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Conservation Easement Landowners' WTA Compensation to Thin their Forest

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1. Introduction

The Lower Mississippi Alluvial Valley (LMAV) covers 24.9 million acres along the Mississippi River in Tennessee, Arkansas, Mississippi, and Louisiana (Gardiner, 2015), historically supporting the largest tract of bottomland hardwoods (BLH) in the United States (King, et al., 2006). These forested wetlands are among the most productive and diverse ecological systems in the United States (Klimas, et al., 2004). BLH are capable of providing valuable ecosystem services, such as habitat for fish and wildlife, flood protection, groundwater recharge and water quality improvement, forest products, recreation, and education opportunities (Walbridge, 1993).

Unfortunately, the LMAV has suffered drastic land-use changes resulting in significant loss of BLH services. Forest coverage reduction and subsequent disrupted habitat functions of the LMAV follows a long history of human activities (e.g., land clearing for agriculture, flood control projects, and urban development), which began since the late 1700s. By the 1980s, only 6.6 million acres of forest land remained (Rudis and Birdsey, 1986). Alterations of the LMAV's BLH have affected forest-dependent wildlife in need of landscape-scale, complex, and diverse forest structures to fulfill their annual life cycles (LMVJV, 2007).

Several government policies were enacted to protect and restore wetlands, including the Wetland Reserve Program (WRP). The WRP was initially authorized in the 1990 Farm Security and Rural Investment Act and later consolidated into the Wetland Reserve Easement

(WRE) in 2014. The WRP was designed to "achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program" (NRCS, 2020). Landowners voluntarily enroll their land, ranging from permanent easements to 30-year-contracts in exchange for financial and technical assistance to help them achieve long-term conservation goals.

The U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS) administers the WRP conservation easement program. By 2007, the NRCS had enrolled almost two million acres and incurred over $2 billion (USDA, 2009). Since then, WRP enrollment continues to increase, with almost three million acres[1] enrolled nationwide as of 2019 (USDA, 2019a, 2019b). Specifically, Arkansas, Mississippi, and Louisiana account for nearly 800 thousand acres enrolled in WRP conservation easements. The most substantial enrollment rate has occurred in the LMAV area.

The role of the WRP to restore the LMAV has been significant, especially towards achieving landscape-scale habitat goals for wildlife (King, et al., 2006). Restoration success is not only measured via increased forest cover but also based on the capacity of BLH forests to provide ecosystem services. A valuation the of cost and benefits of the wetland restoration provided by the WRP program in the LMAV, including costs borne by landowners and federal government, and benefits to society like greenhouse gas mitigation, nitrogen mitigation, and waterfowl recreation, suggests annual benefits worth approximately $300 million (Jenkins, et al., 2010).

[1] This total includes WRE acres enrolled from 2014 onward, which accounts for 11% of all WRP and WRE acres in the United States.

The WRP's predominant restoration strategy consists of retiring marginal agricultural lands followed by reforestation. Evaluations of early restoration efforts highlighted that reforestation focused mostly on planting a few species of slow-growing trees, such as oaks (Allen, 1997, King and Keeland, 1999). Today, LMAV's restoration progress suggests that the BLH plantations have not yet achieved important criteria like diverse species composition, structural complexity, and potential for quality timber production (LMVJV, 2007). Although not a primary objective of the WRP, the latter is an attractive feature to encourage management as the commercialization of forest products (e.g., pulpwood) becomes feasible. Reforested stands of BLH are not expected to provide the same functionality level and structural complexity of natural stands since extended periods are required for BLH forests to reach "old-growth" conditions needed to benefit wildlife species. However, functional deficiencies of reforested stands can be improved with active forest management to accelerate restoration success.

To improve current suboptimal conditions of the BLH stands and its associated ecosystem services, some have advocated for the adoption of forest management practices to achieve the desired stand condition within the BLH stands in WRP properties. Desired stand structure consists, amongst several stand structure criteria, of 60-70% overstory canopy cover, or a similar measure of 60-70 ft^2/acre basal area (LMVJV, 2007). Assessment of the existing forested wetlands of the LMAV confirms that about 74% of forested wetlands within the LMAV have canopy cover higher than 70%, and approximately 54% exhibit basal area greater than 70 ft^2/ac (GCPO, 2016). Thinning is an imperative technique to reduce canopy coverage and basal area that would otherwise take several decades to achieve naturally.

Based on the database of conservation easement landowners enrolled as of 2013 in Louisiana, there are at least 200 thousand WRP acres that are likely to have high stand density becoming potential forest management sites for the next five to ten years. The collaboration of conservation easement landowners in the adoption of forest management is crucial for improving BLH stands and their long-term capacity to provide ecosystem services, such as healthy forests and habitat for wildlife. King, et al. (2006) anticipated management of BLH stands as the primary challenge of the WRP to achieve its conservation goals. Landscape-level management becomes challenging as WRP easements are owned by many landowners whose management objectives are diverse. Therefore, understanding what motivates conservation easement landowners' management decisions is an essential step in enhancing the restoration efforts of LMAV.

To our knowledge, only one study has assessed LMAV landowners' attitudes toward managing BLH forests, specifically in the Mississippi Delta area (Gordon and Barton, 2015). The research addressed landowners' motives for long-term sustainable forest management but included only qualitative analysis. This paper aims to explore the willingness of conservation easement (hereafter simply referred to as 'easement') landowners to adopt thinning to improve the BLH forest health and wildlife habitat quality and their Willingness to Accept (WTA) compensation to implement thinning. This study's results are expected to aid NRCS decision-making for future management planning of the WRP easements by reducing the knowledge deficiencies associated with landowners' preferences for managing forested easements. This research will also provide a better understanding of the extent of the market for thinning among easement landowners to achieve conservation goals.

2. Literature Review

Nonindustrial private forest (NIPF) landowners, also known as family forest landowners, own approximately 36% (290 million acres) of total forestland in the United States (Butler, et al., 2016) and 82% (6.2 million acres) in the LMAV (Oswalt, 2013). Given this magnitude, extensive research has occurred, primarily focused on the landowners' behavior and factors that influence their forest management decisions. Reviews and meta-analysis of this literature are provided by Amacher, et al. (2003), Beach, et al. (2005), Straka (2011), and Floress, et al. (2019).

Early research explored factors that affect landowner's decision towards forest productivity (e.g., reforestation and harvesting for timber supply), but has evolved to explain landowners' motivations (Straka, 2011). A central topic of the NIPF literature is the tradeoff landowners make between nontimber and other land uses (Amacher, et al., 2003). Many papers have argued that landowners' decisions are a function of both timber and nontimber benefits and that landowners preferences influence these decisions, and land and management characteristics (Conway, et al., 2003, Pattanayak, et al., 2002)

Several studies have used Stated Preference methods to explore NIPF landowners' preferences in various contexts, including forest conservation and provision of ecosystem services. These include willingness to adopt sustainable forest management (Kilgore, et al., 2008), to harvest biomass for renewable energy production (Gruchy, et al., 2012), to delay harvest for carbon sequestration (Khanal, et al., 2017), endangered species and wildlife habitat improvements (Kline, et al., 2000, Langpap, 2004, Matta, et al., 2009), and ecosystem services provision (Mutandwa, et al., 2019). These studies coincide with the primary categories of

variables that help explain the landowners' behavior and decision to engage in forest management, which include property conditions, landowners' characteristics, ownership objectives, and management characteristics. This categorization is a common approach in the understanding of landowners' preferences and tailoring policymaking accordingly.

Regarding landowner characteristics, most studies find that age is generally negatively related to changing away from their status quo[2] (Langpap, 2004, Matta, et al., 2009). Education and income are also significant predictors of landowner behavior. Higher education increases the likelihood of choosing to harvest (Gruchy, et al., 2012, Joshi and Arano, 2009), and the probability of delaying or forgoing harvest increases with income, respectively (Khanal, et al., 2017, Kline, et al., 2000). Other landowners' characteristics, such as length of land ownership, positively influence timber harvesting activities (Joshi and Arano, 2009) while absentee ownership reduces the probability of conducting timber harvest.

Several property characteristics have been studied, of which forest size appear to be a significant predictor of landowners' behavior (Floress, et al., 2019). The effect of forest size on landowners' decisions is ambiguous. Larger holdings are associated with a lower opportunity cost of managing stands for conservation (Langpap, 2004, Lindhjem and Mitani, 2012). Also, as acreage increases, landowners are more interested in timber production because of increasing marginal returns (Gruchy, et al., 2012, Kline, et al., 2000).

Ownership objectives are often used in the analysis of landowners' management behavior. For instance, landowners who are motivated to providing wildlife habitat (Langpap, 2004) and own the land for recreation purposes (Kline, et al., 2000) are more likely to engage in

[2] Exceptions include Kline et al. (2000) and Conway et al (2003).

conservation-oriented management. In contrast, those who consider legacy as a forest ownership goal are indifferent in participating in conservation programs (Kilgore, et al., 2008) or delaying harvests to enhance ecosystem services (Mutandwa, et al., 2019). Joshi and Arano (2009) explored the factors influencing landowners harvest and wildlife management decisions. They found that working with a forester is not a significant predictor for engaging in forest management activities.

While determinants of NIPF landowner's behavior is well documented, the literature on the easement landowners' management preferences is scarce. Specifically, information remains limited on how much landowners continue to adopt conservation practices in their land once payments end (Dayer, et al., 2018). Evidence suggests that easements are usefull in preserving forestland; however, participating in easements does not influence greater implementation of active forest management practices needed for the long-term protection of the forests (Song, et al., 2014).

Pocewicz, et al. (2011) compared biodiversity in sagebrush ecosystems and infrastructure density (e.g., residential structures and roads) of properties with and without easements to investigate if differences between them were explained by development pressure or management practices. Although no differences exist between easement and non-easement properties in low-pressure areas, in high-pressure areas, easement properties featured more wildlife species and less infrastructure development. Concerning land management, results indicate that management practices do not differ between easement and non-easement properties.

Stroman and Kreuter (2015) explored the factors that influence land management practices on 251 conservation easement properties held by 23 easement-holding organizations, including NGOs, federal, state, or local government agencies in Texas. They find that ownership objectives such as production, investment, and wildlife-related recreation are important determinants for adopting conservation-oriented land management actions. For instance, those landowners whose primary ownership objective is production (e.g., farming and ranching) were 39% less likely to engage in timber management while those who own the land for investment purposes are 75% more likely to conduct timber management. In contrast, landowners having wildlife-related recreation as primary ownership objectives are 25% more likely to implement management practices that benefit wildlife.

To address this knowledge gap in the easement landowner literature, we explore how easement landowners' characteristics and preferences affect their decision to thin their forested easement. The analysis conducted in this paper will enrich the understanding of easement landowners' motivation and preferences and provide a direction to decision-makers to efficiently identify segments of the WRP population that are willing to adopt management. Using data collected from a survey of landowners currently enrolled in the WRP program in Louisiana, we employ the Contingent Valuation approach to calculate the mean willingness to accept compensation to thin their forested easement, and study what factors influence the adoption of thinning.

3. Methods

3.1 Conceptual Framework

An important element for the success of restoration goals in the LMAV is the improvement of BLH forests by adopting thinning in conservation areas owned by easement landowners. The reservation price (WTA) for thinning will depend on landowners' preferences (Amacher, et al., 2003). Contrary to non-easement landowners, easement landowners' may have higher motivations for protecting the conservation values of their land. Then persuading easement landowners to thin their land becomes more challenging if associated with the negative connotation of harvesting. By providing specific benefits of thinning and its capacity to enhance forest health and habitat quality, easement landowners can link their conservation goals with this management activity and therefore be more likely to thin the forested easement and demand lower compensation levels.

To understand WTA for forest thinning, we rely on the random utility model framework for analyzing the response to a payment card in a contingent valuation study (Haab and McConnell, 2002). We assume that an easement landowner has the following utility derived from the forested easement

$$u_j(y, \mathbf{z}) \tag{1}$$

where $j = 1$ if the easement landowner chooses to thin the forested easement, and $j = 0$ if the easement landowner foregoes the thinning opportunity and the status quo remains. The utility is a function of y, the landowner's income, and $\mathbf{z}$, a vector of observable landowner's

socioeconomic characteristics and preferences for the market and nonmarket properties of the forested easement.

Note that WRP easement landowners' utility would be generally constrained to exclude timber-related market objectives because of restrictions imposed by the easement holder agency. Faced with the emergent need to manage the forested easement, market opportunities (e.g., thinning sales) can now be integrated into the easement landowners' utility function. They do possess the right to other market opportunities like selling hunting leases.

The random utility theory assumes that the true utility an easement landowner derives from the forested easement is a combination of both deterministic, $v_j(y, \boldsymbol{z})$, and stochastic, ε_j, elements. The random component ε_j implies that preferences are known with certainty by the landowner but unobserved by the researcher. Therefore, the indirect utility is expressed as

$$u_j = v_j(y, \boldsymbol{z}) + \varepsilon_j \tag{2}$$

A utility-maximizing easement landowner will adopt thinning as long as the utility associated with the quality of the forested easement after thinning together with compensation amount, WTA, exceeds the status quo utility:

$$u_1(y + WTA, \boldsymbol{z}, \varepsilon_1) \geq u_0(y, \boldsymbol{z}, \varepsilon_0) \tag{3}$$

3.2 Contingent Valuation

Nonmarket elicitation approaches range from revealed preferences (RP) to stated preferences (SP) methods to assign value to goods and services that are not captured by traditional markets, such as environmental goods. To generate value estimates, the RP

approach relies on observed behavior in response to changes in an environmental good. RP presents some limitations given that certain goods cannot be valued with behavioral methods. In the absence of actual behavior, SP becomes essential for welfare analysis, for it is the only available means to estimate non-use values (Johnston, et al., 2017). SP is also helpful in predicting and understanding the welfare effects of potential policies under consideration. This includes estimating individual willingness to pay (WTP) or willingness to accept (WTA) for changes in environmental goods and identifying the factors that affect these estimates (Haab and McConnell, 2002).

The validity of SP methods has generated extensive debate concerning its ability to produce accurate predictions. One of the issues fueling this debate is the presence of Hypothetical Bias (HB). HB consists of the difference between hypothetical and real welfare estimates, with hypothetical estimates usually overstating real estimates. Several meta-analyses (List and Gallet, 2001, Penn and Hu, 2018) found that HB is a systematic problem in the SP literature, but that the magnitude of the bias varies depending on the experimental design specifications (e.g., type of good being studied, public versus private; elicitation format, Dichotomous Choice versus Choice Experiment; or welfare measures, WTP versus WTA).

Lloyd-Smith and Adamowicz (2018) assessed the validity of WTA in the valuation of private and public goods, concluding that for public goods, WTA welfare measures are valid only if respondents perceive their responses as consequential. Eliciting welfare measures for private goods, on the other hand, exhibit strategic behavior. Penn and Hu (Forthcoming) found that HB is significantly smaller in WTA studies, as compared to WTP studies, and that there is no evidence of HB when comparing real and hypothetical WTA settings.

Sources of HB have been associated with psychological and socioeconomic factors or related to strategic and untruthful responses generated by elicitation mechanisms lacking incentive-compatible properties. The implementation of different elicitations mechanisms, such as Dichotomous Choice (DC), Open-ended (OE), and Payment Card (PC), often lead to different value estimates (Cameron, et al., 2002). Nonetheless, DC has been recommended as the preferred elicitation format in Contingent Valuation studies due to its incentive-compatible properties (Johnston, et al., 2017). Whereas alternative elicitations formats, such as open-ended (OE) and payment card (PC) generally lack incentive-compatibility, a series of conditions have been established to mitigate incentive challenges of these elicitation formats (Vossler and Holladay, 2018).

Several techniques have been identified and implemented to mitigate HB. Mitigation techniques include *ex-ante* and *ex-post* approaches, such as consequentiality, certainty follow-up, and cheap talk. These approaches are effective tools to reduce HB to different extents. Evidence suggests that consequentiality and certainty follow-ups have a greater impact on reducing HB than cheap talk (Penn and Hu, 2018). Relatedly, Penn and Hu (2019) argued that the infectiveness of cheap talk to reduce HB might be due to the presence of little HB, but that cheap talk efficacy can be enhanced if used as a complement to other HB mitigation techniques.

4. Survey Design

To understand easement landowners willingness to thin their easements, we conducted a survey of these landowners inspired by previous NIPF contingent valuation studies (Kilgore, et al., 2008, Langpap, 2004, Lindhjem and Mitani, 2012, Mutandwa, et al., 2019, Vedel, et al., 2015). The survey instrument contained 40 questions in four sections: (1) property and landowner characteristics (e.g., property size, ownership objectives, and outdoor recreation activities) (2) management characteristics (e.g., past and future management plans), (3) description of the hypothetical scenario and WTA elicitation, and (4) landowner' demographic information. Ownership objectives related to forest products (e.g., timber production) are commonly included in NIPF surveys but excluded from this survey based on the direction of regional NRCS leaders as incongruent with WRP program goals.

The elicitation section started with a description of the scenario[3]. This hypothetical scenario instructed landowners to assume a market opening where they have the opportunity to thin their forested easement and sell the forest products to private loggers with the permission of the NRCS. The hypothetical scenario was posed in terms of a private logging contract as opposed to a government program to set a precedent that in the event that forested easements were to be thinned, landowners will voluntary decide if they would like to adopt thinning and that they would be in charge of any market transaction with loggers. The role of the easement holder agency would be authorizing and monitoring management

[3] The exact wording of hypothetical scenario is available in the supplementary material.

activities to ensure that the thinning plan is consistent with the long-term protection and restoration objectives of the easement program.

The survey incorporated a between-subjects design to explore variation in landowners' compensation requirements based on two different levels of information. The purpose of presenting varying levels of information is to test whether providing facts about the environmental benefits of thinning influence easement landowners to demand lower WTA. Having a lower compensation level is important from the market perspective since it will be more attractive for loggers to enter into logging contracts with easement landowners in a cost-effective manner.

The between-subjects design consisted of half of the sample receiving information about the benefits of thinning on BLH forest stands health and habitat for wildlife (treatment group) while the other half was deprived of this information[4] (control group). Landowners who received information about the environmental benefits of thinning were first explained the baseline conditions mature BLH plantations are likely to have. For example, that they develop unfavorable conditions that hurt the forest health and wildlife habitat quality, hence the need for adopting forest management practices, such as thinning. Further, to present a tangible change in the quality of the BLH plantations, specific impacts of thinning were included, such as "trees grow faster, healthier, and become more resistant to insects and disease pests" and that "foraging and nesting habitat for forest-dependent wildlife like bears, deer, and birds is improved." This information treatment also showcased photographs of game and nongame

[4] The exact language of the information treatments is available in the supplementary material.

species that potentially benefit from thinning to facilitate the connection between the information provided above and species that they might be familiar with.

Empirical evidence suggests that providing information about positive changes in the quality of the environmental good influence welfare estimates upward, in the case of WTP[5] (Blomquist and Whitehead, 1998). Information treatments have also been used in previous forestry literature in WTP settings. Rekola (2001)'s information treatment about forest regeneration had no significant effect on WTP among rural area residents of Finland. On the other hand, Rambonilaza and Brahic (2016) claimed that the impact of additional information on estimates is sensitive to familiarity with the good being value or prior knowledge of the environmental issue. They suggested that with additional ecological information, only individuals who are familiar with the concept of biodiversity, are aware of the environmental issue, and use the forest regularly assign higher values. Providing additional information about thinning enhances landowners' awareness of its conservation properties. Following this reasoning, we hypothesize that landowners assigned to the treatment group will request a lower compensation level compared to the control group.

To help each easement landowner have realistic expectations of how much pulpwood a thinning harvest generates, they were informed that their easement could yield between 15 and 25 tons of pulpwood per acre. By providing this information and the bids presented in the PC, landowners can foresee future revenue, thus facilitating the calculations when choosing a

[5] We would expect inverse relationship for WTA; that is, additional information will influence welfares estimates downward.

compensation amount. To reinforce this quantitative information, landowners were asked to answer "how many tons of pulpwood per acre does a thinning harvest generate?"

After describing the hypothetical scenario, we introduced the WTA elicitation question. In the context of payment for the provision of ecosystem services (e.g., healthy forest and wildlife habitat), eliciting values using a WTA welfare measure is appropriate given that forested easements are private goods and the property rights reside with the easement landowner. As Lloyd-Smith and Adamowicz (2018) demonstrated, eliciting WTA for private goods is prone to strategic behavior bias. This can be mitigated by using consequentiality follow-up questions to generate WTA bounds. Although we did not follow the complete protocol to control for strategic behavior used by Lloyd-Smith and Adamowicz (2018) (e.g., incorporating *ex-ante* strategic behavior questions), we included a follow-up policy consequentiality question in which we ask respondents to state to what extent they believe their survey responses will be taken into account by decision-makers.

[Figure 1]

The willingness to accept compensation question was posed in a PC format. The main reason for the employment of the PC was due to its ability to preserve data efficiency given the limited sample size available. PC features are common among forest landowner studies due to the limited population sizes (e.g., Lindhjem and Mitani (2012)). The exact wording of the elicitation questions was as follows

[Figure 2]

Compensation levels offered to landowners were based on hardwood pulpwood prices reported for Louisiana in the second quarter of 2019, which on average ranged between $10.56

and $14.83 per ton (TimberMart-South, 2019). Reported hardwood pulpwood prices in 2019 went as high as $20.59 per ton; however, to avoid possible anchoring bias, the PC excluded extremely high bids. Lower bids, starting at $0.00, were also included following the recommendations from conservation specialists.

The official list with names and mailing addresses of WRP landowners was provided by the NRCS. The sample consisted of all WRP landowners in Louisiana whose easements were reforested and enrolled in the program in 2013 or before for a total of 660 landowners. Easements that were enrolled in the program after 2013 were not included in the sample unless they had an existing forest. It is irrelevant to consider young BLH plantations since thinning is not typically required until plantations are at least 15 or 20 years old. WRP easements included in the sample are located in 35 out of the 64 parishes in Louisiana, and most of them are distributed in the LMAV and the Red River Valley.

The questionnaire was pretested in two focus groups conducted with private landowners and conservation easement specialists. Suggested changes were incorporated into the final questionnaire, which was reviewed and approved by local NRCS representatives and the Louisiana State University Agricultural Center's Institutional Review Board.

Given that the only available contact information was name and mailing address, a mail mode was selected. The questionnaire was mailed following the Tailored Designed Method (Dillman, et al., 2014) in February 2020. Five contact waves were employed over a period of seven weeks consisting of initial notification letter (week one), invitation cover letter and survey questionnaire (week two), thank-you reminder postcard (week three), follow-up

reminder letter and replacement questionnaire (week five), and final reminder and thank-you postcard (week seven).

From the initial 660 surveys that were mailed, 64 surveys were not delivered due to incorrect addresses. Of the 596 delivered surveys, 299 were returned generating a response rate of 50%. From the 299 surveys that were returned, two were public organizations, four refused to participate in the survey, nine indicated to have sold or passed the WRP easement on to their children, and 36 answered less than 85% of the questionnaire. Two hundred forty-eight surveys were used in the analysis, an effective response rate of 42%. This response rate is comparable to other NIPF and easement landowner studies that also used mail surveys (Matta, et al., 2009, 40.1%, Stroman and Kreuter, 2015, 50%).

A mitigation technique used in this study to reduce possible selection bias consisted of not disclosing the real purpose of the survey to respondents. By not telling respondents what the survey was about, we reduced the probability that people who are opposed (in favor) to managing the easement felt discouraged (encouraged) from completing the questionnaire.

5. Econometric Model

Following Haab and McConnell (2002), we use interval regression to calculate minimum WTA. Deriving the econometric model from the theoretical framework presented in section 4.1, for an easement landowner i who chooses the compensation amount t_k, the probability that the true WTA lies between the interval t_k and t_{k+1} is given by

$$\Pr(\textit{-choose } t_k) = \Pr(t_k \leq WTA < t_{k+1}) \tag{4}$$

We assume a normal distribution for WTA, such that $WTA_i = x_i'\beta + \varepsilon_i$, where x is a vector of explanatory variables, β is a vector of parameters, and ε is the error term, which is normally distributed with mean zero and variance σ^2, then

$$\Pr(\ choose\ t_k) = \Phi\left(\frac{t_{k+1} - x_i'\beta}{\sigma}\right) - \Phi\left(\frac{t_k - x_i'\beta}{\sigma}\right) \quad (5)$$

where Φ is the standard normal CDF. The maximum likelihood function to estimate the value of β is

$$lnL = \sum_{i=1}^{T} \ln\left(\Phi\left(\frac{t_{k+1} - x_i'\beta}{\sigma}\right) - \Phi\left(\frac{t_k - x_i'\beta}{\sigma}\right)\right) \quad (6)$$

Mean WTA is derived from the expression

$$WTA = \alpha + \sum(\bar{x}\beta) \quad (7)$$

where α is the constant in the interval regression model and $\bar{x}$ is the mean value of explanatory variables.

6. Results and Discussion

Of the 248 easement landowners who participated, 79.0% were willing to thin the forest rather than keeping the status quo, of which 87.8% answered the elicitation question. The analysis was conducted with 172 landowners who answered the WTA question, of which 81 belong to the control group and 91 to the treatment group. First, we explore whether the

control group provides different WTA estimates than the treatment group. As shown in Figure 3, the distribution of WTA responses in the PC by groups suggests no clear pattern of whether control and treatment groups generate different valuations[6]. To test if the distribution of responses for control and treatment groups are similar, we perform a t-test and conclude that the difference between mean WTA for both groups is not significant (p-value= 0.2998).

6.1 Variables and Descriptive Statistics

Descriptive statistics and definitions of the variables used for the analysis appear in Table 1. Survey results indicate that the average easement landowner was 64 years old and predominately male (94.7%). The average easement landowner has obtained an advanced education degree. Thirty-eight percent have earned a bachelors' degree and 22.6% a graduate or professional degree. On average, forested easement size is 428.3 acres (median= 275 acres), and has been owned for 21.1 years, but as little as one year and as much as 80 years[7]. Grantor landowners account for 50% of the sample. The remaining 50% acquired the property with the easement already in place either through inheritance or purchase. About 63.4% of easement landowners reported personal recreation as an extremely important reason for owning the easement followed by a family heritage to pass on to family or heirs (50.6%), to protect or improve wildlife habitat (49.4), a long-term investment (35.5%), and to provide fee-based recreation (14.53%). The average frequency of participation in nontimber activities, such as

[6] No landowner chose the WTA amount corresponding to $1, but two landowners provided their own compensation level equal to $10 and $23. For the landowner who chose $10, his valuation was coded as $11. Since $23 is greater than the highest amount in the PC, a unique cell was created.

[7] About 3% of landowners reported length of ownership greater than age. We make a conservative correction that landowner age cannot be less than tenure, adjusting answers so tenure equal age. Adjusted answers ranged from 80 to 180 years.

hiking, wildlife watching, and hunting, is between 7 and 12 times per year. At least 33% have worked with a consulting forester before, 22.7% have requested authorization to cut and remove trees, and 59.3% intend to conduct management activities within the next ten years.

Given that little information exists regarding WRP landowners, determining the representative of this sample to the population of WRP landowners in Louisiana is difficult. We compare our sample with other easement and NIPF studies to assess if our sample matches their general forest landowner findings (Table 2). NIPF studies chosen for this comparison are located either in Louisiana or the other states that cover portions of LMAV (e.g., AR, MS, and TN). For this comparison, we exclude study-specific variables, such as participation in nontimber activities and plan to manage in the future, that do not match the variable specification of other studies.

Regarding demographic characteristics, the proportion of male landowners is higher in our sample compared to the other studies, while age and level of education are similar. On average, Louisiana landowners double forestland holding size, but median easement holding size is superior for easements in Texas than WRP easements in Louisiana. Easements in Texas have been owned longer than our WRP sample. However, it is important to mention that Stroman and Kreuter (2015) reports the length of ownership within the family, whereas this study reports ownership years of the current landowner. Percentage of original grantor landowners is lower within our sample than other easement studies, which indicate that WRP easements in Louisiana have been inherited or sold with more frequency than easements in Texas or Colorado. Similarly, the percentage of landowners who live on the easement in Louisiana is lower than in Texas. While 23% of WRP landowners in Louisiana have requested

authorization to cut trees, in Colorado, 19% of easement landowners requested a management plan for timber harvesting. WRP landowners in Louisiana have worked with a professional forester to a lesser extent than those reported by Perera, et al. (2007) and Measells, et al. (2005).

6.2 Regression Results

Table 2 showcases the results of three regression models using the interval amount based on their corresponding selection in the payment card as the dependent variable. Model 1 includes only the environmental information variable to test the effect of the *Enviro Info* variable on the compensation level required to thin the forested easements, which shows that this variable by itself does not significantly impact WTA. Model 2 incorporates explanatory variables commonly used in the study of landowners' decisions (property and ownership characteristics, ownership reasons, and sociodemographic characteristics). Model 3 controls for participation on nontimber activities (hiking, wildlife watching, and hunting) and management characteristics (thinning, plans for future management, and experience working with foresters). We perform a Likelihood-ratio test to assess the goodness of fit between Model 2 and Model 3, and we conclude that Model 3 improves significantly the model fit ($X^2 = 27.52, df = 6, p = 0.0001$); therefore, the following discussion is based on Model 3.

The estimates in Model 3 indicate that male landowners who received the environmental information, have owned the land for more extended periods, participated in

hiking recreation activities, had the intention to thin the easement[8], and who have worked with a consulting forester in the past demand lower WTA. On the other hand, landowners who consider family heritage an important reason for owning the land require higher compensation to adopt thinning in the easement.

The variable *Enviro Info* is negative and significant, meaning that easement landowners who had access to the information about the benefits of thinning request $1.98 less than landowners who did not receive the information treatment. Although there is evidence that providing environmental information works at reducing the compensation level, this result is not robust. The variables *Enviro Info* and *Thinning* appear to be related; however, if we include an interaction variable of these variables, *Enviro Info* becomes insignificant. Consistent with Stroman and Kreuter (2015), *Easement Size* is not a significant predictor of easement landowners to engage in conservation-oriented actions, such as timber management.

Demographic variables, such as *Male,* have a marginal effect on WTA estimates. Male is negative and significant, indicating that male landowners generate lower WTA. This matches other studies that found that male landowners are more likely than female to implement forest management activities for the provision of ecosystem services (Mutandwa, et al., 2019); specifically, male landowners are more likely to manage for wildlife and perform commercial timber harvests (Butler, et al., 2018). Consistent with Mutandwa, et al. (2019) and Stroman and Kreuter (2015) who indicated that age and education are not significant predictors for the implementation of forest management, we found no correlation between WTA and

[8] Landowners were asked if they had requested authorization to NRCS to cut and remove trees in the easement in the past. We treat this question as a proxy of landowner's intention to conduct thinning in the easement.

landowners' age and level of education. However, these findings contradict Gruchy, et al. (2012) and Joshi and Arano (2009) who suggested that age and education are significant negative and positive predictors of timber harvesting decisions, respectively.

Tenure is marginally significant and indicates that landowners who have owned the easement for longer periods need lower WTA to undertake thinning. Joshi and Arano (2009) found similar results. *Grantor* landowners were expected to request lower WTA; however, the estimate is not significant. This result contradicts Stroman and Kreuter (2015) findings, which suggest that landowners who originally cede the easement are more likely to engage in timber management activities. The estimate for the variable *Proximity* is not significant[9]. Previous studies have found absenteeism as a significant predictor of landowner's decisions. Absentee landowners are generally less likely to engage in timber harvesting actions (Conway, et al., 2003) and resident landowners are inclined to claim higher WTA (Lindhjem and Mitani, 2012).

Of the four ownership objectives included in the model, only *Legacy* has a significant effect on WTA, with those who intend to bequeath their forestland requiring higher compensation to thin. That is, a unit increase in the level of importance of legacy as ownership reason increases WTA by $1.02. This contrasts previous studies in which legacy did not affect the likelihood of adopting sustainable forest management (Kilgore, et al., 2008, Mutandwa, et al., 2019). Management characteristics, such as *Thinning* and *Forester,* significantly influence WTA. Landowners who have requested authorization to thin the easement and who had worked with a consulting forester before demand $3.23 and $2.12 less than landowners who

[9] Several variants of proximity such as "resident" (if landowner lives on the property) and "absentee" (if landowner resides 50 miles away from the property (Conway et al., 2003)) were also not statistically significant.

did not have the intention to thin or work with foresters. While Joshi and Arano (2009) found that working with a forester is not a significant predictor for engaging in forest management activities, early research demonstrated that foresters' technical assistance increases the probability of timber stand improvement (Boyd, 1984).

Hiking is negative and significant, indicating that landowners who participate in this activity yield lower WTA, whereas *Wildlife Watching* and *Hunting* do not affect WTA. In our sample, hikers are sensitive to the aesthetic impact of thinning but in the opposite direction as suggested in previous studies. For example, Conway, et al. (2003) demonstrated that non-hunting nontimber activities (e.g., hiking and wildlife watching) were inversely correlated with harvesting. Following this reasoning, we expected hikers to request higher compensation levels for any forest disturbance leading to relatively "unpleasant" postharvest amenities. On the other hand, we expected hunters to advocate for thinning activities since many game (and nongame) species benefit from the forest early-succession habitat conditions (Conway, et al., 2003).

6.3 Mean Willingness to Accept

Using the coefficients obtained in Model 3, we compute the mean WTA to adopt thinning in the WRP forested easements. Easement landowners' required WTA per ton of pulpwood equals $11.63. Landowners' WTA is above current market prices since the first quarter of 2020 closed with hardwood pulpwood prices of about $9 per ton (TimberMart-South, 2020). Considering that landowners can expect to yield between 15 and 25 tons of pulpwood per acre, thinning costs can amount to $174.3 and 290.6 per acre. Estimates from

this study appear to be higher with respect to other studies' mean WTA estimates (Kilgore, et al., 2008, Kline, et al., 2000, Mutandwa, et al., 2019). For example, Mutandwa, et al. (2019) reported mean WTA estimates between $190.22 to $595.23 hectare/year ($77-$240.9 acres/year) to manage stands for the provision of ecosystem services.

The per-acre WRP economic cost, including easement, administration, restoration, technical assistance, and landowner costs, was on average $1620.7 in 2007 (USDA, 2009). The cost of maintaining the forested easements to achieve long-term conservation goals of the WRP program requires additional spending ranging from 10.8% to 17.9% of the initial restoration costs. Considering that the cumulative acreage of landowners who are willing to thin their forested easement is approximately 55 thousand acres, the cost of achieving the desired forest stand conditions within this portion of WRP easements is between $9.5 and $15.9 million.

7. Conclusion

In the next several years, a majority of WRP forested easements within the LMAV will need to be thinned in order to achieve NRCS goals for attaining ecosystem service thresholds. The willingness of easement landowners to engage in forest management activities to enhance the BLH stands within the WRP easements is essential for the success of restoration efforts in the LMAV.

Results from this study suggest that ownership characteristics and objectives, involvement in nontimber activities, and management characteristics have a significant impact on the level of compensation required by easement landowners to adopt thinning on their

forested easement. Specifically, male landowners who have owned the easement for longer periods, had previous intention of conducting thinning, participated in hiking, and have worked with consulting foresters would demand lower WTA. On the contrary, landowners who plan to retain the forested easement for family heritage require higher compensation to adopt thinning. As demonstrated through our survey, providing information about the environmental benefits of actively managing the easement also decreases the WTA by $1.98 per ton.

These findings are important to target thinning initiatives toward the segment of easement landowners with the previously mentioned characteristics. Doing so will help achieve the restoration objectives in the most cost-effective manner. Increasing awareness among easement landowners about the importance of thinning to improve the BLH conditions within the easements should be a priority of the easement holder agency. The implementation of information campaigns to increase awareness among easement landowners can help reduce logging expenses between $29.8 and $49.6 thousand per 1000 acres. Therefore, the usefulness of environmental information to reduce landowner's reservation price and match them to current market conditions is beneficial.

Improving knowledge on easement landowners' preferences is just one among the many challenges in the management of WRP easements. This study brings about potential research questions to be addressed in the future. For example, future work should consider understanding loggers' (e.g., demand side of the market) preferences for thinning forested easements. Analysis of the spatial and age-class distribution of forested easements across the LMAV should also be conducted to optimize large-scale forest management. At the institutional level, assessment of the NRCS needs in order to manage the potential increase in

administrative burden for the provision of forest management permits, as well as monitoring efforts to ensure that management activities comply with conservation objectives.

Note that 50% of the sample chose not to participate in the study leading to possible self-selection bias. Without access to additional data, we cannot test whether such bias is present in this study and one should be careful to extrapolate these findings to the whole WRP population. Even if self-selection bias exists, landowners who chose to complete the questionnaire are in control of nearly 87 thousand acres, representing 26.5% percent of the entire WRP easement acreage in Louisiana. This is a considerable amount of land and should be relevant for policymaking.

Another limitation we encounter in the study is high rates of item nonresponse for the elicitation question due to limited knowledge of the pulpwood market. At least 12.2% of respondents who are willing to thin the forested easement failed to answer the WTA question, of which 7.6% indicated they were unaware of the current market prices for pulpwood. Future work design should provide a benchmark price to better inform landowners on current going rates in efforts to reduce asymmetric information and help landowners make informed decisions. Related to limited information, we did not account for biological characteristics of the easements that could have driven landowners' WTA answers. For example, including questions to control for site and forest stand quality or initial plating failure and stand mortality could potentially be important indicators affecting WTA.

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Figures

Figure 1. Policy consequentiality question

To what extent do you believe that your survey responses will be taken into account by decision-makers?

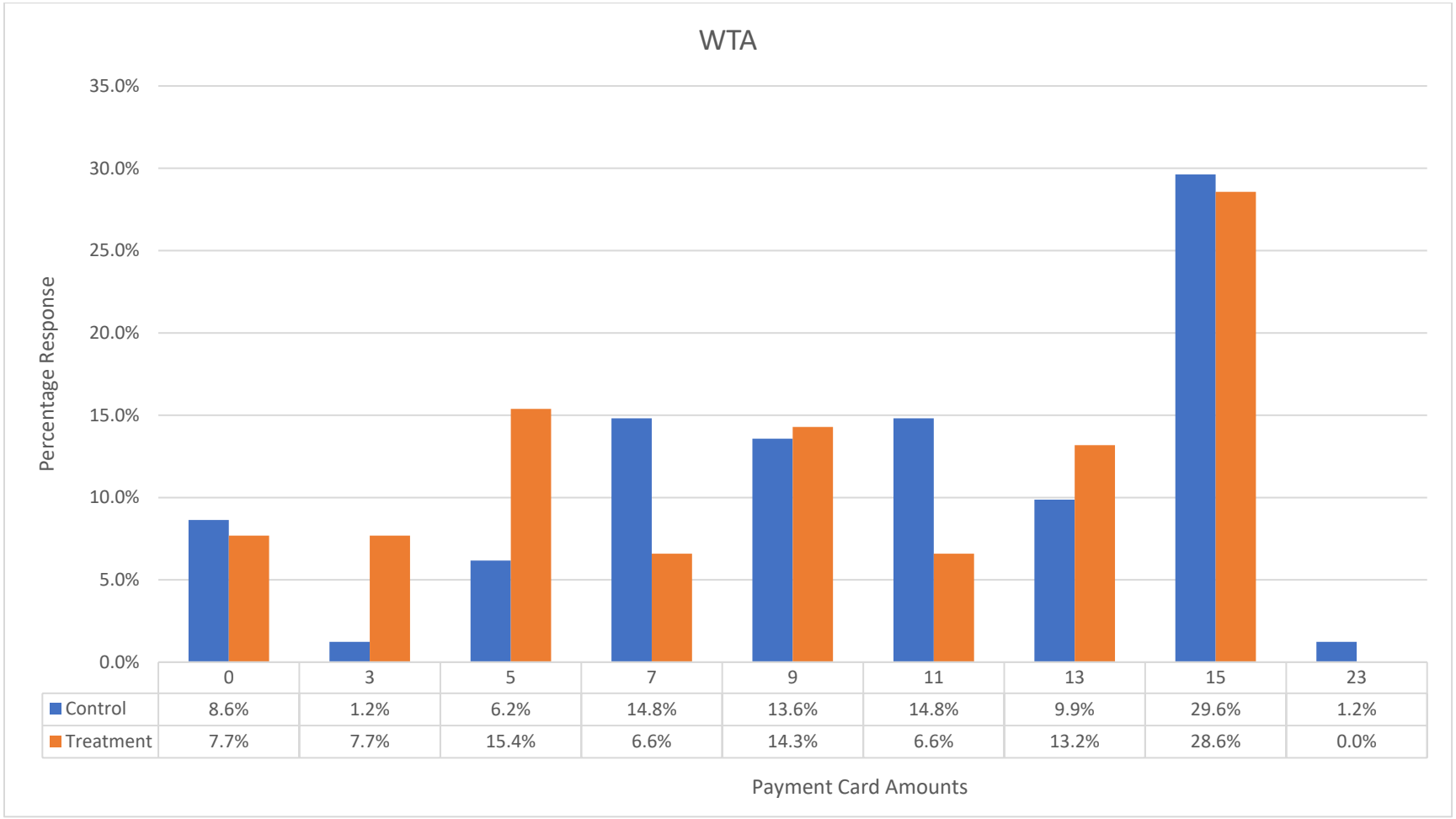
- ☐ To a great extent
- ☐ To a moderate extent
- ☐ To some extent
- ☐ To a small extent
- ☐ Not at all

Figure 2. WTA elicitation question

Circle the amount below that is closest to the minimum amount per ton of pulpwood that you would be willing to accept to thin this forested easement. *(Circle one)*

$0.00	$1.00	$3.00	$5.00	$7.00	$9.00	$11.00	$13.00	$15.00

Figure 3. Distribution of Willingness to Accept Responses in Payment Card



	0	3	5	7	9	11	13	15	23
Control	8.6%	1.2%	6.2%	14.8%	13.6%	14.8%	9.9%	29.6%	1.2%
Treatment	7.7%	7.7%	15.4%	6.6%	14.3%	6.6%	13.2%	28.6%	0.0%

Table 1. Descriptive statistics

Variable	Description	Mean	Std. Dev.
Enviro Info	Dummy: Received information about benefits of thinning 1, 0 otherwise	0.53	0.50
Property characteristics			
Easement Size100	Continuous: Size of the WRP easement (per 100 acres)	4.28	4.50
Landowner characteristics			
Tenure	Continuous: Length of easement ownership (years)	21.15	15.38
Grantor	1 if Landowner granted the easement, 0 otherwise	0.50	0.50
Proximity	Ordinal: Residence proximity to easement (1= live on property, 5=live more than 200 miles from property)	2.73	1.12
Importance of Ownership Reason			
Legacy	Ordinal: A family heritage to pass on to heirs (Extremely important=5, Not important=1)	4.17	1.05
Investment	Ordinal: Long-term investment (Extremely important=5, Not important=1)	3.81	1.19
Wildlife	Ordinal: Protect or improve wildlife habitat (Extremely important=5, Not important=1)	4.35	0.78
Recreation	Ordinal: Personal recreation (Extremely important=5, Not important=1)	4.44	0.91
Demographics			
Male	Dummy: 1 if landowner is male, 0 otherwise	0.95	0.22
Age	Dummy: 1 if landowner's age is 60 years or older, 0 otherwise	0.83	0.38
Education	Dummy: Landowner have attained bachelor's degree or higher 1, 0 otherwise	0.60	0.49
Nontimber Activities			
Hiking	Ordinal: Annual hiking frequency (5=13 or more times a year, 1=Never)	3.72	1.48
Wildlife watching	Ordinal: Annual wildlife watching frequency (5=13 or more times a year, 1=Never)	4.23	1.26
Hunting	Ordinal: Annual hunting frequency (5=13 or more times a year, 1=Never)	4.30	1.28
Management Characteristics			
Thinning	Dummy: Requested authorization to thin the forested easement 1, 0 otherwise	0.23	0.42
Plan manage	Dummy: Plan to conduct management within 10 years 1, 0 otherwise	0.59	0.49
Forester	Dummy: Have worked with a consulting forester before 1, 0 otherwise	0.33	0.47

Table 2. Comparison between Louisiana WRP landowners and other Easement and NIPF landowners.

		Stroman and Kreuter (2015)	Ernst and Wallace (2008)	Vlosky (2000)	Perera, et al. (2007)	Gordon and Barton (2015)	Measells, et al. (2005)
Population	WRP	Easement	Easement	NIPF	NIPF	NIPF	NIPF
Location	LA	TX	CO	LA	LA, MS	Mississippi Delta	AR, LA, MS, TN
Sample size	172	251	126	981	591	36	375
Property characteristics							
Forestland size in acres (mean)	781			760		324	330
Easement size in acres (median)	275	350	26				
Landowner characteristics							
Tenure (mean)	21	38					
Grantor	50%	82%	65%				
Live on property	15%	36%					
Ownership Reason							
Family heritage	2 (51%)		3 (24%)	2	2		1 (57%)
Long-term Investment	4 (35%)		4 (20%)	3	4		2 (43%)
Protect or improve wildlife habitat	3 (49%)		1 (67%)				
Personal recreation	1 (63%)			4	3	1	3 (39%)
Income generation (e.g., hunting leases)	5 (15%)						4 (36%)
Timber production[a]				1	1 (30%)	2	
Amenities[b]				5			
Community-mindedness[a]			2 (30%)				
Agricultural production[a]			5 (19%)				
Demographics							
Male	95%	83%			76%	89%	75%
Age (years)	64	62		65	65	63	61
College degree or higher	60%		82%	63%	56%		49%
Management Characteristics							
Thinning/Timber harvesting	23%		19%				
Forester	33%				57%		48%

[a]Ownership objective not included in our analysis
[b]Forest amenity values, such as privacy, solitude, enjoyment, and beauty where included in the personal recreation ownership objective in our analysis.

Table 3. Interval regression results

	Model1		Model2		Model3	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Enviro Info	-0.885	-0.981	-0.925	-0.959	-1.984**	-0.934
Easement size			-0.014	-0.111	0.082	-0.105
Tenure			-0.067*	-0.040	-0.061*	-0.037
Grantor			1.931	-1.247	1.539	-1.169
Proximity			0.296	-0.470	0.221	-0.436
Legacy			0.796	-0.486	1.021**	-0.451
Investment			0.229	-0.409	0.284	-0.390
Wildlife			-0.879	-0.721	-0.539	-0.691
Recreation			-0.342	-0.633	0.540	-0.693
Male			-3.308	-2.253	-3.752*	-2.060
Age			-0.226	-1.337	-0.069	-1.255
Education			-0.874	-1.033	-0.258	-0.991
Hiking					-0.702**	-0.358
Wildlife watching					-0.028	-0.461
Hunting					-0.687	-0.481
Thinning					-3.237***	-1.137
Plan manage					-0.991	-0.965
Forester					-2.126**	-0.977
Constant	12.122***	-0.724	16.827**	-5.248	18.307***	-4.98
lnsigma	1.816***	-0.069	1.772***	-0.069	1.679***	-0.069
Sigma	6.150	0.426	5.883	0.407	5.359	0.369
Observations	172		172		172	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Supplementary Material

1. Hypothetical Scenario and Information Treatment: Control Group

SECTION 3: HYPOTHETICAL SCENARIO

Assume that this forested easement is 15 years or older, and you have been authorized by the NRCS to conduct a thinning to improve its condition. You have been offered the opportunity to enter into a private logging contract with a certified logger. Under this contract, the logger will thin this forest and you will receive a payment according to the volume (in tons) of pulpwood removed.

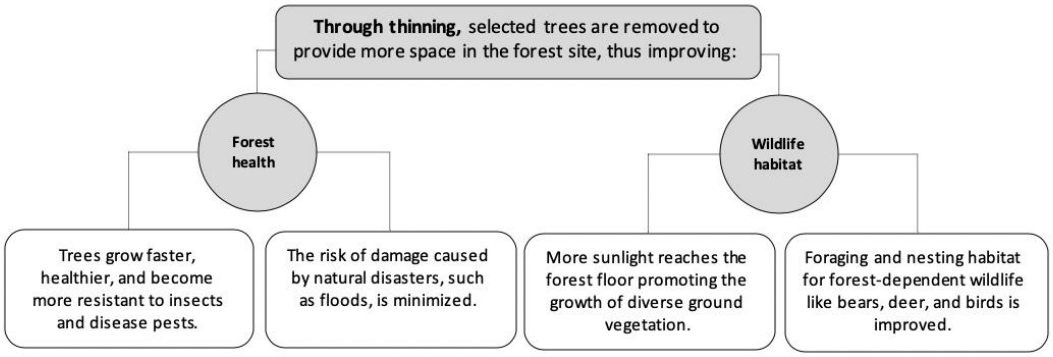
It is estimated that thinning harvests generate between **15 and 25 tons of pulpwood per acre.**

The price you would be paid is uncertain at this time because the cost of thinning hardwood forest of the conservation easements is unknown. In the event that you are authorized by the NRCS to thin this forest, we want to know how much you would be willing to accept as payment from a private logger. Results from this survey will be used to inform decision-makers.

2. Hypothetical Scenario and Information Treatment: Treatment Group

SECTION 3: HYPOTHETICAL SCENARIO

As hardwood plantations age, trees' size increases and their crowns grow larger, overcrowding the site. Competition among trees decreases the forest health and wildlife habitat quality. Management practices, such as thinning, are effective tools to restore these attributes.



The pictures below show some wildlife species that benefit from thinning the forest:

Assume that this forested easement is 15 years or older, and you have been authorized by the NRCS to conduct a thinning to improve its condition. You have been offered the opportunity to enter into a private logging contract with a certified logger. Under this contract, the logger will thin this forest and you will receive a payment according to the volume (in tons) of pulpwood removed.

It is estimated that thinning harvests generate between **15 and 25 tons of pulpwood per acre.**

The price you would be paid is uncertain at this time because the cost of thinning hardwood forest of the conservation easements is unknown. In the event that you are authorized by the NRCS to thin this forest, we want to know how much you would be willing to accept as payment from a private logger. Results from this survey will be used to inform decision-makers.