Do forest property characteristics reveal landowners' willingness to accept payment for ecosystem services contracts?

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Abstract:

As the importance of family forest owners as providers of ecosystem services continues to grow, many studies are focusing on factors that affect their decisions to participate in payment for ecosystem services (PES) programs. Forest owners' ownership objectives are known to play a major role in determining their participation in PES programs. It is expensive and time-consuming, however, to implement interviews or surveys to obtain information about forest owners' values and attitudes. Past studies found that a manner in which a forest is managed reveals forest owners' goals and management preferences for the property. In this study, we predicted forest owners' participation in PES programs using observable forest management behavior. We used forest property characteristics, which are identified using publicly available aerial images and databases, as proxies for current forest management on one's property. We examined whether and how forest property characteristics were related to family forest owners' preferences towards PES programs. We obtained information about family forest owners' preferences towards PES programs through a choice experiment and analyzed their forest property conditions. Research findings confirmed that there were significant correlations between the forest owners' objectives and the forest property characteristics. The results from a random parameter logit model indicated that the existence of planted pine, bottomland hardwood forests, and a residential structure on one's property significantly increased the likelihood that the forest owner will participate in PES programs. We further found that forest owners' willingness to accept (WTA) compensation to participate in PES programs was negatively related to the proportion of planted pine areas and bottomland hardwood forests area. Also, the existence of a residential structure on one's property decreased forest owners' WTA.

Keywords: choice experiment, forest types, ownership objectives, revealed preference, family forest owners

JEL: Q23, Q57

1. Introduction

Forest owners' objectives are critical in making their forest management decisions (Blanco, et al., 2015, Boon and Meilby, 2007, Dhubháin, et al., 2007, Jennings and van Putten, 2006, Karppinen, 1998, Kendra and Hull, 2005, Khanal, et al., 2017, Kurtz and Lewis, 1981, Kuuluvainen, et al., 1996, Marty, et al., 1988, Ross-Davis and Broussard, 2007). Forest owners who value amenities of their forests will manage their forests in the way that they can enjoy those benefits (Boon and Meilby, 2007, Jennings and van Putten, 2006, Khanal, et al., 2017, Raunikar and Buongiorno, 2006). On the other hand, landowners whose main ownership objective is to generate a financial return from their land will be more interested in managing land so that they can earn money from timber harvests or leasing hunting rights (Blanco, et al., 2015, Boon and Meilby, 2007, Jennings and van Putten, 2006, Karppinen, 1998, Marty, et al., 1988). Forest owners who pursue both non-timber and timber objectives will manage their land in a way that will generate the most benefits from their property (Khanal, et al., 2017). Furthermore, some forest owners will choose not to actively manage their forestland since they are less interested in specific non-timber or timber outputs or property itself (Bieling, 2004, Boon, et al., 2004, Kendra and Hull, 2005, Ross-Davis and Broussard, 2007). There are other factors as well that affect forest management decision such as biophysical and spatial characteristics of the property, or institutional factors, but what forest owners want to achieve on their property is a major determinant in their decision. Consequently, current forest management on one's property may at least implicitly reveal one's preferences towards his or her property.

As the importance of family forest owners, who own 62 percent of the U.S. private forests (Butler, 2008), as providers of ecosystem services continues to grow, many studies have tried to identify the factors that affect family forest owners' participation in conservational incentive programs and to identify the targets that are more likely to participate in conservation programs. They examined a broad spectrum of factors from forest owner specific information (Bieling, 2004, Kilgore, et al., 2008, Kline, et al., 2000, Knoot, et al., 2015, Langpap, 2004, Layton and Siikamäki, 2009, LeVert, et al., 2009, Lindhjem and Mitani, 2012, Mäntymaa, et al., 2009, Matta, et al., 2009, Nagubadi, et al., 1996, Rabotyagov and Lin, 2013, Stevens, et al., 2002), property characteristics (Kline, et al., 2000, Langpap, 2004, Lindhjem and Mitani, 2012, Matta, et al., 2009, Rabotyagov and Lin, 2013, Stevens, et al., 2002, Vedel, et al., 2015), and payment for ecosystem services (PES) program

designs (Horne, 2006, Kelly, et al., 2015, Matta, et al., 2009, Rabotyagov and Lin, 2013, Stevens, et al., 2002, Vedel, et al., 2015). Many studies concluded that forest owners' attitudes and management preferences are one of the major determinants in their enrollment in PES programs (Kline, et al., 2000, Mäntymaa, et al., 2009, Matta, et al., 2009, Rabotyagov and Lin, 2013). Therefore, we expected that because current forest management that is expressed by forest property characteristics reveals a forest owners' values and objectives associated with the property, it might be possible to use current forest management adopted on the property in predicting the landowner's willingness to participate (WTP) in PES programs and willingness to accept (WTA) compensation to participate.

In this study, we examined the potential of using observable forest property characteristics from aerial images and public databases to predict forest owners' willingness to enroll their property in PES programs. The objectives of the study were to 1) collect information about forest owners' preferences towards PES programs using a choice experiment, 2) analyze current forest management approaches in participants' properties, 3) test correlations between forest types and forest parcel ownership objectives for the property, and 4) predict forest owners' WTP in PES programs and WTA using forest property characteristic variables.

2. Materials and Methods

2.1 Data collection

Our survey was conducted in the southeastern Georgia, one of Forest Inventory and Analysis (FIA) survey units. The area is geographically classified as the Coastal Plain region, which is represented by relatively flat and sandy and clay soils with not much organic material. The climate is humid subtropical, and the region has relatively higher precipitation than other geographic areas in the state including the Piedmont and the southern Appalachians (Nagy et al., 2011). The southeastern Georgia is the most forested area in the state. Approximately 80 percent of the region is covered by forests (Brandeis et al., 2016). We identified family forest owners who own riparian forest parcels in the study area using each county tax assessor's office. Most of the county tax assessor's offices in Georgia provide landowner information as well as the property information such as the location of the property and parcel boundary. We identified 4,600 riparian forest parcels that

seemed to have a water body on them and that are more than twenty acres. Twenty-acre was chosen as a cutoff point, because owners of the smaller properties are less likely to be involved in silvicultural activities (Conway, et al., 2003, Kennedy, 2001). Also, forest management such as harvesting activities is limited in smaller tract because of the cost effectiveness (Paula, et al., 2011).

After collecting the riparian forest parcel information, we checked the parcels again using ArcGIS 9.4, a geographic information system (GIS) software, so that we could ensure the forest parcels have characteristics of riparian forests. We overlaid the parcel boundaries with National Hydrography Dataset provided by U.S. Geological Survey and filtered the parcels without intermittent streams, permanent streams, or other surface water bodies.

Total 4,600 forest owners were identified, and in the late summer of 2016, we sent mail surveys to randomly selected 1,350 forest owners among them. Two weeks later, the reminder postcards were sent. Four weeks later, the final replacement surveys were sent. We also attached URL address to an online survey in mail surveys and postcards. Furthermore, we included phone numbers and email addresses of the principal investigator and co-investigator in the surveys and reminder postcards so that survey participants could ask questions associated with the survey. Since there are many forest owners who own more than one forest or non-forest property, we used the parcel tax number, which is a unique id assigned to a property in each county, as an identifier. Forest owners were asked to complete questionnaires about their ownership objectives and multiple-choice questions associated with specific forest. The questionnaire was reviewed by a group of experts and family forest owners. After the review, we revised the terms used in the survey and clarified the questions before we sent the questionnaires.

2.2 Identification of forest property characteristics

Previous studies found that forest types on the property were associated with forest owners' objectives (Blanco, et al., 2015, Greene and Blatner, 1986, Khanal, et al., 2017). In this study, we chose the forest types and residential structure on the property as a proxy for forest management that reflects family forest owners' objectives and preferences. The popular forest types in our study area, include oak-hickory, oak-gum-cypress, mixed oak-pine, and loblolly-shortleaf pine forests (Brandeis et al., 2016). In this study, we used the following classification made based on the

popular forest types in the area: 1) bottomland hardwood (BH) forests, 2) upland hardwood (UH) forests, 3) natural pine (NP) forests, 4) planted pine (PP) forests, 5) and mixed oak-pine (OP) forests. According to this classification, oak-gum-cypress forests were considered as bottomland hardwood forests. Other hardwood forests were considered as upland hardwood forests. Pine forests were classified as PP and NP forests based on observable management. Mixed oak-pine forests, which consist of both hardwoods and substantial pine stocking are classified as OP forests.

Each forest property in the sample was analyzed based on multiple high-resolution images of the properties including the National Agriculture Imagery Program images, Google Earth historical images, and Digital Globe sub-meter images. Because forests in the same forest type groups are associated with similar species composition and site requirements, we used both aerial photo interpretation and geological information in classifying forest types in sample parcels. For example, since it is hard to distinguish BH from UH stands, we used the National Wetlands Inventory to identify bottomland hardwood forests. We classified the hardwood stands that were overlaid with the National Wetlands Inventory maps as bottomland hardwood forests. When it comes to identifying PP forests, if pine stands on a parcel was recently clearcut and artificially regenerated and if there existed visible tree rows on the pine stands, the forest stands were classified as planted pine. If there is no or very low evidence of intensive management, we classified the stands as NP. We obtained the information about the proportions of different forest types, water, and the non-forested land of each property.

In terms of residential structure, it was difficult to identify a residential structure from other types of non-residential structures such as barn or storage merely based on aerial pictures. Furthermore, some properties were densely forested, which made the analysis difficult. Instead of relying on aerial photos, we matched mailing address and property address and concluded that if both addresses are the same, there is some sort of residential structure on the property.

To increase the accuracy of the forest property characteristics analysis, we asked survey participants if there existed intensively managed pine stands on their parcel and if the residential objective is one of the most important ownership objectives associated with the specific property. We found that our analysis results were consistent with their responses.

2.3 Correlations between forest types and ownership objectives

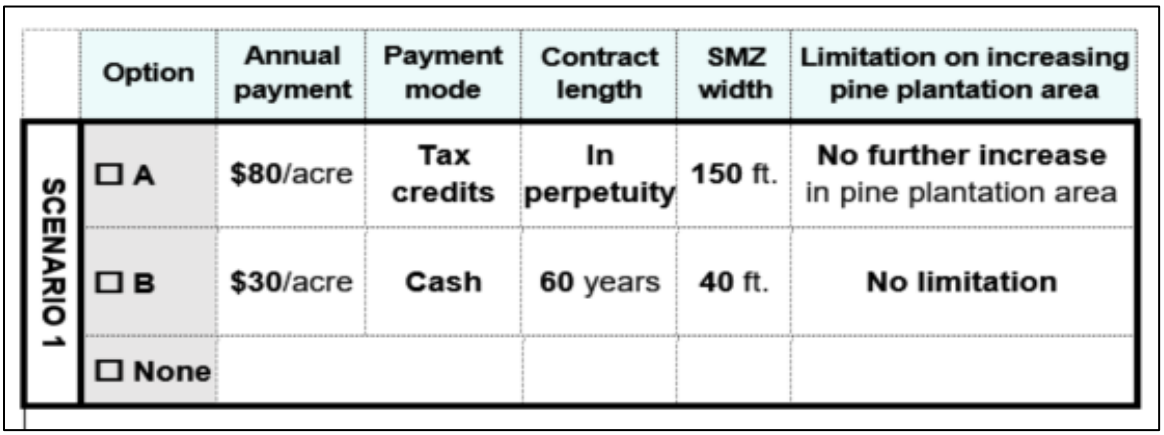
To investigate the relationships between how the proportion of each forest type on one's property and various forest ownership objectives, we conducted Spearman rho tests. Spearman's correlation can be employed to evaluate the strength of the correlation between interval, ordinal, or ratio variables. Using Spearman's correlation, we can discover if the strength of certain ownership objective is related to monotonic increase or decrease in the percentage of specific forest types. Spearman's correlation coefficient is constrained between −1 and +1. The closer coefficient is to −1 or +1, the stronger the monotonic relationship between two variables. We obtained survey participants' ownership objectives information for the specific property by asking them to assign a Likert scale value from 1 (unimportant) to 5 (very important) regarding with presented ownership objectives as following: 1) aesthetic enjoyment (Aesthetic), 2) personal residence (Residence), 3) personal recreation (PerRec), 4) maintaining healthy environment (Environment), 4) income from timber harvest (Timber), 5) income from recreation (IncRec), 6) land investment (Investment), and 7) family legacy (Legacy).

2.4 Choice experiment

A choice experiment was adopted to examine forest owners' WTP in PES programs and their WTA. The choice experiment has been a popular tool in investigating forest owners' preferences towards hypothetical PES programs (Horne, 2006, Kelly, et al., 2015, Matta, et al., 2009, Rabotyagov and Lin, 2013, Stevens, et al., 2002, Vedel, et al., 2015). Five PES program attributes were tested in the study (Table 1). An example of choice experiment questions is provided in Figure 1. All survey participants were asked to complete six choice scenarios. Each scenario consisted of three options including two PES contracts and the status quo option.

Table 1 PES program attributes and levels

PES program attributes	Levels in each attribute
1. Annual payment	10, 30, 60, 80 U.S. dollars per acre
2. Payment mode	Cash Tax credits
3. Contract length	10, 30, 60 years and perpetual
4. Streamside Management Zone width	40, 70, 100, 150 ft.
5. Restriction on increasing pine plantation area	No restriction No further increase in pine plantation area



	Option	Annual payment	Payment mode	Contract length	SMZ width	Limitation on increasing pine plantation area
SCENARIO 1	☐ A	$80/acre	Tax credits	In perpetuity	150 ft.	No further increase in pine plantation area
	☐ B	$30/acre	Cash	60 years	40 ft.	No limitation
	☐ None					

Figure 1 An example of choice experiment question

2.5 Econometric analysis

A multinomial logit (MNL) model and random parameters logit (RPL) with error component specification were used to analyze choice experiment data and the impact of forest types in family forest owners' decision to participate in PES programs. Both models are widely used in analyzing choice experiment data, but recently RPL is becoming a dominant model to analyze such data with many comparable advantages to other types of logit models with stricter assumptions. RPL

specification allows Independence of Irrelevant Alternatives (IIA) of MNL specification, and it incorporates the preference heterogeneity among different respondents (Train, 2009). We adopted RPL as the main model and used MNL for obtaining supplement information. A forest owner i's likelihood to choose a choice experiment alternative j in n th choice sequence for RPL specification is as following:

$$Prob(j|C) = \iint \prod_{n=1}^{N} \left[\frac{exp\left([X_{ijn};\ F_i]\ \beta_i + E_{ij}\eta_j\right)}{\sum_j^J exp\left([X_{ijn};\ F_i]\ \beta_i + E_{ij}\eta_j\right)} \right] \phi(\beta_i)\phi(E_i)d\beta_i dE_i \qquad (1)$$

Where X_{ijn} represents the contract attributes of PES alternatives and F_i demonstrates current forest management on the property questioned. E_{ij} is random error component with zero mean, and η_j is parameter estimate for the error component. The RPL model was estimated using maximum likelihood procedure in Nlogit 6.0 software. We used 1,000 Halton draw to estimate the RPL model. Variables used in estimation are in Table 2.

Table 2 Variables used in econometric analysis, n = 250

Variable	Description
	PES program attributes
Contract Years	Proposed contract length: 10, 30, or 60 years (continuously coded)
Permanent	Perpetual contract length that is perpetual (dummy coded, 1 = yes, 0 = no)
Cash	Payment is provided in cash (effect coded, 1 = cash, -1 = tax credits, 0 = otherwise)
SMZ 70	Minimum SMZ requirement of 70 foot (effect coded, 1 = SMZ 70, -1 = SMZ 40, 0 = otherwise)
SMZ 100	Minimum SMZ requirement of 100 foot (effect coded, 1 = SMZ 100, -1 = SMZ 40, 0 = otherwise)
SMZ 150	Minimum SMZ requirement of 150 foot (effect coded, 1 = SMZ 150, -1 = SMZ 40, 0 = otherwise)
Restriction	Restriction on increasing pine plantation (effect coded, 1 = restriction, -1 = no restriction, 0 = otherwise)
Payment	Proposed payment amount: 10, 30, 60, or 80 U.S. dollars per acre (continuously coded)

Interaction between PES program attributes and forest property characteristics	
*Restriction *(1-% of PP)*	Interaction between restriction on increasing pine plantation and the proportion of non-planted pine area
Forest property characteristics	
% of PP	The proportion of planted pine forests on a property
% of BH	The proportion of bottomland hardwood forests on a property
% of UH	The proportion of upland hardwood forests on a property
% of OP	The proportion of mixed oak-pine forests on a property
RE	1 if there is a residence structure on a property (1 = yes, 0 = no)
Size	Size of the forest parcel (acre)

We assumed annual payment amount coefficient to be fixed so that we could estimate the parameters and distributions for WTA compensation for enrolling in PES program. WTA estimates and distributions for the program attributes and alternative specific component (ASC) for status quo options were calculated using delta method (Hensher et al., 2015).

3. Results

3.1 Survey results

The response rate was 22 percent. 296 surveys were completed and returned. We concluded that 250 surveys were usable after excluding the incomplete questionnaires and properties that were difficult to conduct the geospatial analysis. To address potential nonresponse bias, we adopted the extrapolation method suggested by Armstrong and Overton (1977), which makes a comparison of survey results with known values for the population. We compared the respondents' socioeconomic characteristics and forest property characteristics to the National Woodland Owner Survey (NWOS) data gathered in Georgia from 2011 to 2013. We found that our sample is representative of the population.

3.2 Ownership objectives and forest types

Table 3 demonstrates various ownership objectives and the proportion of the respondents who rated each objective.

Table 3 Forest ownership objectives (n = 250)

Ownership objectives	Proportion of forest owners (percent)					Sum
Likert scale	1 Unimportant	2	3	4	5 Very important	
Aesthetic	12	6	22	26	34	100
Residence	50	10	7	9	24	100
PerRec	18	5	18	24	35	100
Environment	8	4	18	26	44	100
Timber	10	8	21	22	39	100
IncRec	52	12	13	9	14	100
Investment	12	6	22	24	36	100
Legacy	11	7	17	16	49	100
Privacy	16	8	15	14	47	100

Table 4 demonstrates the Spearman correlation between forest types and ownership objectives.

Table 4 Spearman correlation between forest types and ownership objectives (n = 250)

Variables	*% of PP*	*% of BH*	*% of UH*	*% of OP*	*% of NP*
Aesthetic	**-0.12***	**0.11***	0.07	0.06	0.01
Residence	**-0.24*****	**0.14****	0.07	0.06	<|0.01|
PerRec	**-0.11***	**0.13****	-0.05	-0.01	-0.08
Environment	**-0.11***	0.02	**0.12***	0.08	<|0.01|
Timber	**0.40*****	**-0.24*****	-0.03	**-0.14****	-0.02
IncRec	**0.12***	**-0.15****	**0.12***	-0.03	0.03
Investment	0.07	-0.04	-0.03	**-0.12***	0.02
Legacy	0.04	-0.10	**0.14****	-0.02	0.02
Privacy	**-0.17*****	0.10	0.04	-0.04	0.07

***Spearman correlation significant (p<0.01), **Spearman correlation significant (p<0.05), *Spearman correlation significant (p<0.10)

We found that the proportion of PP in the forest property is correlated with all the ownership objectives we provided other than *Investment* and *Legacy*. The proportion of BH was related to all the ownership objectives excluding *Environment, Investment, Legacy,* and *Privacy*. The percentages of UH and OP were linked to fewer forest ownership objectives than first two forest types. However, NP seemed to have no notable correlation with any of the ownership objectives.

The proportion of PP stands in a forest parcel appeared to be negatively correlated with *Aesthetic, Residence, PerRec, Environment,* and *Privacy* variables. On the other hand, the PP percentage was positively related to *Timber* and *IncRec* variables. The proportion of BH forest was positively correlated with *Aesthetic, Residence,* and *PerRec,* and was negatively correlated with *Timber* and *IncRec.* It was notable that while the proportion of PP and BH are correlated with the same variables including *Aesthetic*, *Residence*, *PerRec*, *Timber*, and *IncRec,* but the signs of the correlations are the opposite. The proportion of PP is negatively correlated with *Aesthetic, Residence,* and *PerRec,* and the proportion of BH is positively correlated with those variables. On the other hand, in terms of *Timber* and *IncRec,* the proportion of PP is positively correlated with those variables and the proportion of BH has a negative correlation with them. The proportion of UH forest was positively correlated with *Environment, IncRec,* and *Legacy*. The proportion of OP forest was negatively correlated with *Timber* and *Investment*.

3.3 Model estimation results

Table 5 shows the estimation results of MNL and RPL models.

Table 5 Results from MNL and RPL estimation models

Variable	MNL Coefficient (p value)		RPL Coefficient (p value)		WTA ($/acre/year) *Based on the RPL model
Random parameters in utility functions					
Contract Years	**−.025*** **	(<.01)	**−.058*** **	(<.01)	**1.7**
Permanent	**−1.202*** **	(<.01)	**−3.540*** **	(<.01)	**99.5**
Cash	**.195*** **	(<.01)	**.407*** **	(<.01)	**11.6**

SMZ 70	.121	(.304)	.214	(.172)	
SMZ 100	−.023	(.766)	.101	(.500)	
SMZ 150	**−.260*** **	(<.01)	**−.616*** **	(<.01)	**17.6**
Restriction	**−.124*** **	(<.01)	**−.274*** **	(<.01)	**7.8**
	Nonrandom parameters in utility functions				
Restriction(1-% of PP)*	−.001	(.274)	−.002	(.271)	
Payment	**.017*** **	(<.01)	**.035*** **	(<.01)	
ASC	**2.523*** **	(<.01)	**6.604***	(.022)	**188.7**
% of PP	**−1.943*** **	(<.01)	**−5.680****	(.049)	**162.3**
% of BH	**−1.968*** **	(<.01)	**−6.001***	(.080)	**171.5**
% of UH	−.605	(.284)	−1.887	(.613)	
% of OP	**−1.528****	(.017)	−4.137	(.200)	
RE	**−.477*** **	(<.01)	**−1.269****	(.045)	**36.3**
Size	**−.002*** **	(<.01)	−.004	(.289)	
	Standard deviations of random parameters				
Contract Years			**.038*** **	(<.01)	
Permanent			**2.767*** **	(<.01)	
Cash			**.594*** **	(<.01)	
SMZ 70			.096	(.918)	
SMZ 100			.155	(.805)	
SMZ 150			**1.083*** **	(<.01)	
Restriction			**.689*** **	(<.01)	
Standard deviations of latent random effects					
Error component			**3.574*** **		
Number of observations			1500		
Adjusted pseudo R^2			.33		
Log Likelihood			−1097		

***, **, * Significance at 1%, 5%, 10% level

The signs and significance of the coefficients for MNL and RPL models were consistent with each other. Both models showed that forest owners were less likely to participate in PES program with long or permanent contract length, a program that provided tax incentives instead of cash, a program that required participants to establish the SMZ more than 150 feet, and a program that limited expanding intensive pine plantation areas beyond the current level. Forest owners expected to receive about 2 dollars more as contract length increased by one year. However, when it comes to the contract that will last in perpetuity, forest owners required 100 dollars per acre per year. Forest owners required 11.6 dollars less if the compensation is paid in cash instead of tax credits. Forest owners required 18 dollars per acre per year if they were required to establish and maintain minimum 150 foot SMZ area. When increasing pine plantation area on the property was limited, forest owners would require about 8 dollars per acre every year as compensation.

The impact of forest property characteristic variables including % of *PP*, % of *BH*, % of *UH*, % of *OP*, *RE* and *Size* were captured by ASC (Holmes and Adamowicz, 2003). The positive sign of the coefficients of property characteristic variables means that forest owners prefer to choose the status quo option, which is not to participate in any of the presented PES alternatives. The negative sign of the coefficients for these variables indicates that the indirect utility of the forest owners increases by choosing to participate in one of the two alternatives. ASCs in both models were positive and significant, which implied that forest owners' utility increased by selecting status quo option when everything else held constant (e.g., when no compensation is provided). In MNL model estimation, the coefficients for % of *PP*, % of *BH*, % of *OP*, and *RE* were negative and significant. In RPL model, the coefficients for % of *PP*, % of *BH*, and *RE* were negative and significant. If a forest owner had a large proportion of planted pine or bottomland hardwood forests on one's property and if the owner had a residence on the property, the landowner was likely to participate in PES programs with smaller compensation than other landowners. For example, forest owners' baseline payment requirement was 189 dollars, but if their property was covered by only planted pine, they would only require 27 dollars to consider participation. If forest owners' property was covered by only bottomland hardwood forests, they would require only 18 dollars as a baseline payment. Furthermore, if there was a residence on one's property, one's WTA will decrease by 36 dollars. The coefficients for other variables associated with the forest types, % of *UH*, % of *OP*, and the interaction between *Restriction* and the proportion of non-pine area *(1 - % of PP)* were not statistically significant.

4. Discussion

4.1 Ownership objectives and forest types

Based on Spearman rho test results, we found that *% of PP* and *% of BH* had significant correlations with the most number of ownership variables among other forest type variables. We could reasonably infer that this might be because these two forest types, PP and BH forest, reflect forest owners' management preferences relatively well compared to others. Furthermore, we found that although these two variables, *% of PP* and *% of BH*, were correlated with the same ownership objectives, the signs of the correlations were the opposite. This means that forest owners who valued a certain objective were more likely to have the high proportion of one of the forest types, and a low proportion of the other forest type. For example, forest owners who reported that earning income from timber harvest was critical were likely to have a high percentage of PP on their property and a low proportion of the BH forests. This tendency supports the potential of forest types as proxies of landowner's management objectives associated with his or her property.

4.1 Forest property characteristics and participation decision

In both MNL and RPL models, the coefficient for *% of PP* and *% of BH* were negative and significant. Forest owners who had a large share of these two types of forests on their property were more likely to choose to participate in PES program and expected substantially less compensation than other forest owners. It is notable that while *% of PP* and *% of BH* seemed to reflect the different preferences on the same objectives (Table 4), the coefficients for these variables in RPL models had the same sign and are substantial (Table 5). As forest owners had either a high proportion of PP area or the high percentage of BH forests, they were more willing to enrolling their property in presented PES programs. Table 4 shows that forest owners who valued non-timber benefits (*Aesthetic*, *Residence*, *PerRec*, and *Privacy*) were more likely to have the high proportion of bottomland hardwood forests on their property. On the other hand, forest owners who believed that objectives associated with generating from timber or recreation were more likely to have the high proportion of pine plantation. We could infer that forest owners who have high *BH* are more likely to participate in PES programs than others since their opportunity costs of enrolling their property in PES is substantially smaller than other landowners. They

appreciated non-timber benefits from their property, and naturally, they had positive willingness to pay for those benefits, which reduced WTA compensation. The result was consistent with the findings of Raunikar and Buongiorno (2006)'s study. They found that NIPF forest owners who had more close-to-natural properties were willing to forego profit from undertaking intensive forest management practices because of their positive WTP for amenities. Furthermore, it is possible to infer that forest owners who have a high proportion of PP are keen to assess financial opportunities associated with their forest property and view participating in PES programs as a good source of additional income in spite the management requirements and loss of development right on their property. From the results, we can see that forest owners' motivation to participate in PES programs can vary from continuous enjoyment of non-timber benefits from the property to additional income. Forest owners who value non-timber values of their property and forest owners who pursue income from their property both are more likely to participate in PES with smaller compensation. This information is useful in targeting potential PES participants and how to communicate PES with forest owners.

3.5 Residence on the property and WTA

RE was found to be significant and negative, which indicates that forest owners who use their property as a primary or vacation residence are more likely to participate in PES and also expect smaller WTA compared to those who are not. The result associated with high WTP of forest owners who had a residence on the property was consistent with previous studies that found family forest owners' probability of participating in PES increase if they reside on the property, or they have a residence on the property (Layton and Siikamäki, 2009, Matta, et al., 2009, Nagubadi, et al., 1996). However, our finding associated with smaller WTA of resident owners is not consistent with the previous study. For example, Lindhjem and Mitani (2012) suggested that residence owners required higher WTA than absentee owners since residence owners were more likely to be engaged in more active forest management and were more keen to opportunity costs of conservation. We infer that the resident owners' WTA is smaller than absentee owners since they reside on the property and consequently appreciating non-timber benefits such amenity more than those who do not. Naturally, residence forest owners' opportunity costs to enroll the property on they are residing on the conservation contract would be lower than non-resident owners.

3.6 Forest property size

Many studies found that size of forest holding affected forest owners' participation in PES programs (Langpap, 2004, Mäntymaa, et al., 2009, Rabotyagov and Lin, 2013, Sullivan, et al., 2005). However, both the MNL and RPL model estimation results show that size of the property does not affect forest owners' willingness to participate in incentive programs. This is maybe because our study is taking a unique approach to calculating forest owners' property sizes. For example, we first obtained information about forest properties that we are interested and then asked questions specific to those forest properties to owners of them. It is reasonable to assume that since many forest owners have more than one forest properties, the size of one forest property may not be a significant factor that affects landowners' decision.

5. Conclusions

We examined the potential of forest property characteristics in estimating forest owners' WTP and WTA regarding PES program participations. We found that the presence of certain forest types (PP and BH) and a residential structure is associated with forest owners' WTP and WTA. Forest owners were more likely to enroll their property in conservation contract if there existed PP or BH forests, or a residential structure on the property. Furthermore, their WTA compensation to participate in PES programs significantly decreased as the proportion of PP and BH increased on the property. The presence of a residential structure also reduced one's WTA as well. Our study found that the presence of certain forest types, PP and BH forests, and a residential structure on one's property might be used in predicting one's likelihood of enrolling the property in conservation contracts.

We expect that the findings of the study would contribute to more strategic and cost-effective targeting and planning of forest incentive programs for conservation. The finding could save much cost and time to conduct surveys or interviews to collect underlying preference information.

However, the results of the study should be used with caution since there are some limitations. First of all, the sample size of the study is relatively small compared to other studies that investigated forest owners' preferences toward PES participation. Secondly, our study does not rule out the impact of potential attribute non-attendance (ANA). When an individual is given a

choice task, instead of making trade-offs among all the attributes, the respondent ignores some attributes that are less preferred and uses simpler rules to decide for various reasons (Payne, et al., 1993). In the choice experiment, ANA is caused when a respondent ignores or fails to consider some of the attributes when choosing one of more alternatives among competing alternatives with varying levels of attributes. We included an additional question to address ANA issue using an approach suggested by Balcombe et al. (2013). We asked respondents to rank the importance of attributes after all choice experiment questions are completed. However, we found that most participants did not complete the question. Thirdly, it should be noted that we are only investigating a forest owner's preference toward one specific property. It is known that many forest owners have multiple forest properties, and it would be useful to study their preferences when considering enrolling one property among multiple holdings.

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