Characteristics of Virginia's Private Forest Landowners and Their Attitudes toward Harvesting

William J. Saulnier
M. Chad Bolding
Scott M. Barrett
Stephen P. Prisley

Abstract

Nonindustrial private forest (NIPF) landowners own 62 percent of Virginia's forestland and determine the likelihood of its harvest and utilization. As many studies have found, NIPF landowners are diverse in management goals, and many factors can affect a landowner's willingness to harvest. Although many landowner surveys have been conducted, adequate information regarding the characteristics of NIPF landowners and their willingness to harvest in Virginia is lacking. Given new markets for wood in the state, there is considerable interest in examining fiber supply availability to determine the sustainability of an expanded forest and renewable energy industry. Landowners and their willingness to supply timber play a vital role in future resource availability. During 2014, a survey was mailed to 3,000 NIPF landowners who owned at least 10 acres of wooded land. Using a base question of willingness to harvest, groups across the state were compared to determine factors that affect their behavior. We found that the variables income, age, forested acres owned, and forest management were all significant and positively related to willingness to harvest. Knowledge of the characteristics of forest landowners and their attitudes toward harvesting can guide efforts to engage more landowners.

Ownership of Virginia's forestland by the traditional forest products industry has gone from 11 percent in 1992 to a low of 1 percent in 2012. Nonindustrial private forestland (NIPF) landowners account for 62 percent of Virginia's forestland ownership in 2012 (Virginia Department of Forestry [VDOF] 2014) and 71 percent in the southeastern United States (Smith et al. 2004). Also, forestland in Virginia has declined by more than 500,000 acres since 1977 (VDOF 2014). Due to the loss of forestland and the majority of remaining forestland being held by private interests, NIPF landowners play an even more important role in supplying wood fiber to markets (Shivan and Mehmood 2010).

As in many areas of the United States, Virginia has recently experienced rapid growth in wood fiber demand from the emerging pellet industry as well as the expansion of electric power generation using woody biomass (Aguilar and Garrett 2009, US Energy Information Administration 2015). The US Department of Energy (2011) predicts an increase in woody biomass consumption from 33 to 119 million dry tons currently to 35 to 129 million dry tons in 2030 under different price scenarios. The added demand of these evolving and dynamic markets has led to concern over the potential strain on the forest resource and future sustainability. Given that the future sustainability of the forest resource is in question, it is important to note that both biophysical and social constraints can reduce the availability of timber to be harvested. Biophysical constraints can include slope, site productivity, and tree size, while social constraints can include size of forest holdings, population density, etc. (Butler et al. 2010).

According to Butler et al. (2010), social constraints reduced the available wood supply more than biophysical constraints in the northern United States. Given the findings of Butler et al. (2010), it can be assumed that social

The authors are, respectively, Former Graduate Research Assistant (wills8@vt.edu), Associate Professor, Forest Operations/Engineering (bolding@vt.edu [corresponding author]), Assistant Professor and Extension Specialist, Forest Operations and Biomass Utilization (sbarrett@vt.edu), and Professor, Forest Inventory and GIS (prisley@vt.edu), Dept. of Forest Resources and Environ. Conservation, Virginia Tech Univ., Blacksburg. This paper was received for publication in July 2015. Article no. 15-00040.

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constraints pose the greatest reduction in the available wood supply in Virginia. In order to better understand the volume actually available for harvest, it is essential to evaluate landowner behavior and study their attitudes toward harvesting and the factors that affect decision making. It is landowners' attitudes toward harvesting that influences their willingness to harvest. With a better understanding of the intricacies involved in landowner management objectives and goals for their forest, we can begin to develop more accurate and current models for predicting resource availability.

Numerous studies of NIPF landowners' willingness to harvest woody biomass (Shivan and Mehmood 2010, 2012; Joshi and Mehmood 2011; Paula et al. 2011; Gruchy et al. 2012; Aguilar et al. 2013; Becker et al. 2013; Joshi et al. 2013a, 2013b) and willingness to harvest timber (Dennis 1990, Lindsay et al. 1992, Joshi and Arano 2008, Kilgore et al. 2015) have been conducted. Although these studies differ by what product is harvested, they provide insight into important characteristic variables that affect NIPF landowners' decisions regarding harvesting in general. The variables identified from these studies included education and income levels, forested and total acres owned, knowledge of forest management, and harvest history (Table 1). There is disagreement in the literature over which variables are important and whether they influence a landowner's willingness to harvest timber. Butler et al. (2010) point out that the relationship between variables and timber harvesting are often inconsistent in previous willingness-to-harvest studies. For instance, Joshi and Mehmood (2011) found education to be positively related to harvesting woody biomass for NIPF landowners in Arkansas, Florida, and Virginia (Table 1). As the level of education increased, so did the likelihood that the NIPF landowner was willing to harvest. Dennis (1990) found in a study of NIPF landowners in New Hampshire that as education increased, the likelihood of harvest decreased. Aguilar et al. (2014) found age to be negatively associated with woody biomass harvesting in Missouri, whereas Joshi et al. (2013a) found it to be positive in Mississippi. These contradictions could be a result of the study area and year as well as specifics about the data and analyses (Butler et al. 2010).

Although there is contradiction in the literature, there is agreement that forested and total acres, management assistance, and previous harvests all were positively associated with likelihood of harvest. Studies by Lindsay et al. (1992) in the northeastern United States on firewood harvesting, Joshi and Mehmood (2011) in Arkansas, Florida, and Virginia, and Paula et al. (2011) in Alabama found that tract size and total forested acres were positively related to a landowner's willingness to harvest. Knowledge of forest management, which could include advice from a professional, a written forest management plan, or help from extension services, has been shown to increase landowners' willingness to harvest (Lindsay et al. 1992, Joshi and Arano 2008, Paula et al. 2011, Joshi et al. 2013a, Kilgore et al. 2015).

Of previous NIPF landowner studies, only three have been conducted in Virginia since 2007 (Shivan and Mehmood 2010, 2012; Joshi and Mehmood 2011). The three studies surveyed landowners in Arkansas, Florida, and Virginia in 2007 and focused on woody biomass harvesting. Woody biomass can include small-diameter trees as well as logging residues generated during a normal timber harvest, such as limbs and tops (Aguilar et al. 2013). Shivan and Mehmood (2010) explored policy preferences of NIPF landowners regarding the promotion of bioenergy generated from woody biomass but did not address a landowner's willingness to harvest directly. Shivan and Mehmood (2012) used econometric models and characteristic variables to study NIPF landowners' willingness to harvest woody biomass at given prices. Joshi and Mehmood (2011) conducted a willingness-to-harvest study of woody biomass and reported that total land owned and education were positively associated with willingness to harvest woody biomass, whereas age was negatively associated with harvesting. The previous study included only some of the variables identified in other studies.

The added demand for timber from emerging markets of pellets and woody biomass and the large percentage of forestland in NIPF ownership highlight the importance of expanding and updating literature regarding NIPF landowners in Virginia. The objectives of this study were to provide more specific and current information on NIPF landowner attitudes and geographic differences within Virginia as well as determining what variables are significant predictors of

Table 1.—Variables affecting the willingness of nonindustrial private forest landowners to harvest timber, according to recent studies.[a]

Source	*n*	State(s) or region	Education	Income	Age	Total acres	Forested acres	Knowledge of management	Previous harvest
Aguilar et al. (2014) WTHB	529	MO	+		−				+
Becker et al. (2013) WTHB	610	MN, WI				+		+	
Dennis (1990) WTHT	68	NH	−	−					
Joshi and Arano (2008) WTHT	244	WV	+		−			+	
Joshi and Mehmood (2011) WTHB	NA	AR, FL, VA	+		−	+			
Joshi et al. (2013a) WTHB	2,560	MS			+			+	
Joshi et al. (2013b) WTHB	2,560	MS	+		−				
Kilgore et al. (2015) WTHT	3,676	United States						+	
Lindsay et al. (1992) WTHT	NA	NE United States				+	+	+	+
Paula et al. (2011) WTHB	363	AL					+	+	
Shivan and Mehmood (2012) WTHB	NA	AR, FL, VA			−		+		

[a] WTHB = willingness to harvest biomass study; WTHT = willingness to harvest timber study; NA = not available.; + = the variable was positively correlated to willingness to harvest in the study; − = the variable was negatively correlated to willingness to harvest in the study; blank cells = the study did not examine the given variable.

willingness to harvest and whether they are positively or negatively associated with harvesting. Eventually, the results from this study will be used to guide a wood availability model that will project the available wood supply in Virginia based on NIPF landowners' willingness to harvest. The model will be used to provide insight into the sustainability of forestland in Virginia.

Methods

Study area

Virginia is composed of three main physiographic regions (from west to east): Mountains, Piedmont, and Coastal Plain. The US Forest Service Forest Inventory Analysis (FIA) (O'Connell et al. 2014) program divides these categories further into five regions: the Northern and Southern Mountains in the west, the Northern and Southern Piedmont in the central portion of the state, and the Coastal Plain to the east. The Northern and Southern Mountains have steep terrain and a mainly deciduous forest cover type. These two regions also have the longest rotation length of all regions. In the Northern and Southern Piedmont, the terrain is categorized as a transition zone with gently rolling hills and occasional steep slopes. In the Piedmont regions, pine plantations are present mainly in the Southern Piedmont as well as bottomland and upland deciduous trees in both the Northern and the Southern Piedmont. Rotation lengths in the Piedmont regions are shorter than in the Mountains but longer than in the Coastal Plain. The Coastal Plain is categorized as mainly flat with slight slopes. Pine plantations and bottomland deciduous trees make up the majority of forest cover for the Coastal Plain. The shortest rotation length occurs in the Coastal Plain. Forest products companies are prevalent in the Coastal Plain and Southern Piedmont and less prevalent in the Mountains and Northern Piedmont (Cooper et al. 2011).

In a study by Wade et al. (2015) of 23 counties in Virginia, regional differences in percent forestland belonging to forest acreage classes of parcels were examined. Of the sampled counties, 73 percent of forested parcels were fewer than 10 acres, which accounted for only 13 percent of the total acreage sampled. The Northern Piedmont was reported to have the most forestland in small forested parcels (<20 acres), and the Coastal Plain had the most forestland in large parcels (>100 acres). The Mountain regions and the Southern Piedmont had very similar distributions of percent forestland belonging to each forest acreage class. There was more forestland attributed to the large forested parcels in the Mountains and the Southern Piedmont than in the Northern Piedmont but less than in the Coastal Plain. Given the results from previous NIPF willingness-to-harvest studies, it is expected that the Northern Piedmont will be overall less willing to harvest than the Coastal Plain due to the size of forested parcels owned.

Questionnaire

A questionnaire was developed using variables identified as significant predictors of landowner behavior from previous studies of NIPF landowners. Twenty-nine questions were included with some requesting multiple answers. Variables used to define groups included landowner demographics such as age, education, and annual household income. Landownership characteristics included method of acquisition, intent to sell, forested acreage, and total acreage. Whether a landowner received advice from a forester, a written management plan, help from state extension personnel, and history of timber harvesting were all variables associated with management background. Responses to a willingness-to-harvest question and management objective questions were used to describe differences among the groups. Both the management objective questions and the willingness-to-harvest question were on a 10-point Likert-type scale. The willingness-to-harvest question did not specify whether all or only a portion of the landowner's timber was to be harvested. Also, the willingness-to-harvest question did not address a time frame in which the timber was to be harvested.

Using Geographic Information Systems software (Environmental Systems Research Institute 2011), 2011 National Land Cover Data (Xian et al. 2011) was overlaid onto a map of publicly available digitized parcels obtained from the Virginia Geographic Information Network for selected counties in each region. Five classes of land cover were identified as forested (evergreen forest, deciduous forest, mixed forest, scrub shrub, and woody wetlands) and aggregated into one forest class (Wade et al. 2015). Forested area and percent forest cover were calculated for each parcel based on the aggregated forest class. After calculating forest cover and area for each parcel, the list of possible survey recipients was reduced by excluding federal- and state-owned parcels, land owned by Timber Investment Management Organizations and Real Estate Investment Trusts, and any land owned by a limited liability company to ensure that our sample consisted of NIPF landowners. Names and addresses of NIPF landowners with at least 10 acres of forest were randomly selected for the survey by generating a random number attached to each landowner in a database. The database was then sorted by the random number from smallest to largest, and landowners were chosen from the top of the list.

The 10-acre cutoff captures landowners who would have been previously missed in other surveys that use 20 acres as a cutoff and excludes landowners with tracts that are fewer than 10 acres in size due to the small amount of harvesting on these tracts. According to Moldenhauer and Bolding (2009), a study of logging firms in South Carolina found that 73 percent of respondents indicated that a reduction in parcel size was occurring and that 32 percent had reduced the number of employees, while 26 percent had reduced their logging systems in an attempt to adapt to the smaller-sized parcels. In a study of loggers in Virginia, Barrett et al. (2012) found that only 9.4 percent of loggers were harvesting on an average tract size of 10 acres or fewer. Given that loggers are actively downsizing to accommodate reductions in parcel size and that less than 10 percent of loggers are harvesting on tracts that are on average 10 acres or fewer, 10 acres was selected to be a cutoff for our survey.

The questionnaire was mailed to 3,000 NIPF landowners in five FIA regions (O'Connell et al. 2014) in Virginia. The sample size was almost double the sample size of 1,600 from previous NIPF willingness-to-harvest studies that included Virginia in their study area (Shivan and Mehmood 2010, 2012; Joshi and Mehmood 2011). There were 4,349 NIPF landowners from four counties in the Coastal Plain, 5,604 NIPF landowners from five counties in the Northern Mountains, 1,168 NIPF landowners from two counties in the Northern Piedmont, 4,564 NIPF landowners from three

counties in the Southern Mountains, and 7,897 NIPF landowners from three counties in the Southern Piedmont that met the criteria to be sampled. We surveyed 600 landowners from each of the five regions (Fig. 1) in Virginia. The potential survey recipients came from counties in each region from which we were able to obtain digital parcel data with landowner names and addresses.

The survey consisted of four separate mailings that generally followed Dillman's (2008) tailored design method. A pre-notice letter was mailed to inform landowners about the study and that they would be receiving a questionnaire shortly. The second mailing contained the questionnaire and was sent approximately 1 week after the first mailing and included a cover letter explaining the study in more detail. A third mailing was a follow-up postcard sent as responses began to decline approximately 1 month after the second mailing, reminding landowners about the questionnaire. The final mailing to nonrespondents occurred 1 week after the third mailing and included a second copy of the questionnaire. Mailings began in July 2014 and ended in October 2014.

Data analysis

Mean responses to the willingness-to-harvest and management objectives questions were used to describe differences in groups of NIPF landowners. Instead of a yes-or-no answer regarding timber harvests (a binary response), a 10-point Likert-type scale was used to gauge landowners' attitudes toward harvesting in general. The scale ranged from 1, strongly oppose, to 10, strongly in favor of harvesting. The attitude of the landowner toward harvesting captured by the 10-point Likert-type question is used to describe how willing the landowner is to harvest. According to Hartley (2013), there is no reason for favoring a set number of points in a Likert-type scale. We chose the 10-point scale in order to provide more sensitivity in determining a landowner's attitude toward harvesting. Mean responses to the willingness-to-harvest question were grouped by landowner descriptive variables. such as education level, income level, acreage class, etc.

Responses to the management objective questions were grouped by those willing to harvest and those less willing to harvest. A cutoff number had to be chosen in the 10-point Likert-type harvesting question to differentiate landowners willing to harvest versus landowners less willing to harvest. The distribution of answers of landowners who had previously harvested and not previously harvested for the harvesting question was analyzed. More than 94 percent of those who had previously harvested answered 5 or above on

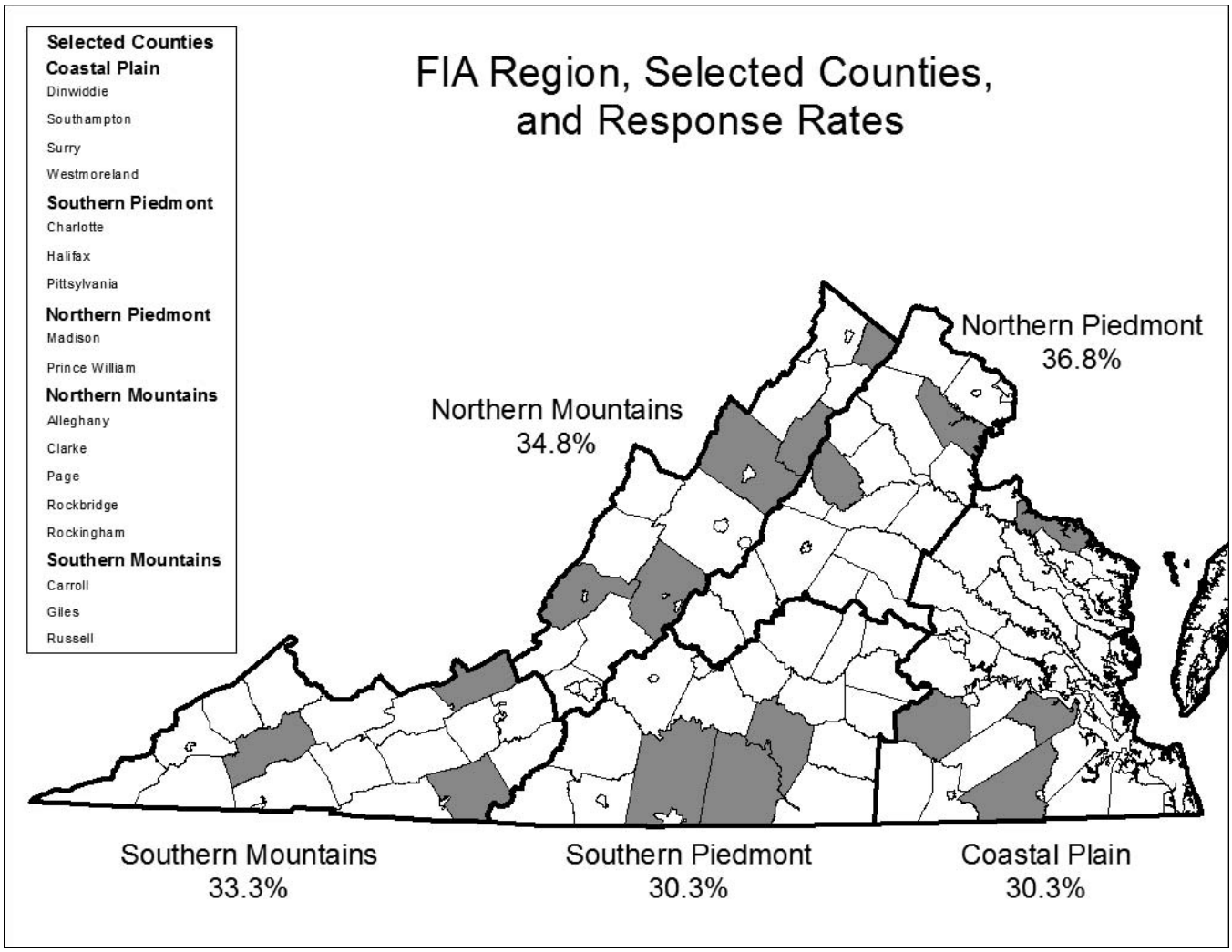

Figure 1.—Selected counties for five Forest Inventory Analysis regions for Virginia with survey response rates.

the willingness-to-harvest question (Fig. 2). From these results, we considered that any landowner who responded to the willingness-to-harvest question with a score of 5 and above was willing to harvest. After separating the NIPF landowners by willing to harvest versus less willing to harvest (based on this criteria), mean responses for questions regarding management objectives were used to describe the NIPF landowners willing to harvest versus those less willing to harvest in Virginia. Management objective questions were in the same 10-point Likert-type scale as the willingness-to-harvest question.

JMP statistical software was used to test for significant differences in means through analysis of variance and Tukey's honestly significant difference test where suitable (SAS Institute Inc. 2014). Significant differences between mean responses of groups were identified at the $\alpha = 0.05$ level. A binomial logistic regression model was used for further analysis to determine which independent variables were significant predictors of willingness to harvest. Although the binomial logistic regression model provided further analysis of the variables studied in this research, the model did not find all variables to be significant. Using a stepwise function, independent variables were excluded at the $\alpha = 0.10$ level. The variables that were excluded included total acres owned, previous harvest history, whether landowners intended to sell their land in 5 years, and how landowners acquired their land. These variables that were excluded from the predictive model are not valuable in the sense of predicting willingness to harvest but are valuable for characteristic information regarding respondents. The binomial regression equation for determining the probability of willingness to harvest is specified as (Menard 2002)

$$P(Y = 1) = e^{(\beta_0+\beta_1 X_1+ \ldots \beta_i X_i)}/1 + e^{(\beta_0+\beta_1 X_1+ \ldots \beta_i X_i)} \quad (1)$$

The predictive model for the binomial logistic regression after eliminating independent variables found to be insignificant predictors of willingness to harvest is as follows:

$$\mathrm{WTH} = \beta_0 + \beta_1 \mathrm{EDU} + \beta_2 \mathrm{INC} + \beta_3 \mathrm{AGE} + \beta_4 \mathrm{MGMT} + \beta_5 \mathrm{FACRE} + \varepsilon \quad (2)$$

The WTH response variable stands for willingness to harvest, with 1 representing willing to harvest, $\beta_1, \ldots \beta_t$ being the coefficients for the independent variables, and ε being the error term. For the purposes of making willingness to harvest a binary dependent variable, respondents who answered 5 or above on the Likert-type willingness-to-harvest question were considered willing to harvest. Significance of the independent variables was identified at the $\alpha = 0.10$, $\alpha = 0.05$, and $\alpha = 0.01$ levels.

EDU, INC, AGE, MGMT, and FACRE are all dummy variables (Table 2). EDU represents whether the landowner had obtained a bachelor's degree or a higher degree. INC differentiates landowners who had an annual household income of $50,000 or more and those who did do not. AGE was used to separate landowners by those younger than 45 years and those 45 years and older. MGMT categorized landowners by whether they had received some form of management assistance regarding their forest. FACRE split landowners by those who had owned more than 40 forested acres and those who owned 40 or fewer forested acres.

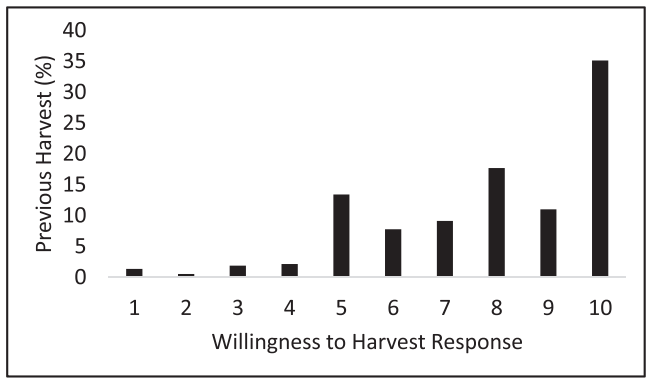

Figure 2.—Percentage of landowners who have previously harvested by their willingness-to-harvest response.

Education was hypothesized to be positively related to willingness to harvest given the results of previous studies (Joshi and Arano 2008, Joshi and Mehmood 2011, Joshi et al. 2013b, Aguilar et al. 2014). Income was hypothesized to negatively influence willingness to harvest given that Dennis (1990) found that it negatively influenced harvesting in the Northeast. As previous studies found (Joshi and Arano 2008, Joshi and Mehmood 2011, Joshi et al. 2013b, Aguilar et al. 2014), age was predicted to be negatively associated with willingness to harvest. Several studies found that management assistance or knowledge of management increased willingness to harvest (Lindsay et al. 1992, Joshi and Arano 2008, Paula et al. 2011, Joshi et al. 2013a, Kilgore et al. 2015), and therefore management assistance was hypothesized to positively influence willingness to harvest. Forest acres was predicted to be positively related to willingness to harvest given that Lindsay et al. (1992), Paula et al. (2011), and Shivan and Mehmood (2012) found a positive relationship between forested acres owned and willingness to harvest. It is important to note that some of these studies used for hypothesis development studied willingness to harvest woody biomass rather than willingness to harvest timber. Given that woody biomass is generally harvested in conjunction with timber, it is assumed that the relationships discovered in studies of the willingness to harvest woody biomass will hold true in studies of willingness to harvest timber.

Results

Of the 3,000 mailed surveys, 234 could not be delivered, reducing our sample size to 2,766. In total, 997 surveys were returned between July and October 2014 with 882 of the respondents indicating that they owned at least 10 acres of forestland. The statewide adjusted response rate was 31.9 percent, similar to other studies regarding NIPF landowner willingness to harvest. Gruchy et al. (2012) reported a 21 percent response rate in Mississippi, while Aguilar et al. (2014) reported a 34 percent response rate in Missouri. Compared with a study by Shivan and Mehmood (2012) of NIPF landowners in Virginia, our response rate was slightly higher than their 27 percent. Overall response rates of 30.3 percent for the Coastal Plain, 34.8 percent for the Northern Mountains, 36.8 percent for the Northern Piedmont, 33.3 percent for the Southern Mountains, and 30.3 percent for the Southern Piedmont were achieved (Fig. 1).

Table 2.—Binomial logistic regression variable definitions and coding.

Variable	Description	Hypothesized effect
EDU	Education. Value equals 1 if bachelor's degree or higher and 0 otherwise.	Positive
INC	Income. Value equals 1 if above $50,000 annual household income and 0 otherwise.	Negative
AGE	Age. Value equals 1 if above 45 years of age and 0 otherwise.	Negative
MGMT	Management background. Value equals 1 if the landowner received any kind of management assistance and 0 otherwise.	Positive
FACRE	Forested acres. Value equals 1 if greater than 40 acres is owned and 0 otherwise.	Positive

Early and late responses for education, income, total acres, and forested acres were tested for a nonresponse bias with no tests indicating bias (Groves et al. 2002). A large percentage of landowners fell into the higher total acreage classes with 43 percent of respondents reporting that they owned 81 acres or more. The average parcel size for the sampling frame was 80 acres and explains why a large percentage of respondents fell into the largest total acreage class. Given the results of previous NIPF landowner surveys (Lindsay et al. 1992, Joshi and Mehmood 2011), it is assumed that large landowners are more willing to harvest and therefore could lead to bias in the willingness-to-harvest results of this study. However, when looking at forested acreage classes as opposed to total acreage classes, there was almost 25 percent of respondents in each of the forested acreage classes. Because of the approximate even distribution of landowners in forested acreage classes, it is assumed that there is minimal bias that could be caused by the large percentage of landowners in the highest total acreage class.

Landowner demographics

The largest number of NIPF landowners in Virginia responded ''Bachelor's or higher'' (51.6%) to the education question (Table 3). The next largest education group was ''High school diploma'' (27.7%), followed by ''Associates/technical training'' (16.5%) and ''Did not graduate high school'' (4.1%). When grouped by education level in the means analysis portion of the study, the least willing to harvest was the Did not graduate high school group, and the most willing to harvest was the Bachelor's or higher group. Those who responded Associates/technical training and Bachelor's or higher were significantly different from those who responded Did not graduate high school ($P = 0.011$ and $P = 0.002$, respectively). As education level increased, so did the mean score of the willingness-to-harvest question.

According to the annual household income responses, the largest percentage of landowners reported that they made between $100,000 and $199,999 (26.5%). The next largest group of respondents for income was the $50,000 to $74,999 (20.0%) class, followed by the $25,000 to $49,999 income class (16.3%) and the $75,000 to $99,999 income class (15.8%). Only 13.6 percent of respondents reported earning $200,000+, and 7.9 percent of landowners reported earning $0 to $24,999. Following the relationship of education, income classes generally showed that as annual income increased, so did the level of willingness to harvest. The group least willing to harvest was the $0 to $24,999 class, and the most likely to harvest was the $100,000 to $199,999 class. The $200,000+ class showed slightly less willingness

Table 3.—Mean responses to the willingness-to-harvest question on a scale of 1, strongly opposed, to 10, strongly in favor, for Virginia by demographic variables.

Demographic variable	*n* (%) responded[a]	Mean WTH response[b]	SE	95% CI Lower	95% CI Upper
Education					
Did not graduate high school	35 (4.1)	5.51 B	0.43	4.68	6.35
High school diploma	236 (27.7)	6.64 AB	0.16	6.32	6.96
Associates/technical training	141 (16.5)	6.98 A	0.21	6.57	7.40
Bachelor's or higher	440 (51.6)	7.12 A	0.12	6.88	7.36
Income					
$0–$24,999	61 (7.9)	6.02 B	0.32	5.39	6.64
$25,000–$49,999	126 (16.3)	6.66 AB	0.22	6.22	7.09
$50,000–$74,999	155 (20.0)	6.76 AB	0.20	6.37	7.15
$75,000–$99,999	122 (15.8)	7.16 A	0.23	6.71	7.60
$100,000–$199,999	205 (26.5)	7.27 A	0.17	6.93	7.61
$200,000+	105 (13.6)	7.12 AB	0.24	6.65	7.60
Age (yr)					
44 and under	56 (6.7)	7.05 A	0.34	6.64	7.72
45–54	131 (15.8)	7.24 A	0.22	6.80	7.67
55–64	258 (31.1)	7.18 A	0.16	6.87	7.49
65–74	247 (29.8)	6.75 A	0.16	6.43	7.07
75 and over	138 (16.6)	6.51 A	0.22	6.09	6.94

[a] Percentages may not add up to 100 percent due to rounding.

[b] Means not connected by a common letter indicate a significant difference at $P < 0.05$ using Tukey's honestly significant difference test. WTH = willingness to harvest.

to harvest. Responses from landowners in the $75,000 to $99,999 and the $100,000 to $199,999 classes were significantly different from the $0 to $24,999 income class ($P = 0.042$ and $P = 0.008$, respectively).

In the age class demographic variable, no significant differences were observed among means ($P = 0.051$). However, landowners in the ''45–54'' and ''55–64'' age classes had the highest mean responses regarding willingness to harvest. The least willing to harvest age class was the oldest class, ''75 and over.'' The mean age for respondents was 63 years. The largest percentage of landowners reported being in the 55 to 64 age class (31.1%), followed by the 65 to 74 age class (29.8%). The next highest reported class was the 75 and over category (16.6%). Meanwhile, 15.8 percent of respondents reported being in the 45 to 54 age class. Only 6.7 percent of respondents reported being in the ''44 and under'' age class.

Land characteristics

Similar to the findings of the Butler (2008) study, the largest portion of landowners reported that they had purchased their land (64.8%) (Table 4). The next largest ownership category was the landowners who had inherited their land at 19.1 percent, followed by landowners who had both inherited and purchased their land (16.1%). Of the three possible groups—''Purchased,'' ''Inherited,'' or ''Inherited and purchased''—the highest mean response to the willingness-to-harvest question occurred in the Inherited and purchased group. The lowest mean response was from landowners who had only inherited their land. No significant differences were determined between the willingness to harvest of the three ownership categories ($P = 0.204$). Landowners who indicated that they intended to sell all or a portion of their land in 5 years (21.1% of respondents) reported a significantly higher willingness to harvest than those not planning to sell in 5 years ($P = 0.001$).

For total acres owned, landowners owning ≥81 total acres of land accounted for the largest percentage of respondents (43.3%), followed by 41 to 80 acres (23.6%), 21 to 40 acres (19.6%), and ≤20 acres (13.5%) (Table 4). Of the possible forest acreage classes, the largest percentage of respondents reported owning ≥81 acres (28.9%), followed by ≤20 acres (27.9%), 41 to 80 acres (21.5%), and 21 to 40 acres (21.2%). As total and forested acreage classes increased, so did the mean response to the willingness-to-harvest question. Landowners with the smallest area (≤20) for total acres and forested acres were the least willing to harvest, and landowners with greater area (≥81) were the most willing to harvest. Nearly half of the respondents fell into the ≥81 category for total acres. Landowners who owned 21 to 40 forested acres and 41 to 80 forested acres responded significantly different in their willingness to harvest from landowners who owned ≤20 forested acres ($P = 0.0359$ and $P = 0.0005$, respectively) and landowners who owned ≥81 forested acres ($P = 0.0001$ and $P = 0.0018$, respectively).

Using the willing-to-harvest and less-willing-to-harvest groups, the total forested acres belonging to those willing to harvest was calculated from our sample. Landowners who indicated that they were willing to harvest reported owning 87,434 acres of total forestland. Respondents who indicated that they were less willing to harvest reported owning 12,944 acres of total forestland. More than 87 percent of the forested acres from our sample were owned by landowners who indicated that they were willing to harvest.

Management background and objectives

Among the four types of management assistance (advice from a forester, forest management plan, extension help, or none), the largest percentage of landowners reported receiving no assistance managing their forest (64.3%). Receiving advice from a forester was the most common

Table 4.—Mean responses to the willingness-to-harvest question on a scale of 1, strongly opposed, to 10, strongly in favor, for Virginia by land characteristics variables.

Land characteristic	*n* (%) responded[a]	Mean WTH response[b]	SE	95% CI	
				Lower	Upper
Ownership					
Inherited	165 (19.1)	6.65 A	0.20	6.26	7.04
Purchased	560 (64.8)	6.91 A	0.11	6.69	7.12
Inherited and purchased	139 (16.1)	7.17 A	0.22	6.75	7.60
Intent to sell in 5 yr					
Yes	179 (21.1)	7.49 A	0.19	7.12	7.86
No	670 (78.9)	6.78 B	0.10	6.58	6.97
Total acres owned					
≤20	115 (13.5)	6.12 A	0.23	5.67	6.58
21–40	167 (19.6)	6.28 A	0.19	5.90	6.65
41–80	201 (23.6)	6.52 A	0.24	5.81	6.74
≥81	369 (43.3)	7.62 B	0.14	7.44	7.99
Forested acres owned					
≤20	241 (27.9)	6.04 A	0.16	5.73	6.36
21–40	188 (21.2)	6.69 B	0.18	6.34	7.04
41–80	186 (21.5)	6.99 B	0.18	6.64	7.35
≥81	250 (28.9)	7.86 C	0.16	7.55	8.17

[a] Percentages may not add up to 100 percent due to rounding.

[b] Means not connected by a common letter indicate a significant difference at $P < 0.05$ using Tukey's honestly significant difference test. WTH = willingness to harvest.

form of receiving assistance (35.7%), while assistance from extension outlets was the least common (15.3%). Landowners who had a forest management plan accounted for 16.8 percent of respondents. Just under half (43.1%) of respondents reported having previously harvested, while the remainder of landowners reported they had not previously harvested.

Landowners who had received some kind of assistance managing their forest were more willing to harvest than those who had received no assistance according to means testing (Table 5). The higher willingness-to-harvest response from landowners who had received some form of assistance could be a result of landowners who already had a desire to harvest seeking management assistance. Of the four forms of assistance, those who had a written management plan were the most willing to harvest. Landowners who had previously harvested had a significantly higher mean response than those who had not previously harvested ($P = 0.0001$).

Landowners were asked to use a 10-point Likert-type scale to indicate how important a specific management objective was, with 1 indicating not important and 10 indicating extremely important. After comparing mean responses to management objectives grouped by those willing to harvest and those less willing to harvest, significant differences in mean responses were observed between those willing to harvest and those less willing to harvest in every management category except for ''Aesthetics'' (Table 6).

Among those who indicated they were willing to harvest, they reported a mean response of 4.25 (of 10) for ''Timber production,'' 7.34 for ''Aesthetics,'' 8.13 for ''Provide habitat,'' 6.52 for ''Provide hunting opportunities,'' 5.91 for ''Recreation,'' 7.24 for ''Privacy from neighbors/roads,'' and 3.17 for ''Development for income.'' Those who indicated they were less willing to harvest reported a mean response of 2.08 for Timber production, 7.14 for Aesthetics, 8.88 for Provide habitat, 4.82 for Provide hunting opportunities, 6.52 for Recreation, 7.86 for Privacy from neighbors/roads, and 2.26 for Development for income.

Based on the highest management objective responses, the willing-to-harvest group favored the management objectives of Timber production, Provide hunting opportunities, and Development. All three of these objectives can be viewed as ways to generate income from the land. The three top objectives for the less-willing-to-harvest group included Providing habitat, Recreation, and Privacy from neighbors/roads.

Willingness to harvest by region

Within each region of Virginia, willingness-to-harvest responses were grouped by forest acreage classes. Throughout all regions, a general relationship was observed, similar to the statewide analysis. As forest acres increased, so did

Table 5.—Mean responses to the willingness-to-harvest question on a scale of 1, strongly opposed, to 10, strongly in favor, for Virginia by management variables.

Management variable	*n* (%) responded[a]	Mean WTH response[b]	SE	95% CI	
				Lower	Upper
Management background					
Advice from forester	307 (35.7)	7.80 A	0.14	7.52	8.07
No advice from forester	552 (64.3)	6.40 B	0.10	6.20	6.61
Forest management plan	144 (16.8)	7.82 A	0.21	7.41	8.23
No forest management plan	715 (83.2)	6.72 B	0.09	6.53	6.90
Extension help	131 (15.3)	7.61 A	0.22	7.18	8.05
No extension help	728 (84.7)	6.77 B	0.09	6.59	6.96
Harvest history					
Previous harvest	373 (43.1)	7.86 A	0.12	7.61	8.10
No previous harvest	492 (56.9)	6.20 B	0.11	5.98	6.41

[a] Percentages may not add up to 100 percent due to rounding.

[b] Means not connected by a common letter indicate a significant difference at $P < 0.05$ using Tukey's honestly significant difference test. WTH = willingness to harvest.

Table 6.—Mean responses to the management objectives questions on a scale of 1, not important, to 10, extremely important, for Virginia by those willing to harvest and those less willing to harvest.

Management objective	Mean objective response			*P* value[a]
	Overall	Willing to harvest	Less willing to harvest	
Timber production	3.92	4.25	2.08	<0.0001*
Aesthetics	7.31	7.34	7.14	0.5144
Provide habitat	8.24	8.13	8.88	<0.0001*
Provide hunting opportunities	6.27	6.52	4.82	<0.0001*
Recreation	6.01	5.91	6.52	0.0407*
Privacy from neighbors/roads	7.34	7.24	7.86	0.0208*
Development for income	3.03	3.17	2.26	0.0002*

[a] * Significant difference between those willing to harvest and those less willing to harvest mean responses for management objectives at $P < 0.05$ using analysis of variance.

Table 7.—Mean responses to the willingness-to-harvest question on a scale of 1, strongly opposed, to 10, strongly in favor, for five Forest Inventory Analysis regions in Virginia by forest acreage classes.[a]

Forest acre class	Coastal Plain		Northern Piedmont		Southern Piedmont		Northern Mountains		Southern Mountains	
	n	Mean WTH response	*n*	Mean WTH response	*n*	Mean WTH response	*n*	Mean WTH response	*n*	Mean WTH response
≤20	19	7.16 AB	92	5.88 A	39	6.23 B	49	5.80 B	38	6.11 A
21–40	28	6.61 B	46	6.37 A	30	7.17 AB	41	7.02 AB	42	6.50 A
41–80	32	7.47 AB	24	6.79 A	43	7.00 AB	46	6.80 AB	37	6.95 A
≥81	79	8.33 A	29	7.03 A	52	8.10 A	40	7.83 A	45	7.33 A

[a] Means not connected by a common letter indicate a significant difference within the region at $P < 0.05$ using Tukey's honestly significant difference test. WTH = willingness to harvest.

the mean response scores (Table 7). No statistical difference was identified between acreage groups in the Northern Piedmont ($P = 0.1484$) and the Southern Mountains ($P = 0.1032$). The lack of statistical difference suggests that forest acreage classes were not a good predictor of whether a landowner was willing to harvest timber in these two regions. Responses from the other three regions—Coastal Plain ($P = 0.0049$), Southern Piedmont ($P = 0.0030$), and Northern Mountains ($P = 0.0025$)—did indicate significant differences between groups in their respective regions. These differences suggest that forest acreage classes could be a good predictor of whether a landowner is willing to harvest timber.

The overall willingness-to-harvest mean responses were compared in order to determine if there were regional differences in willingness to harvest. The Coastal Plain had the highest mean response and was significantly different from the Northern Piedmont ($P = 0.0001$), the Northern Mountains ($P = 0.0084$), and the Southern Mountains ($P = 0.0015$) (Table 8). In the Northern and Southern Mountains, the mean responses were similar to each other but significantly different from the Coastal Plain. Landowners in the Southern Piedmont had the second-highest overall mean score and were different from landowners in the Northern Piedmont ($P = 0.0062$). The lowest mean response was recorded in the Northern Piedmont.

Binomial logistic regression results

Of the independent variables tested in the predictive model, all were found to be significant at the $\alpha = 0.10$ level. The variable FACRE was positively associated with willingness to harvest at the $\alpha = 0.01$ level (Table 9). AGE was found to be positive and significant at the $\alpha = 0.05$ level. INC and MGMT were also found to be positive and significant at the $\alpha = 0.10$ level. EDU was found to be negative and significant at the $\alpha = 0.10$ level. Of the variables tested in the regression model, the only variable to contradict the means-testing portion of the results was the education variable. Education was found to be a significant predictor of differences between groups, and it appeared that as education increased, so did the mean response. However, the binomial logistic regression model found that education was actually negatively associated with willingness to harvest.

Table 8.—Mean responses to the willingness-to-harvest question on a scale of 1, strongly opposed, to 10, strongly in favor, for five Forest Inventory Analysis (FIA) regions in Virginia.

FIA region	*n*	Mean WTH response[a]
Coastal Plain	163	7.71 A
Southern Piedmont	167	7.19 AB
Northern Mountains	176	6.81 BC
Southern Mountains	167	6.66 BC
Northern Piedmont	192	6.28 C

[a] Means not connected by a common letter indicate a significant difference at $P < 0.05$ using Tukey's honestly significant difference test. WTH = willingness to harvest.

Discussion

Demographics

Similar to the Virginia survey by Joshi and Mehmood (2011), we found that over half of the respondents reported obtaining a Bachelor's degree or higher. Also, Joshi and Mehmood (2011) had reported that just over half of respondents indicated that they earned more than $75,000 per year. Our study found almost identical results. Landowners with less education than a bachelor's degree and relatively high incomes were more willing to harvest than those who were more educated and had lower incomes according to the regression model. Dennis (1990) found that as income and education increased, the likelihood of harvesting went down. More recently, Joshi and Mehmood (2011) reported that as education and income increased, so did the likelihood of harvesting. Our study did not produce the exact results reported by either Dennis (1990) or Joshi and Mehmood (2011). The differences between our study and the Dennis (1990) and Joshi and Mehmood (2011) studies could be a result of attitudes changing over time or could possibly reflect regional differences in the population sampled. The anomaly in the $200,000+ income bracket that showed a drop in the mean willingness-to-harvest response could have been a result of financially secure landowners not pursuing additional sources of income. However, this does not mean that landowners in this group were not

Table 9.—Binomial logistic regression estimates for determining significant factors that influence nonindustrial private forest landowners' willingness to harvest timber.

Independent variable[a]	Coefficient	SE	*P* value
Intercept	1.279		
EDU	−0.237	0.122	0.0516
INC	0.232	0.129	0.0713
AGE	0.527	0.231	0.0226
MGMT	0.203	0.119	0.0859
FACRE	0.336	0.115	0.0034

[a] For definitions of variables, see Table 2.

willing to harvest; as a group, they still had a relatively high mean response of 7.12 (of 10).

Contrary to the findings in the means analysis portion of the study, age was found to be a significant predictor of willingness to harvest at the $\alpha = 0.05$ level in the regression model. The relationship between age and willingness to harvest was found to be positive. Our study found similar results to previous NIPF landowner studies (Joshi and Arano 2008; Joshi and Mehmood 2011; Shivan and Mehmood 2012; Joshi et al. 2013a, 2013b). Landowners in the 45 to 54 and 55 to 64 age classes were the most willing to harvest according to means testing. The least likely to harvest group of the 75 and over age class could be a result of landowners assuming that they will not benefit from the additional income or that they do not believe the forest will be mature enough to be harvested in their lifetime. A few elderly landowners provided written comments on the questionnaire expressing both of these viewpoints.

Land characteristics

Landowners who indicated that they intended to sell some or all of their land in 5 years were more willing to harvest than those who did not intend to sell according to the means-testing portion of the analysis. It appears that the landowners who intended to sell were driven by income opportunities from their land, and this might be why they were more willing to harvest timber than those who did not intend to sell. This idea is generally supported by Rozance and Rabotyagov (2014), who found that landowners in Washington who were wealthier were less likely to develop their land, possibly owing to the landowner not relying on the forestland for financial gains.

In both the total acreage and the forested acreage classes, the willingness-to-harvest mean response increased with the amount of land owned. In the binomial logistic regression portion of the study, forested acreage classes were found to be positively associated with willingness to harvest. Similarly, Lindsay et al. (1992) and Joshi and Mehmood (2011) reported that land area owned was positively associated with willingness to harvest. Also, Lindsay et al. (1992), Paula et al. (2011), and Shivan and Mehmood (2012) reported that as forested acres increased, so did the landowners' willingness to harvest. The reasoning behind this phenomenon could be that the landowners believed that only a portion of their forestland would be harvested rather than all of it. A clear-cut may not be as aesthetically displeasing on a large tract, where only a portion is cut at one time, compared with a small tract, where the entire forest is harvested at one time. Shivan and Mehmood (2012) theorized that landowners with a large amount of forested acres were more willing to harvest due to the fact that they could generate a large amount of revenue. Landowners with a smaller amount of forested acres could realize that the total money generated from a harvest may not be enough to entice them to harvest. The total revenue generated from the harvest could also explain why an increase in forested acres provides an increase in willingness to harvest.

Another reason why landowners with more acreage were more willing to harvest could be that income was correlated with the size of landholdings in our data set. From our results, landowners in higher income classes were generally more willing to harvest. This could explain why an increase in tract area increased landowners' willingness to harvest. Also, of the landowners reporting that they had a management plan, 52 percent were in the largest forested acreage class. Given that management plans generally include some type of silvicultural harvests, the higher willingness-to-harvest response in the larger forested acreage classes could be explained.

Management background and objectives

Similarities between education level and management assistance levels in the means-testing portion of the study suggest that as landowners became more knowledgeable of timber harvesting and income opportunities in general, they were more inclined to harvest timber. However, the result that higher levels of education increased the mean response to the willingness-to-harvest question could be unlikely given that the EDU variable in the binomial logistic regression was negatively associated with willingness to harvest. Similar to the results of the logistic regression analysis of this study, previous studies have found that as landowners became more knowledgeable of forest management through assistance, they were more likely to harvest (Lindsay et al. 1992, Joshi and Arano 2008, Paula et al. 2011, Becker et al. 2013, Joshi et al. 2013a, Kilgore et al. 2015). Caution must be taken when interpreting this result because of the possibility that landowners may have been seeking educational opportunities because they were already inclined to harvest and wanted to be more informed about forest harvesting. Regardless of whether or not management assistance increases willingness to harvest, the results show that those who were interested in harvesting also showed interest in management assistance.

Landowners who were willing to harvest demonstrated that they were more interested in management objectives that have the potential to generate income. The two obvious income-generating management objectives are Timber production and Development for income, but the Provide hunting opportunities objective can produce income for landowners as well through leases that allow hunters access to their land. Landowners who were less willing to harvest preferred management objectives that could be viewed as passive management. Providing habitat, Recreation, and Privacy generally require no active harvesting other than harvests that benefit certain species of wildlife or harvests that promote recreational opportunities. Contrary to our results, Aguilar et al. (2013) found that landowners who valued aesthetics, habitat, and hunting and fishing were the most likely to harvest in Missouri. It is possible that the landowners who were willing to harvest in Virginia were more concerned about income opportunities from their land than were landowners in Missouri. This could be a result of differences in landowner populations, markets for forest products, and predominant forest stand types in the different regions.

Differences in willingness-to-harvest response across regions

The Coastal Plain and Southern Piedmont of Virginia are known to be wood-supplying regions owing to the large number of forest products companies and the markets they create. The large active markets in the region provide an avenue for landowners to sell their timber. Also, these regions are home to the majority of the pine plantations in the state. It can be assumed that landowners who have pine

plantations are engaged in timber production and could be why these two areas were more willing to harvest timber.

The Northern and Southern Mountains had lower mean responses than the Coastal Plain and Southern Piedmont. In the two mountainous regions, the topography is steeper than other regions and could prohibit harvest due to increased logging costs and logistical problems associated with harvesting on steep sites. Also, the predominantly deciduous forest cover in the mountains has a longer rotation length than pine plantations in the Coastal Plain and Southern Piedmont. Increased logging costs, logistical problems, and longer rotation lengths could all be reasons why landowners in the Northern and Southern Mountains were less willing to harvest than those in the Coastal Plain and Southern Piedmont.

Landowners in the Northern Piedmont were the least willing to harvest. This region, of all regions, also reported the smallest number of previous harvests. The highly developed Northern Piedmont had the highest number of owners of small parcels (Table 7). From our findings, we know that owners of smaller forested parcels are less willing to harvest; this could provide an explanation for the low willingness to harvest in the Northern Piedmont.

Conclusions

As demand for wood fiber increases owing to additional markets and competition, it becomes more important to determine how much wood is available for harvest in Virginia. With most of the forest in the state being privately held, it is important to identify those who could supply timber and whether they are willing to supply it to markets. The main goal of this survey was to identify relationships between landowner characteristic variables and a landowner's willingness to harvest. The results of this survey provide data needed to improve model forecasts and also provide insight into landowner attitudes and preferences.

Results show differences in willingness-to-harvest responses across variables, such as education, income, and total and forested acreage classes, using means testing. In the binomial logistic regression model, the variables of education, income, age, management background, and forested acres owned were found to be significant predictors of willingness to harvest. However, some of the variables were only marginally significant at the $\alpha = 0.10$ level. There were also differences across the regions in the state. According to Butler et al. (2010), inconsistencies in willingness-to-harvest studies are common. However, our results generally agree with previous studies regarding characteristics of forest landowners that impact willingness to harvest. With a relatively large sample size for Virginia, we captured the attitudes of the NIPF landowners in the state regarding their willingness to harvest. Although our study is limited to Virginia, these results may be relevant to other states with similar characteristics.

The results generated from our study can help guide future policy decisions regarding the forest products industry as well as how forests are managed in Virginia. Evidence of management assistance increasing the willingness to harvest highlights the importance of forest landowner educational programs. Caution must be taken when dedicating funds to educational programs given that the increase in willingness to harvest could have been attributed to landowners who were already willing to harvest seeking educational opportunities. Even if landowners who previously harvested were the individuals who sought educational opportunities, more funding could be made available to management assistance programs to keep these landowners in consideration of harvesting again.

Results suggested that landowners with large forested tracts were also more willing to harvest, which also highlights the importance of maintaining larger parcels. Landowner incentive programs that reduce the property tax rate for parcels that are passed on as one parcel rather than subdivided could be an effective way to maintain larger parcels and increase the availability of timber. Extension programs and policy efforts could be developed to encourage landowners to keep a forested parcel in forest rather than clearing it for some other land use, such as agriculture. More funding could be given to reforestation cost share programs in order to completely or partially cover the costs associated with reforestation of harvested parcels to ensure that tracts that were forested remain forested after harvest. Additional research is needed to identify whether the relationships discovered in this study hold true in the future or whether landowners' attitudes change over time. Maintaining an up-to-date outlook on NIPF landowners is critical to providing information needed for determining the available wood supply in the state.

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