



ELSEVIER

Contents lists available at SciVerse ScienceDirect

Journal of Forest Economics

journal homepage: www.elsevier.de/jfe



Certification of family forests: What influences owners' awareness and participation?

Selmin F. Creamer^{a,*}, Keith A. Blatner^b, Brett J. Butler^c

^a Human Dimensions Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY 14853, United States

^b Department of Natural Resource Sciences, Washington State University, Pullman, WA 99164, United States

^c USDA Forest Service, Northern Research Station, Amherst, MA 01003, United States

ARTICLE INFO

Article history:

Received 23 February 2011

Accepted 5 December 2011

JEL classification:

C35

Q23

Keywords:

Selection model

Bivariate probit

U.S. survey data

Pacific Coast region

Southern region

ABSTRACT

In the United States, 35% of the forestland is owned by family forest owners with approximately 0.2% of this land reported to be enrolled in a forest certification system. The current study was conducted to provide insights into factors influencing family forest owners' decisions to certify their lands. The bivariate probit model with sample selection results suggests that receiving professional advice regarding the forestlands and having a written management or stewardship plan had the highest positive marginal effects on awareness of certification programs and participation in these programs. Non-timber objectives had negative marginal effects on awareness of certification programs.

© 2011 Published by Elsevier GmbH on behalf of Department of Forest Economics, Swedish University of Agricultural Sciences, Umeå.

Introduction

Family forest owners (FFOs), sometimes referred to as nonindustrial private forest (NIPF) owners, represent 92% of the private forest owners, holding 62% of the private forestlands (U.S. Forest Service, 2008). This group includes families, trusts, estates, partnerships, and other unincorporated groups of individuals (Butler, 2008). In the United States, 10 million FFOs hold 276 million acres alone, more than a third of the 751 million acres of the forestlands in the United States (Hodgden et al., 2007).

* Corresponding author. Tel.: +1 607 255 2504.

E-mail address: sfc55@cornell.edu (S.F. Creamer).

Historically, the biggest share of the United States timber has come from the NIPF lands (Beach et al., 2005), supplying 50% of the United States round wood timber supply (Zhang et al., 2005), and this number is expected to increase, reaching 60% by 2030 (Harrell, 1989). Due to policy changes and budget restrictions (Society of American Foresters, 2007), timber harvests on national forests had the largest proportional decline (57% from 1996 to 2006) compared to timber harvests under other ownerships (Smith et al., 2009). Moreover, the increase in domestic demand for wood products, combined with the harvesting restrictions on public lands, drew attention to the NIPF lands for future timber supply. Consequently, the forest management decisions of FFOs are crucial for not only improving the forest health and maintaining the biological diversity of the forests, but also increasing forest productivity.

Even though family forests provide crucial private and public benefits, only a small percentage of the owners systematically incorporate all of the management practices that ensure the sustainability of their forestlands (Hodgden et al., 2007). This may be related to the fact that current management practices are not aligned with FFOs' diverse values, objectives, and attitudes since FFOs own and manage their forestlands for non-timber and timber reasons, even though timber production is not a high priority (Hodgden et al., 2007).

Forest certification programs, such as American Tree Farm Systems (ATFS), Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI), and Green Tag (GT),¹ present a non-regulatory process that is designed to encourage FFOs to reforest and adhere to good forest management. These programs assess sustainable forest management² through performance and/or process standards, attempting to respond not just to forest owners' economic, social, silvicultural, and environmental needs, but needs of the society and nature as well.

Historically, forest certification has been promoted in support of various perspectives, such as environmentalist, consumer, and producer (Haener and Luckert, 1998). Landowners and manufacturers have viewed forest certification as a potential market based tool, promoting their image and credibility, increasing market access, and capitalizing on price premiums (Hansen, 1998). Although the attainment of price premiums is still debatable, forest certification has facilitated the entrance of certified forest products to a number of environmentally sensitive markets, thereby improving the public images of these forestry companies (Chen et al., 2010).

Between 2000 and 2007, the acreage of certified forests has increased from 112 million to over 750 million acres worldwide (Metafore, 2008). Despite global efforts to prevent and reduce tropical deforestation, voluntary participation in forest certification programs has been primarily limited to developed countries in the northern hemisphere (Metafore, 2008). For example, only 1% of the tropical forests, 14% of the temperate forests, and 9% of the boreal forests were certified, leaving 92% of the global forest area uncertified as of 2007 (Metafore, 2008). Most of the United States forest area has remained uncertified (87%) and the total certified forest area in the United States reached a plateau by 2007 (Metafore, 2008). This was mainly attributed to the lack of participation by FFOs and public forests since only 0.2% of the nonindustrial private forestlands and 12% of the public forestlands were certified (Metafore, 2008). In addition, the lack of awareness of sustainable forestry practices was further identified as a barrier for the potential marketability of forest certification programs (Rickenbach, 2002), possibly hindering the likelihood of present and future participation in these programs.

The main objective of this study is to answer the question on how to get FFOs to participate in forest certification programs, in order to improve their forests' health and productivity and consequently satisfy the demand for round wood timber. The second objective is to determine the factors influencing FFOs' awareness of certification programs. These aims will serve various motivations worldwide to learn about FFOs' policy responses and factors behind their participation behavior. The current study concentrates on the Pacific Coast and Southern regions of the United States, where contrasting regulatory environments and forestland ownership patterns exist. In contrast to the forestlands in

¹ FSC is a suitable fit for large and small ownerships. ATFS is appropriate for private landowners with 10–10,000 contiguous acres. Both programs have group certification options. SFI and GT are suitable for large and small ownerships, respectively (Hughes et al., 2009).

² Sustainable forest management is based on the principle of balancing the environmental, social, and economic aspects of forestry to meet the needs of the present without compromising the ability of future generations to meet their needs, and is a broader concept than sustained yield forestry, which only emphasizes timber yield production (Bare, 2000).

the Southern regions, Pacific Coast region forestlands are heavily regulated, and the majority of these forests are held by federal, state, and local governments.³

To our knowledge, no prior study has been conducted to accomplish the particular objectives stated above, although certain studies determined that the awareness of forestry programs was a factor positively influencing participation (Bell et al., 1994; Mercker and Hodges, 2008; Sun et al., 2009).⁴ At this juncture, it is also particularly important to investigate the factors affecting FFOs' awareness of certification programs and participation in them since forest fragmentation, parcellation, and conversion are increasing the number of FFOs, while simultaneously reducing the holding size, eventually complicating the management and future of these forestlands (Stein et al., 2005).

The choice of method for the empirical model is the bivariate probit model with sample selection. The forest owner's awareness of forest certification and participation are estimated following a two step approach, in which the factors affecting the awareness of the certification programs is determined first and the factors affecting the participation behavior, conditioned on the forest owner's awareness of these programs, is determined second. The main contribution of the current study is the enhanced modeling approach used in conjunction with the fairly rare data set offered by the U.S. Forest Service's National Woodland Owner Survey. To our knowledge, this particular model and data set have not been used in any of the studies conducted on forest certification program participation behavior. In this paper, relevant studies that have examined forest owner typologies and FFOs' participation behavior in forestry programs are presented in the literature review. Then the description and the organization of the data are illustrated. Next, the details of the empirical model – selection model, outcome model, estimation, and marginal effects – are described in the methods section. Finally, the results of the empirical model are presented, the implications of the results are discussed, and conclusions are illustrated.

Literature review

The literature on NIPF owners includes studies examining their characteristics, attitudes, and motivations for owning their forestlands. In addition, current forestland management practices or programs that are available to help them better manage their lands and how these practices or programs can be improved, are included in the extant literature (Hodgden et al., 2007).

Several studies examined NIPF owners, grouping them based on their ownership objectives (Kurtz and Lewis, 1981; Kuuluvainen et al., 1996; Kline et al., 2000; Kluender and Walkingstick, 2000; Boon et al., 2004; Kendra and Hull, 2005; Majumdar et al., 2008; Hujala et al., 2010), attitudes towards farm forestry in tropical Eastern Australia (Herbohn et al., 2005), their motivation to communicate with foresters (Hujala et al., 2010), and their decision making modes (Hujala et al., 2009). Table 1 illustrates the details of these studies.

A large body of literature has investigated the program participation behavior of NIPF owners for various forestry programs and practices, such as conservation reserve programs, forest stewardship programs, cost-share programs, classified forestry programs, forestry incentive programs, reforestation tax credit, forest resource development programs, managed timberland tax, and incentive programs, etc. Nevertheless, only a few studies have examined what influences NIPF owners' awareness of these programs (McLean-Meynsse et al., 1994; Sun et al., 2009).

NIPF owners with higher level of education (Boyd, 1984; Doolittle and Straka, 1987; Hammett et al., 1992; Zbinden and Lee, 2005; Joshi and Arano, 2009) and income (DeSteiguer, 1984; Romm et al., 1987; Joshi and Arano, 2009; Fortney et al., 2011) were more likely to participate in forestry programs. Furthermore, *total land acreage* (Nagubadi et al., 1996), *having a written forest management plan* (Esseks and Kraft, 1988, 1989; Bell et al., 1994; Joshi and Arano, 2009), and *having timber objectives* (Nagubadi et al., 1996) were also positively related to participation in these programs. *Information sources* (Zbinden and Lee, 2005) and *the desire for and receipt of information* (Bell et al., 1994; Esseks

³ FFOs hold 9% of the forestlands in the Pacific Coast and 58% of the forestlands in the South.

⁴ Kilgore et al., 2007 and Leahy et al., 2008 determined the contrary.

Table 1

Details of the selected studies on NIPF owners.

Literature	Classification of owners based on their ownership objectives
Kurtz and Lewis (1981)	(1) timber agriculturalist, (2) timber conservationist, (3) forest environmentalists, (4) range pragmatists
Kuuluvainen et al. (1996)	(1) multi-objective owners, (2) self-employed owners, (3) recreationists, (4) investors
Kline et al. (2000)	(1) passive owners, (2) recreationists, (3) timber producers, (4) multi-objective owners
Kluender and Walkingstick (2000)	(1) poor rural residents, (2) resident conservationists, (3) affluent managers, (4) timber managers
Boon et al. (2004)	(1) classic forest owner, (2) indifferent farmer, (3) hobby owner
Kendra and Hull (2005)	(1) absentee investors, (2) professionals, (3) preservationists, (4) young families, (5) forest planners (6) farmers
Majumdar et al. (2008)	(1) multi-objective, (2) non-timber, (3) timber
Favada et al. (2009)	(1) multi-objective owners, (2) recreationists, (3) self-employed owners, (4) investors, (5) indifferent owners
	Classification of owners based on their attitudes towards farm forestry
	<i>Reasons for planting trees</i> (1) commercial, (2) personal satisfaction, (3) conservation
	<i>Impediments to tree planting</i> (1) economic problems, (2) satisfied/flexibility, (3) lack advice, (4) lack labor, finance, equipment, (5) fire/pest risks (6) poor land
	<i>Incentives for tree planting</i> (1) economic incentives, (2) information incentives, (3) joint incentives
	Classification of owners based on their decision making modes
Hujala et al. (2009)	(1) trusting realizers, (2) active learners, (3) independent managers
	Classification of owners based on their motivation to communicate with foresters
Hujala et al. (2010)	(1) studious learners, (2) self-reliant owners, (3) delegators, (4) deliberate thinkers

and Kraft, 1988, 1989), government information sources in particular (Nagubadi et al., 1996), were also significant factors affecting these owners' participation in forestry programs.

Sun et al. (2009) determined that forest owners with timber objectives were more likely to know about forestry incentive programs, but less likely to participate in these programs. However, timber oriented West Virginia NIPF owners were more likely to participate in harvesting, silvicultural, and property management activities. Additionally, non-timber oriented owners were more likely to participate in silvicultural, property, and habitat management or/and recreational improvement activities (Joshi and Arano, 2009).

Length of ownership (land tenure) was found to be negatively related to the participation in forestry assistance programs (Nagubadi et al., 1996). Nevertheless, Joshi and Arano (2009) found the length of ownership to be positively related to the participation in timber harvesting activities and negatively related to the participation in silvicultural and property management activities. While most studies found that *proximity of the residence to the woodland* was positively related to the participation decisions (Romm et al., 1987; Nagubadi et al., 1996; Joshi and Arano, 2009), Fortney et al. (2011) illustrated the contrary. *Acquisition method* also had an effect on the participation decisions. NIPF owners who had bought their forestlands were more likely to participate in silvicultural and property management activities than the owners who inherited the forestlands or those who acquired it as a gift (Joshi and Arano, 2009).

Finally, NIPF owners' perceptions, attitudes, and interests towards forest certification programs and their willingness to consider participating in them have been examined (Vlosky, 2000; Vlosky and Granskog, 2003; Newsom et al., 2003; Kilgore et al., 2005, 2007; Perera et al., 2007; Mercker

and Hodges, 2008; Leahy et al., 2008). However, the literature investigating the forest certification participation behavior of NIPF owners (thus FFOs) is still limited. Most previous research has focused solely on the state level, often used only qualitative data, and has not incorporated awareness of certification programs in their modeling efforts.

Data

Description

The analysis is based on the compilation of the FFOs' responses collected for the U.S. Forest Service's National Woodland Owner Survey between 2002 and 2006 (Butler, 2008). The primary survey instrument is a self-administered questionnaire mailed out to FFOs. A total of thirty questions are used in the survey. The questions are further classified into the following major categories: (1) woodland characteristics, use, and management, (2) future of woodland, (3) ownership characteristics, (4) ownership objectives, (5) owners' concerns and issues, (6) owners' sources of information, and (7) demographics.

The current study focuses on two specific regions of the United States: Pacific Coast (Alaska, Washington, California, and Oregon) and South (Florida, Georgia, North Carolina, South Carolina, Virginia, Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Eastern Oklahoma, Tennessee, and Eastern Texas). 58% and 9% of the forestland are held by the FFOs in the Southern and Pacific regions, respectively (Butler, 2008).⁵

The examination of data reveal that 33% (134 out of 409 respondents) of the FFOs in the Pacific Coast region and 28% (1160 out of 4330 respondents) of the FFOs in the Southern region are aware of forest certification programs. Out of these FFOs, only 22% (29 out of 134 respondents) in the Pacific Coast region and 21% in the Southern region (239 out of 1160 respondents) participate in these programs.

Organization

The data are comprised of FFOs' responses and are filtered to include owners with ten acres of forestland or above. Ten acres or above is the commonly used figure by forest certification programs as the minimum size of land that can be certified. The analysis is conducted on the responses collected from 5418 respondents.

In order to determine meaningful groups, for the FFOs' ownership objectives and the media instruments that FFOs use to learn about woodland management (ranked by their usefulness), we built upon the typology works reported in Table 1. The current study adopts the methodology used in Majumdar et al. (2008).⁶ The principle component analysis with varimax rotation is used to determine the main factors for the independent variables. The Ward's minimum method (hierarchical clustering method) is used to explore the number of clusters to represent the given input in the best interpretable format. Finally, the clusters are formed and interpreted, based on the non-hierarchical (K-means) method, using the FASTCLUS routine in SAS. Three major clusters are determined based on the FFOs' ownership objectives: (1) timber, non-timber, and multi-objective; two major clusters are determined based on the media used by FFOs to learn about woodland management: (2) mass media and personal communications.

The timber cluster ($n = 1348$) is based on the activities and considerations motivated by investment, timber, hunting, and legacy; the non-timber cluster (1443) is comprised of the activities and considerations motivated by aesthetics, biodiversity, privacy, and recreation. Additionally, the multi-objective cluster (2505) represents the largest group and includes recreation, hunting, biodiversity, privacy,

⁵ In the Southern region, 80% of the nonindustrial private forestlands is held by FFOs, representing 90% of the nonindustrial private forest ownership. In the Pacific Coast region, 86% of the nonindustrial private forestlands is held by FFOs, representing 33% of the nonindustrial private forest ownership (Butler, 2008).

⁶ Majumdar et al. (2008) used a multivariate cluster analysis to identify major clusters of FFOs, based on their land ownership reasons and forest stewardship attitudes, using the National Woodland Owner Survey dataset. Three major clusters of FFOs in Alabama, Georgia, and South Carolina were identified: (1) multi-objective, (2) non-timber, and (3) timber.

Table 2
Data description.

Variables	Definitions
Forest certification awareness	1 = Yes, 0 = No
Forest certified land	1 = Yes, 0 = No
Regions	1 = Pacific Coast, 0 = Southeast or South Central
Income	1–20 = <\$25,000 2–25 = \$25,000–\$49,999 3–50 = \$50,000–\$99,999 4–100 = \$100,000–\$199,999 5–200 = \$200,000+
Education	1 = Associate's, bachelor's and advanced degree 0 = 12th grade or lower, high school and some college
Land tenure (years/10)	Continuous variable
Land acreage (acres/1000)	Continuous variable
Acquisition method	1 = Bought, 0 = Inherited and/or gifted
Primary residence	1 = Yes, 0 = No
Ownership motivation	1 = Non-timber, 0 = Timber or multi-objective
Advice	1 = Yes, 0 = No
Learning	1 = Personal media, 0 = Mass media
Management or stewardship plan	1 = Yes, 0 = No

timber, and investment activities. Finally, the mass media cluster (1515) consists of communication media, such as publication, newsletter, internet, conference, video, and TV; the personal media cluster (2167) is comprised of communication media that require interaction with another person, such as visiting, meeting with a forester or a logger, and membership to forestry organizations. Table 2 illustrates the description of data used in the study.

Method

The forest owners cannot get their forestlands certified, unless they first know about forest certification programs. Hence, the lack of forest certification program awareness may possibly act as a barrier against participation in these programs.⁷ In the current study, the concept of awareness is based on the following survey question: "Have you ever heard or read about green certification before?" The forest owners may choose not to participate in forest certification programs based on two possible reasons, either they are not aware of forest certification programs, or they decide not to participate in spite of their awareness of these programs.

A bivariate probit model with sample selection (Wynand and van Praag, 1981; Meng and Schmidt, 1985; Boyes et al., 1989; Greene, 1992; Lee et al., 2003) is considered a good fit for the analysis. During the first step, the factors affecting forest certification awareness are established by the *selection equation*, and the probability of obtaining forest certification conditional on the forest certification awareness is determined during the second step by the *outcome equation*.

Selection equation

A forest owner's awareness of forest certification programs is expressed through the selection equation, in which Ω_s represents the vector of the exogenous variables such as income, forestland acreage, education, etc. γ_s represents the set of parameters to be estimated, and ε_s represents the error term.

$$z_s = \Omega_{s_i}' \gamma_s + \varepsilon_{s_i} \quad (1)$$

where $z_{s_i} = 1$ if the forest owner is aware of forest certification programs; 0 otherwise.

⁷ Among 4739 forest owners who respond to the forest certification program awareness question, only 27% (1294) are aware of these programs, and among the forest owners who are aware of these programs, only 21% (268) participate in these programs.

$\text{Prob}(z_{s_i} = 1 | \Omega_{s_i}) = \Phi_1(\Omega'_{s_i} \gamma_s)$ illustrates the probability of the i th forest owner being aware of forest certification programs, in which z_{s_i} and Ω_{s_i} are observed for all forest owners.

Outcome equation

A forest owner's participation in a forest certification program, conditional on her/his awareness of the program, is expressed through the below outcome equation. Ω_o represents the vector of the exogenous variables, γ_o represents the set of parameters, and ε_o represents the error term.

$$E_o = \Omega'_{o_i} \gamma_o + \varepsilon_{o_i} \quad (2)$$

where $E_o = 1$ if the forest owner participates in the forest certification program; 0 otherwise.

E_o is observed only when $z_s = 1$, and ε_s and ε_o are bivariate normally distributed iid with $\text{cov}_{\varepsilon_s \varepsilon_o} = \rho$.

$\text{Prob}(z_{s_i} = 1, E_{o_i} = 1 | \Omega_{s_i}, \Omega_{o_i}) = \Phi_2(\Omega'_{s_i} \gamma_s, \Omega'_{o_i} \gamma_o, \rho)$ illustrates the probability of the i th forest owner participating in the forest certification program, given her/his awareness of the program, and $\text{Prob}(z_{s_i} = 1, E_{o_i} = 0 | \Omega_{s_i}, \Omega_{o_i}) = [\Phi_1(\Omega'_{s_i} \gamma_s) - \Phi_2(\Omega'_{s_i} \gamma_s, \Omega'_{o_i} \gamma_o, \rho)]$ illustrates the probability of the i th forest owner not participating in the forest certification program, given her/his awareness of the program.

Estimation

Given the nature of the model, there are three types of observations, which are used in the calculation of the log-likelihood function, with the unconditional probabilities.

$$z_s = 0: \text{Prob}(z_{s_i} = 0 | \Omega_{s_i}, \Omega_{o_i}) = 1 - \Phi_1(\Omega'_{s_i} \gamma_s) \quad (3)$$

$$z_s = 1, E_o = 0: \text{Prob}(z_{s_i} = 1, E_{o_i} = 0 | \Omega_{s_i}, \Omega_{o_i}) = [\Phi_1(\Omega'_{s_i} \gamma_s) - \Phi_2(\Omega'_{s_i} \gamma_s, \Omega'_{o_i} \gamma_o, \rho)] \quad (4)$$

$$z_s = 1, E_o = 1: \text{Prob}(z_{s_i} = 1, E_{o_i} = 1 | \Omega_{s_i}, \Omega_{o_i}) = \Phi_2(\Omega'_{s_i} \gamma_s, \Omega'_{o_i} \gamma_o, \rho) \quad (5)$$

where Φ_1 is the standard normal cumulative distribution function, and Φ_2 is the bivariate normal cumulative distribution function with correlation ρ .

The estimation of the bivariate probit model with sample selection is completed in one step, using the full information maximum likelihood. The log likelihood function for the i th forest owner in a sample is written as follows (Meng and Schmidt, 1985).

$$\ln L = \sum z_{s_i} E_{o_i} (\ln \Phi_2(\Omega'_{s_i} \gamma_s, \Omega'_{o_i} \gamma_o, \rho)) + \sum z_{s_i} (1 - E_{o_i}) (\ln(\Phi_1(\Omega'_{s_i} \gamma_s) - \Phi_2(\Omega'_{s_i} \gamma_s, \Omega'_{o_i} \gamma_o, \rho))) + \sum (1 - z_{s_i}) \ln(\Phi_1(-\Omega'_{s_i} \gamma_s)) \quad (6)$$

Eq. (6) is maximized with respect to γ_o , γ_s , and ρ . Maximization of (6) yields estimates that are consistent, asymptotically normal, and efficient.

Marginal effects

The marginal effects for the bivariate probit model with sample selection are calculated at the means of the variables for the outcome and selection equations. The differences, rather than the derivatives, are computed for the explanatory variables which have a value of 0 or 1 in the estimation sample.

Table 3
Means and standard deviations of independent variables (forest certification awareness).

Independent variables	Individuals without forest certification awareness (n = 3445)		Individuals with forest certification awareness (n = 1294)		Pr > F
	Mean	SD	Mean	SD	
<i>Pacific Coast</i>	0.08	0.27	0.10	0.31	0.01
<i>Income</i>	2.84	1.16	3.29	1.15	<0.00
<i>Education</i>	0.49	0.50	0.64	0.48	<0.00
<i>Land tenure</i>	3.05	1.84	3.54	2.05	<0.00
<i>Land acreage</i>	0.73	2.64	3.11	9.99	<0.00
<i>Acquisition method</i>	0.53	0.50	0.44	0.50	<0.00
<i>Primary residence</i>	0.57	0.50	0.53	0.50	0.01
<i>Timber</i>	0.26	0.43	0.29	0.46	0.01
<i>Multi-objective</i>	0.46	0.50	0.56	0.50	<0.00
<i>Non-timber</i>	0.29	0.46	0.15	0.36	<0.00
<i>Advice</i>	0.36	0.48	0.70	0.46	<0.00
<i>Learning</i>	0.57	0.50	0.74	0.44	<0.00
<i>Management or stewardship plan</i>	0.12	0.33	0.38	0.49	<0.00

The marginal effect of the continuous independent variables for the probability of forest getting certified, conditional on the forest owner’s awareness of the forest certification program, is calculated for the *outcome equation* and is illustrated below.

$$\frac{\delta(\Phi_2(\Omega'_{s_i}\gamma_s, \Omega'_{o_i}\gamma_o, \rho))}{\delta\Omega_{o_i}} / (\Phi_1(\Omega'_{s_i}\gamma_s)) \tag{7}$$

where the probability of the forest owner participating in the forest certification program, conditional on her/his awareness of the program, is illustrated below (Greene, 2003).

$$\delta \frac{\Phi_2(\Omega'_{s_i}\gamma_s, \Omega'_{o_i}\gamma_o, \rho)}{\Phi_1(\Omega'_{s_i}\gamma_s)} = \frac{\text{Prob}(z_{s_i} = 1, E_{o_i} = 1 | \Omega'_{s_i}, \Omega'_{o_i})}{\text{Prob}(z_{s_i} = 1 | \Omega'_{s_i})} \tag{8}$$

Finally, the marginal effect of the continuous independent variables for the probability of the forest owner being aware of the forest certification programs is calculated for the *selection equation* and is illustrated below.

$$\frac{\delta \Phi_1(\Omega'_{s_i}\gamma_s)}{\delta\Omega_{s_i}} \tag{9}$$

where the unconditional mean function representing the probability of the forest owner being aware of the forest certification program is illustrated below (Greene, 2003).

$$\Phi_1(\Omega'_{s_i}\gamma_s) = \text{Prob}(z_{s_i} = 1) \tag{10}$$

Results

Mean value of independent variables

Mean values of the independent variables and their standard deviations for the forest certification awareness are presented in Table 3. Comparison of the mean values for all the independent variables illustrates significant differences. On average, the forest owners who are aware of forest certification programs are more educated and have high income. These owners have written management or stewardship plans. They possess timber and multiple (timber and non-timber) objectives. Additionally, they own bigger land acreage, hold their forestlands for a longer period, receive advice regarding their woodlands, and find personal media more useful than mass media for learning about their forestlands.

Table 4

Means and standard deviations of independent variables (forest certification participation).

Independent variables	Forest certification nonparticipants (n=960)		Forest certification participants (n=268)		Pr > F
	Mean	SD	Mean	SD	
Pacific Coast	0.10	0.30	0.11	0.31	0.73
Income	3.22	1.15	3.40	1.16	0.06
Education	0.62	0.49	0.72	0.45	0.00
Land tenure	3.52	1.99	36.45	22.48	0.43
Land acreage	2.52	6.27	4.86	17.14	0.00
Acquisition method	0.44	0.42	0.43	0.50	0.70
Primary residence	0.54	0.50	0.52	0.50	0.62
Timber	0.31	0.46	0.27	0.45	0.25
Multi-objective	0.52	0.50	0.63	0.48	0.00
Non-timber	0.17	0.37	0.098	0.30	0.01
Advice	0.65	0.48	0.84	0.37	<0.00
Learning	0.70	0.46	0.83	0.38	<0.00
Management or stewardship plan	0.31	0.46	0.66	0.48	<0.00

On the other hand, the forest owners who are not aware of forest certification programs usually reside in their woodlands, have non-timber objectives, and tend to acquire their lands through purchase.

Mean values of the independent variables and their standard deviations for forest certification participation are presented in Table 4. Comparison of the mean values of income, education, land acreage, non-timber objectives, multiple objectives, advice, learning, and management or stewardship plan illustrate significant differences between forest certification participants and nonparticipants. On average, the forest owners with certified forestlands own bigger land acreage, have high income, and find personal media more useful than mass media for learning about their forestlands. Moreover, they are more educated and possess both timber and multiple objectives. In addition, they usually have written management or stewardship plans and receive professional advice regarding their forestlands. In contrast, the forest owners who do not participate in forest certification programs typically have non-timber objectives.

Forest certification model

The likelihood ratio test for determining the absence of correlation between the selection and outcome equations reveals that the correlation between the two equations is not statistically significant ($\chi^2(1) = 0.97$, $\text{Prob} > \chi^2 = 0.3257$).⁸ Nevertheless, the discussion of the results is based on the bivariate probit model with sample selection, given the fact that the previous literature on factors influencing the forest owners' awareness of forestry programs is limited. Additionally, only 1 degree of freedom is lost during the estimation of bivariate probit model with sample selection.

The Wald chi-square results indicate that the bivariate probit model is significant (Wald $\chi^2(9) = 112.99$). In the selection model, *income*, *land acreage*, *land tenure*, *management or stewardship plan*, *advice*, and *non-timber* are significant at the 0.01 level. *Pacific Coast* and *primary residence* are significant at the 0.05 level. All the significant coefficients are positively related to the probability of forest owner's awareness of forest certification programs, except *non-timber* (Table 5).

The marginal effect for the land acreage indicates that an increase of 1000 acres in the total land area increases the likelihood of hearing about certification programs by 1.1% at the mean level. It is reasonable to assume that the larger the forestland holdings are, the more economic interest these owners may have in their investment. Accordingly, they may be more aware of the existing forestland management practices. Furthermore, the forest owner in the higher income group is 4.6% more likely to be aware of these programs than the forest owner who belongs to the income group that is one

⁸ Log likelihood value is -861.5171.

Table 5
Selection model results – forest certification awareness (dependent variable).

Independent variables	Coefficient	$P > z $	Marginal effect	Mean
Education	0.096	0.250	0.030	0.611
Pacific Coast	0.338	0.027	0.114	0.070
Income	0.149	0.000	0.046	3.052
Land tenure	0.009	0.000	0.003	30.172
Land acreage	0.035	0.005	0.011	1.070
Primary residence	0.199	0.018	0.061	0.578
Non-timber	-0.263	0.012	-0.077	0.263
Learning	0.133	0.139	0.040	0.637
Management or stewardship plan	0.404	0.000	0.133	0.236
Advice	0.517	0.000	0.160	0.483
Acquisition method (constant)	-2.045	0.000	0.000	0.517

level lower. The owners who are at a higher income bracket may have more resources available to use, in order to determine the best forestland management practice; consequently, they may be more aware of various forestry approaches.

For every additional 10 years of tenure, the probability of hearing about certification increases by 0.3%. As forest owners hold their lands for longer durations, they may hear or learn more about sustainable forestland management practices, assuming that the duration of ownership indicates an interest in the long term management of the forestland. Additionally, the forest owner whose primary residence is located in the forestlands is 6.1% more likely to be aware of forest certification programs than the owner residing elsewhere. It is possible that these owners may be more motivated to learn about managing their forestlands sustainably since it may be easier to undertake and supervise the activities that are required by certification programs.

Having a written management/stewardship plan or receiving professional advice increases the probability of hearing about certification programs by 13% or 16%, respectively. It is naturally expected that potential learning opportunities are created during the preparation of management or stewardship plans and information exchanges between the forest owners and individuals providing the professional advice. Furthermore, having the forestlands in the Pacific Coast region increases the likelihood of knowing about certification programs by 11.4%, as opposed to, having them in the Southern regions.

Most of the private forest regulations still originate at the state level and are highly variable. Some states regulate intensively, while some do not regulate at all (Gootee et al., 2010). California, Oregon, Washington, and Alaska are among the first states to establish the “state forest practice laws” (Ellefson et al., 1997). Moreover, these states’ forest regulatory programs are recognized with respect to the range of resources and forestry practices they address and the intensity of enforcement and severity of penalties they entail in response to failing to obey the laws and related rules (Ellefson et al., 2004). Therefore, it is reasonable to assume that the stricter the regulations on FFOs’ forestlands are, the more aware FFOs are of these rules and laws, and various ways to manage their forestlands.

Non-timber objectives decrease likelihood of hearing about certification programs by 7.7%. This particular result is realistic assuming that non-timber objectives are less commercially motivated than timber and multiple objectives. Accordingly, these owners may not have enough incentive to learn more about forestland management. In summary, having received professional advice about the forestlands within the last 5 years has the highest positive marginal effect, and total acreage has the lowest positive marginal effect on the forest owner’s likelihood of having forest certification awareness.

In the outcome model (Table 6), *management or stewardship plan* and *advice* are significant at the 0.01 level, and *land acreage* is significant at the 0.05 level. All the significant coefficients are positively related to the probability of forest owner’s participation in forest certification programs.

Having a written management or stewardship plan has the highest effect on the forest owner’s likelihood of getting her/his forestlands certified, and total land acreage has the lowest marginal effect. The forest owner with a written management or stewardship plan is 23.6% more likely to get her/his

Table 6

Outcome model results – forest certification program participation (dependent variable).

Independent variables	Coefficient	$P > z $	Marginal effect	Mean
Pacific Coast	0.145	0.503	–0.024	0.070
Income	–0.004	0.937	–0.044	3.052
Land tenure	0.004	0.224	–0.001	30.172
Land acreage	0.030	0.028	0.003	1.070
Primary residence	0.058	0.601	–0.031	0.578
Non-timber	–0.168	0.332	0.001	0.263
Management or stewardship plan	0.718	0.000	0.236	0.236
Advice	0.486	0.001	0.071	0.483
(constant)	–2.286	0.000		

forestlands certified. The result is not surprising, assuming that having a written management or stewardship plan is an indication that the land is actively managed. Furthermore, having a written management plan is a prerequisite to get forestlands certified. Forest certification programs are based on a professional forester's assessment of the owners' forest management practices, and require that forest owners consult with the foresters before harvesting. As a result, it is reasonable to observe that receiving professional advice increases the forest owner's likelihood of certifying her/his forestlands by 7.1%.

A 1000 acre increase in the total land area increases the probability of forest owner's participation in certification programs by 0.03%. It is possible that small acreage holders may hesitate engaging in intensive timber activities due to the diseconomies of scale (Zhang et al., 2005), assuming that forest owners with larger acreage has more economic interests in their forestlands. Moreover, there may also be some concerns among small scale forest owners regarding the costs of participation in these programs.

Discussion

This current study investigated the effects of information sources, woodland characteristics, ownership objectives, and forest owner characteristics on FFOs' awareness of forest certification programs and their participation in these programs. The analysis was conducted, based on the responses collected from the U.S. Forest Service's National Woodland Owners Survey between 2002 and 2006, including two regions of the United States: Pacific Coast and South. The survey results for both regions revealed that 27% (1294 out of 4739 respondents) of the FFOs were aware of certification programs, and only 21% (268 out of 1294 respondents) of these FFOs participated in them. On average, the forest owners who were aware of certification programs and participated in them had multiple objectives, high income levels, and written management or stewardship plans; they were also more educated. Additionally, they held larger forest acreage, received professional advice regarding their forestlands, and found personal media more useful for learning about their forestlands.

The results provide insights on FFOs that can be used by certification programs, landowner associations, forestry cooperatives, extension programs, government and non-profit organizations, and private industry supported programs in order to design, promote, and implement certification programs, and create effective incentives for participation. Physical and regulatory environments that FFOs reside in have a likely effect on their awareness of certification programs. The stricter the forestry rules for private forests, the more attentive the forest owners may become about various forestland management practices, including certification programs. Constructing an informationally structured environment for FFOs may be the key to increase the awareness of these practices, in which participation is voluntary. However, it is essential that concerted efforts of the parties involved in the process should be efficient and well-informed; the division of responsibilities should be clearly defined in order to avoid confusion and frustration among FFOs.

The information sources, either in the form of receiving a forestland management advice or holding a forest management/stewardship plan, have the highest effects on increasing awareness of certification programs and participation in them. In the light of these findings, targeting FFOs who have access

to these sources may be a quick and cost-effective recipe to increase participation; however, it may be even more effective to increase the number of customized management plans via actively seeking out FFOs to provide advice, and use that as a steppingstone to increase their participation in certification programs. Careful consideration should also be given to providing the proper management plans and advice, given the fact that only 18% of the FFOs from each region had management or stewardship plans.⁹

As the preferences for forest preservation and use are changing with the increased emphasis on non-timber and multiple objectives, the incentives required to get FFOs forestlands certified become more important. Aside from the private nature of certification programs, the possible mismatch between the preferences of FFOs and the incentives that are provided for them to participate in these programs may represent an explanation for the weak connection between certification programs and FFOs (York et al., 2006),¹⁰ and the differences in the awareness and participation rates of the owners with different objectives.

The FFOs on larger forestlands are more likely to be aware of certification programs, and these lands are more likely to be certified. For this reason, seeking out the FFOs on the fragmented and parcelized forestlands is particularly crucial in order to eliminate possible preconceived notions about certification programs and information asymmetry between the small and large acreage holders.

Conclusions

This quantitative study, using an enhanced modeling approach in conjunction with the fairly rare data set offered by the U.S. Forest Service, extends the previous literature that has mostly examined forest owners' perceptions, attitudes, and interests towards forest certification. Additionally, comparable patterns of factors – receiving professional advice, having a management plan, and land acreage – from the previous literature on participation in forest programs were confirmed. A new string of literature related to forest certification programs has also been constructed through investigating the factors of forest certification awareness, while extending the limited literature on awareness of forest programs. Finally, new variables were tested and non-timber objectives were found to be negatively related to the awareness of forest certification programs.

Non-timber oriented forest owners have the lowest participation rate overall and are also less likely to be aware of these programs than other owners. Focus group studies, surveys, or workshops could provide a better understanding of these owners who are less commercially motivated. The results could be utilized (1) to design a well formulated strategy to reach out to these owners more effectively and increase their awareness of certification programs, (2) to increase the number of customized management plans based on their particular objectives, and (3) to design incentive schemes to facilitate their participation in these programs.

The current study confirmed that different physical and regulatory environments forest owners reside in have an impact on the awareness of certification programs. Further research could be conducted to assess the range of impact of the components that form these environments may have on different levels of awareness (being fully aware of the costs and benefits of certification programs, just knowing the bare minimum about these programs, etc.). Eventually, the results could provide insights on how to construct an informationally structured setting for FFOs, residing in various environments, to increase further awareness of certification programs, and possibly participation in them.

Acknowledgment

We are grateful to Jonathan K. Yoder, Gregmar I. Galinato, and Philip R. Wandschneider for their useful comments and suggestions.

⁹ Among these owners, 24% from the Pacific Coast and 16% from the South certified their forestlands. 40% of the FFOs from the Pacific Coast and 43% of the FFOs from the South received advice regarding their forestlands within the last 5 years; only 13% and 9% of them certified their forestlands, respectively.

¹⁰ Among the FFOs who participated in certification programs, 27% of them had timber objectives, 63% of them had multiple objectives, and only 10% of them had non-timber objectives.

References

- Bare, B.B., 2000. Observations on Forest Certification. College of Forest Resources, University of Washington, Seattle, Available at <http://faculty.washington.edu/bare/32Bare.pdf> (accessed November 20, 2010).
- Beach, R.H., Pattanayak, S.K., Yang, J.-C., Murray, B.C., Abt, R.C., 2005. Econometric studies of nonindustrial private forest management: a review and synthesis. *Forest Policy and Economics* 7 (3), 261–281.
- Bell, C.D., Roberts, R.K., English, B.C., Park, W.M., 1994. A logit analysis of participation in Tennessee's Forest Stewardship Program. *Journal of Agricultural and Applied Economics* 26 (2), 463–472.
- Boon, T.E., Meilby, H., Thorsen, B.J., 2004. An empirically based typology of private forest owners in Denmark: improving communication between authorities and owners. *Scandinavian Journal of Forest Research* 19 (S4), 45–55.
- Boyd, R., 1984. Government support of nonindustrial production: the case of private forests. *Southern Journal of Economics* 51 (1), 89–107.
- Boyes, W., Hoffman, D., Low, S., 1989. An econometric analysis of the bank credit scoring problem. *Journal of Econometrics* 40 (1), 3–14.
- Butler, B.J., 2008. Family forest owners of the United States, 2006. A technical document supporting the Forest Service 2010 RPA Assessment. Gen. Tech. Rep. NRS-27. USDA Forest Service, Northern Research Station, Newtown Square, PA.
- Chen, J., Innes, L., Tikina, A., 2010. Private cost–benefits of voluntary forest product certification. *International Forestry Review* 12 (1), 1–12.
- DeSteiguer, J.E., 1984. Impact of cost-share programs on private reforestation investment. *Forest Science* 30 (3), 697–704.
- Doolittle, L., Straka, T.J., 1987. Regeneration following harvest on nonindustrial private pine sites in the South: a diffusion of innovations perspective. *Southern Journal of Applied Forestry* 11 (1), 37–41.
- Ellefson, P.V., Cheng, A.S., Moulton, R.J., 1997. State forest practice regulatory programs: an approach to implementing ecosystem management on private forest lands in the United States. *Environmental Management* 21 (3), 421–432.
- Ellefson, P.V., Kilgore, M.A., Hibbard C.M., Granskog, J.E., 2004. Regulation of forestry practices on private land in the United States: assessment of state agency responsibilities and program effectiveness. Staff paper series number 176. Publication locale: Department of Forest Resources, College of Natural Resources and Agricultural Experiment Station, University of Minnesota. Available at http://www.tennesseeforests.org/facts_downloads/state-forestry-practices-report-2004.pdf (accessed July 18, 2011).
- Esseks, J.D., Kraft, S.E., 1988. Why eligible landowners did not participate in the conservation reserve program. *Journal of Soil and Water Conservation* 43 (3), 251–256.
- Esseks, J.D., Kraft, S.E., 1989. Marketing the conservation reserve program. *Journal of Soil and Water Conservation* 44 (5), 425–430.
- Favada, I.M., Karppinen, H., Kuuluvainen, J., Mikkola, J., Stavness, C., 2009. Effects of timber prices, ownership objectives, and owner characteristics on timber supply. *Forest Science* 55 (6), 512–523.
- Fortney, J., Arano, K.G., Jacobson, M., 2011. An evaluation of West Virginia's managed timberland tax incentive program. *Forest Policy and Economics* 13 (1), 69–78.
- Greene, W.A., 1992. Statistical model for credit scoring. Working Paper 92-29. Stern School of Business, Department of Economics, New York University, NY.
- Greene, W.H., 2003. *Econometric Analysis*, 5th edition. Prentice Hall, Upper Saddle River, NJ.
- Gootee, R.S., Blatner, K.A., Baumgartner, D., Carroll, M.S., Weber, E.P., 2010. Choosing what to believe about forests: differences between professional and non-professional evaluative criteria. *Small-Scale Forestry* 9 (2), 137–152.
- Haener, M.K., Luckert, M.K., 1998. Forest certification: economic issues and welfare implications. *Canadian Public Policy* 24 (S2), 83–94.
- Hammett, A.L., Cabbage, E.W., Luppold, W.G., 1992. A logistical regression model of southern hardwood lumber export participation. *Wood and Fiber Science* 24 (3), 15–29.
- Hansen, E., 1998. Understanding Forest Certification Oregon State University Extension Service FS 329. Available at <http://sfp.cas.psu.edu/pdfs/certsht.pdf> (accessed October 10, 2010).
- Harrell, J.B., 1989. Federal and state cost-share programs for forest farmers. *Forest Farmer* (November–December), 20–27.
- Herbohn, J.L., Emtage, N.F., Harrison, S.R., Smorfit, D.B., 2005. Attitudes of landholders to farm forestry in tropical Eastern Australia. *Australian Forestry* 68 (1), 50–58.
- Hodgden, B., Cusack, C., Tyrell, M., 2007. Literature review: an annotated bibliography on family forest owners. In: GISF Research Paper 002–R. Yale University, School of Forestry & Environmental Studies, Global Institute of Sustainable Forestry, New Haven, CT, Available at <http://sustainingfamilyforests.org/pdfs/litreview.pdf> (accessed October 10, 2010).
- Hughes, G., Vlosky, R., Dunn, M.A., 2009. Private Landowners' Guide to Forest Certification in the South. Mississippi State University Extension Service 2447.
- Hujala, T., Tikkanen, J., Hänninen, H., Virkkula, O., 2009. Family forest owners' perception of decision support. *Scandinavian Journal of Forest Research* 24 (5), 448–460.
- Hujala, T., Kurttila, M., Karppinen, H., 2010. Cross-evaluation of two forest owner typologies: how do motives of ownership and needs of communication interact? In: Medved, M. (ed.), *Small Scale Forestry in a Changing World: Opportunities and Challenges and the Role of Extension and Technology Transfer*. Proceedings of the IUFRO conference, 06–12 June 2010, Bled, Slovenia. CD-ROM. Slovenian Forest Institute & Slovenia Forest Service, Ljubljana, pp. 320–330.
- Joshi, S., Arano, K.J., 2009. Determinants of private forest management decisions: a study on West Virginia NIPF landowners. *Forest Policy and Economics* 11 (2), 118–125.
- Kendra, A., Hull, R.B., 2005. Motivations and behaviors of new forest owners in Virginia. *Forest Science* 51 (2), 142–154.
- Kilgore, M., Leahy, J., Hibbard, C., Donnay, J., Flitsch, K., Anderson, D., Thompson, J., Ellefson, P., Ek, A., 2005. Developing a certification framework for Minnesota's family forests. A report to the Blandin Foundation, Vital Forests/Vital Communities Public Policy Initiative. Staff Paper Series no.183. Department of Forest Resources, University of Minnesota, St. Paul, MN, p. 119.
- Kilgore, M., Leahy, J., Hibbard, C., Donnay, J., 2007. Assessing family forest land certification opportunities: a Minnesota case study. *Journal of Forestry* 105 (1), 27–33.

- Kline, J.D., Alig, R.J., Johnson, R.L., 2000. Fostering the production of nontimber services amongst forest owners with heterogeneous objectives. *Forest Science* 46 (2), 302–311.
- Kluender, R.A., Walkingstick, T.L., 2000. Rethinking how nonindustrial landowners view their lands. *Southern Journal of Applied Forestry* 24 (3), 150–158.
- Kurtz, W.B., Lewis, B.J., 1981. Decision-making framework for nonindustrial private forest owners: an application in the Missouri Ozarks. *Journal of Forestry* 79 (5), 285–288.
- Kuuluvainen, J., Karpainen, H., Ovaskainen, V., 1996. Landowner objectives and nonindustrial private timber supply. *Forest Science* 42 (3), 300–309.
- Leahy, J., Kilgore, M., Hibbard, C., Donnay, J., 2008. Family forest land owners' interest in and perceptions of forest certification: focus group findings from Northern Minnesota. *Northern Journal of Applied Forestry* 25 (2), 73–81.
- Lee, E., Lee, J., Eastwood, D., 2003. A two step estimation of consumer adoption of technology based service innovations. *Journal of Consumer Affairs* 37 (2), 37–62.
- Majumdar, I., Lawrence, T., Butler, B., 2008. Characterizing family forest owners: a cluster analysis approach. *Forest Science* 54 (2), 176–184.
- McLean-Meynsse, P.E., Hui, J., Joseph Jr., R., 1994. An empirical analysis of Louisiana small farmers' involvement in the conservation reserve program. *Journal of Agricultural and Applied Economics* 26 (2), 379–385.
- Meng, C.-L., Schmidt, P., 1985. On the cost of partial observability in the bivariate probit model. *International Economic Review* 26 (1), 71–85.
- Mercker, D., Hodges, D.G., 2008. Modeling landowner behavior regarding forest certification. In: 16th Central Hardwood Forest Conference, Purdue University, Lafayette, IN. April 8–10, 2008.
- Metafore, 2008. Global Certified Forestland Ownership with a Focus on North America. Available at <http://www.metafore.org/downloads/jpampush.mfs.4.17.08.pdf> (accessed October 10, 2010).
- Nagubadi, V., McNamara, K.T., Hoover, W.L., Mills, W.L., 1996. Program participation behavior of nonindustrial forest landowners: a probit analysis. *Journal of Agricultural and Applied Economics* 28 (2), 323–336.
- Newsom, D., Cashore, B., Auld, G., Granskog, J., 2003. Forest certification in the heart of Dixie: a survey of Alabama landowners. In: Teeter, L. (Ed.), *Forest Policy for Private Forestry: Global and Regional Challenges*. CABI Publishing, New York, NY, pp. 291–300.
- Perera, P., Vlosky, R., Hughes, G., Dunn, M., 2007. What do Louisiana and Mississippi nonindustrial private forest landowners think about forest certification? *Southern Journal of Applied Forestry* 31 (4), 170–175.
- Rickenbach, M.G., 2002. Forest certification of small ownerships – some practical challenges. *Journal of Forestry* 100 (6), 43–47.
- Romm, J., Tuazon, R., Washburn, C., 1987. Relating forestry investment to the characteristics of nonindustrial private forestland owners in Northern California. *Forest Science* 33 (1), 197–209.
- Smith, W.B., Mile, P.D., Perry, C.H., Pugh, S.A., 2009. Forest resources of the United States, 2007. A technical document supporting the Forest Service 2010 RPA Assessment. Gen. Tech. Rep. WO-78. U.S. Department of Agriculture, Forest Service, Washington Office, Washington, D.C.
- Society of American Foresters, 2007. Timber Harvesting on Federal & Other Public Lands: An Essential Tool for Sustaining Forests & Communities. Available at http://www.eforester.org/fp/documents/timber_harvesting.pdf (accessed October 10, 2010).
- Stein, S.M., McRoberts, R.E., Alig, R.J., Nelson, M.D., Theobald, D.M., Eley, M., Dechter, M., Carr, M., 2005. Forests on the Edge: Housing Development on America's Private Forests. U.S. Forest Service, Pacific Northwest Research Station, Portland, OR.
- Sun, X., Sun, C., Munn, I.A., Hussain, A., 2009. Knowledge of public assistance programs and application behavior of nonindustrial private forest landowners: a two-step sample selection model. *Journal of Forest Economics* 15 (3), 187–204.
- U.S. Forest Service, 2008. Who owns America's forests? Forest Ownership Patterns and Family Forest Highlights from the National Woodland Owner Survey. Northern Research Station, NRS-INF-06-08. Available at <http://www.forestfoundation.org/pdfs/Who-Owns-Brochure-V3.pdf> (accessed November 9, 2010).
- Vlosky, R.P., 2000. Certification: Perceptions of Non-Industrial Private Forestland Owners in Louisiana. Working Paper 41. Louisiana Forest Products Laboratory, Louisiana State University Agricultural Center, Baton Rouge, LA.
- Vlosky, R.P., Granskog, J.E., 2003. Certification: a comparison of perceptions of corporate and non-industrial private forestland owners in Louisiana. In: Teeter, L. (Ed.), *Forest Policy for Private Forestry: Global and Regional Challenges*. CABI, New York, NY, pp. 283–289.
- Wynand, P., van Praag, B., 1981. The demand for deductibles in private health insurance. *Journal of Econometrics* 17 (2), 229–252.
- York, A.M., Janssen, M.A., Ostrom, E., 2006. Incentives affecting land use decisions of nonindustrial private forest owners. In: Dauvergne, P. (Ed.), *Handbook of Global Environmental Economics*. Edward Elgar Publishing, Northampton, MA, pp. 233–248.
- Zbinden, S., Lee, D.R., 2005. Paying for environmental services: an analysis of participation in Costa Rica's PSA program. *World Development* 33 (2), 255–272.
- Zhang, Y., Zhang, D., Schelhas, J., 2005. Small-scale non-industrial private forest ownership in the United States: rational and implications for forest management. *Silva Fennica* 39 (3), 443–454.