐	☐

26. Your age: _____ years

27. What is your highest completed education? Check one box.

☐ Primary school (elementary and middle school)
☐ High school
☐ Intermediate/college education
☐ Graduate degree/master's/doctorate

28. Do you have any education in agriculture or forestry (from high school, technical college, or university)? Check one box.

☐ No
☐ Yes

29. What is your <u>total</u> annual income, from forestry and other sources, before tax? Check one box.

☐ less than 200 000 kr/year
☐ 200 001 - 500 000 kr/year
☐ 500 001 – 750 000 kr/year
☐ 750 001 – 1 000 000 kr/year
☐ more than 1 000 000 kr/year

30. Here you can write any comments you may have about the questionnaire:

****

Thank you for taking the time to fill out this questionnaire! Please return the form by using the enclosed pre-addressed envelope. Postage is already paid. If you have any questions about the study, please contact us by the phone numbers/email addresses provided in the cover letter.

Appendix B: Description of Variables and Survey Questions Used in Norwegian Family Forest Owner Models

Variable	Description	Survey Question Used
Carbon program characteristics		
PAYMENT	Categorical variable indicating the payment amount offered (50, 200, 400, or 600 NOK/hectare/year)	
YEARS	Categorical variable indicating the contract length required (10, 25, or 50 years)	
Forest land characteristics		
HECTARES	Continuous variable indicating the total amount of forest land owned in hectares	1A
HARVEST	Binary variable indicating whether the respondent has harvested timber in the past	8
Landowner characteristics		
MALE	Binary variable indicating the gender of the respondent (1 = male)	25
HIGHER.ED	Binary variable indicating whether the respondent has attained education beyond a high school diploma	27
TENURE	Continuous variable indicating length of ownership	2
RESIDE	Binary variable indicating whether the respondent resides on or within 10 km of their forest land	22
FAMILIARITY	Categorical variable indicating the respondent's level of familiarity with managing forests for carbon sequestration	12
OTHER.INCOME	Categorical variable indicating importance of generating nontimber income from the forest land	6b
NON.MARKET	Continuous (composite) variable indicating the importance of nonmarket forest amenities (e.g. soil and water quality, aesthetics, biodiversity)	Composite (mean): 6c,d,e
BARRIERS	Continuous (composite) variable indicating the extent to which various required actions are perceived as barriers to participation	Composite (mean): 15a,b,c,d,e,f,g,h,i,j
CO2.COMP	Continuous (composite) variable indicating the respondents attitudes towards climate change and using forests to mitigate climate change	Composite (mean): 21a,b,c

Appendix C: Lake States Forest Landowner Survey

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 <u>have not</u>, indicate the extent each would keep you from participating in a program that allows you to sell carbon credits generated from your forest land. <u>Assume each activity could be undertaken at no cost to you</u>.

[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.]

		If NO – Answer→ Do you already have or do this?		Barrier to participating in a program allowing you to sell forest carbon credits? **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 <u>if you were annually paid $3 for each parcel acre?</u> (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 <u>how certain</u> 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) ----Past----		(I plan to do this) ---Future---	
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
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 forest land 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
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 <u>where you currently live</u>? *(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
_____ High School/GED
_____ Some College
_____ Technical/Community College Degree
_____ Bachelor's Degree
_____ Some Graduate School
_____ Graduate Degree

21. Annual household income: *(Check one)*

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

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: Description of Variables and Survey Questions Used in Lake States Family Forest Owner Model

Variable	Description	Survey Question Used
Carbon program characteristics		
PAYMENT	Categorical variable indicating the payment amount offered (3, 5, 10, 20, 30, 40, 50, 60 USD/acre/year)	
YEAR	Categorical variable indicating the contract length required (15, 25, 40, or 50 years)	
Forest land characteristics		
TOT.ACRES	Continuous variable indicating the size of the parcel	3
PAST.HARV	Binary variable indicating whether the respondent has harvested timber in the past	11
Landowner characteristics		
GENDER	Binary variable indicating the gender of the respondent (1 = male)	19
EDUC	Categorical variable indicating level of education	20
TENURE	Continuous variable indicating length of ownership	15
RESIDE	Binary variable indicating whether the respondent resides on their forest land	16
FAMILIARITY	Categorical variable indicating the respondent's level of familiarity with carbon credits	4
ADD.INCOME	Categorical variable indicating importance of other forest income	5d
NON.MARKET	Continuous (composite) variable indicating the importance of nonmarket forest amenities (e.g. soil and water quality, aesthetics, biodiversity)	Composite (sum): 5a,b,c
BARRIERS	Continuous (composite) variable indicating the extent to which various required actions are perceived as barriers to participation	Composite (sum): 7a,b,c,d,e,f,g,h
CO2.COMP	Continuous (composite) variable indicating the respondents attitudes towards climate change and using forests to mitigate climate change	Composite (sum): 12a,b,c,d
MGMT.CHGS	Categorical variable indicating the importance placed on requiring management changes	5f
ASSIST.PROG	Binary variable indicating past participation in an educational or forest assistance program	11c (past)