SOCIAL AVAILABILITY OF WOODY BIOMASS FOR RENEWABLE ENERGY: MISSOURI NON-INDUSTRIAL PRIVATE FOREST LANDOWNERS’ PERSPECTIVE

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by
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DECEMBER 2012
The undersigned, appointed by the Dean of the Graduate School, have examined
the thesis entitled

SOCIAL AVAILABILITY OF WOODY BIOMASS
FOR RENEWABLE ENERGY: MISSOURI NON-INDUSTRIAL PRIVATE
FOREST LANDOWNERS’ PERSPECTIVE

Presented by Marissa “Jo” Daniel

A candidate for the degree of Master of Science,

And hereby certify that in their opinion it is worthy of acceptance.

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From a young child I was taught to give thanks and credit where credit is due. Not only does it make the other person smile and feel significant but it also helps us realize no matter how strong and independent we are, everyone needs a helpful hand now and again. I would like to begin by thanking my family; my father, for instilling ambition in me. He pushed me to continuously climb the ladder of achievement, and never settle for something mediocre. My mother for her continuous support in all my endeavors and reminding me to step back, relax, enjoy life, and never forget who I am. My sister, brother, and nephews for making me smile, and being there for me no matter what the situation.

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Social Availability of Woody Biomass for Renewable Energy: Missouri Non-Industrial Private Forest Landowners’ Perspective

Abstract

The importance of bioenergy, particularly woody biomass, continues to gain significance in Missouri. Although physical estimates of standing wood have been used to assess and project total above-ground woody biomass, these estimates fail to explore its social availability. Over 85% of Missouri’s forests are privately owned, indicating that without the state’s private landowners’ acceptance utilizing woody biomass as bioenergy feedstock to the energy industry is impossible. Data was collected through focus groups and a mail survey, following the Tailored Design Method, to determine the states level of social acceptance towards woody biomass harvesting. Factor and cluster analysis were conducted to provide a current typology of Missouri’s Non-industrial Private Forest Landowners (NIPFLs) as well as analyze the impacts of dominant timber prices and government incentive payments.

Ordinal probability regression models and a marginal effects analysis determined the percentage of socially available woody biomass feedstock in Missouri as a function of timber and biomass prices, subsidy payments, and demographic profiles. Although results indicate many landowners are not knowledgeable about woody biomass for energy, they are interested in learning more about its potential uses. Results also suggest that landowners will sell their timber and woody biomass if the prices are sufficiently high enough in those markets. Today’s market prices however are not deemed adequate to interest NIPFLs whose primary objectives include conservation/recreation rather than forest management considerations.
1. Introduction

Alternative energy can be obtained from a variety of sources: solar, wind, water, corn, soybeans, or trees. Utilization of small trees, also known as woody biomass, for energy is one method for producing alternative energy (USDA 2008). Woody biomass is specifically defined as small-diameter trees (less than seven inches) traditionally used for firewood, as well as portions of trees (e.g. such as tree limbs, tree tops, needles, and leaves) that cannot to be used for other forest products. Woody biomass is able to produce both electrical and thermal energy as well as transportation fuel substitutes such as ethanol or biodiesel (USDA et al. 2003). Woody biomass can provide a logical alternative to fossil fuels in the United States, and specifically Missouri. Although physical estimates of standing wood have been used to assess and project total above-ground woody biomass, these estimates fail to explore its social availability. Over 85% of Missouri’s forests are privately owned, indicating that without the state’s private landowners’ acceptance, utilizing woody biomass as bioenergy feedstock to the energy industry is impossible (Aguilar and Garrett 2009). The study of social feasibility involves analyzing potential factors affecting a landowner’s decision to allow a woody biomass harvest on their property. This thesis determines the social acceptance for woody biomass harvesting by analyzing current utilization of Missouri’s forests by Non-Industrial Private Forest Landowners (NIPFLs), price parameters required for harvesting woody biomass, public assistance available to NIPFLs, perceived benefits and concerns of woody biomass, and factors that affect the social acceptance of woody biomass in Missouri.
1.1 Study Aim & Objectives

This project was designed to gather information from Missouri’s NIPFLs regarding their knowledge of woody biomass harvesting, benefits they foresee, and concerns they perceive. An estimation of landowners’ willingness-to-accept (WTA) public payments for woody biomass was also calculated on a per ton basis. Specific objectives were:

1. Based on potential concerns and anticipated benefits of woody biomass harvesting, evaluate Missouri’s NIPFLs’ level of willingness to provide woody biomass to energy markets.

2. Based on survey data and an econometric model, calculate NIPFL’s WTA public payments for their woody biomass feedstock. These models will determine in what manner site conditions (landowner currently possessing a management plan, plot size, species composition) as well as profiles (residence status, age, gender) affect landowners minimum WTA subsidies in order to participate in the Biomass Crop Assistance Program (BCAP).

3. Evaluate the difference in current subsidy payments to the NIPFL’s WTA payment values.
1.2 Conceptual Framework

The study arose from the need to gain a better understanding of Missouri’s NIPFLs with regards to their willingness to harvest woody biomass and receive public incentive payments for this commodity. A review of the literature on Missouri’s landowner types, current and past timber markets, willingness to harvest timber, available public incentive programs within the state, present and potential policy for woody biomass, and future sites for cellulosic ethanol production formulated the research parameters to analyze. These questions consisted of: determining perceptions over woody biomass treatments (understanding, benefits, and concerns), what role public payments had with NIPFLs, and how the attitudes and reactions in willingness-to-harvest (WTH) differed at various prices levels. These questions were addressed through a survey instrument focused in southern Missouri.

The survey contained six sections: woodland management, bioenergy, public incentives, harvesting your woodlands, you and your woodlands, and demographics. The harvesting your woodlands section included conjoint analysis questions asking a landowner to rate their likelihood of accepting a specific price to harvest their timber, woody biomass, and receive a public incentive payment from their woodlands. The questions specified the harvest would be conducted by a professional logger who followed Best Management Practices (BMPs). This section also asked why the landowner owned their woodland. Past studies have indicated landowners own woodlands for more reasons than to harvest (Butler et al 2007; Kurtz 2004). These individuals are always seeking to maximize their overall utility, thus harvesting simply based upon price isn’t generally a primary indicator. By understanding NIPFLs history
and current motivation, a more realistic perception of their future willingness to harvest can be determined.

1.3 Research Timeline

The exploratory analysis began in the summer of 2010 with focus group meetings, analysis of previous survey instruments from around the nation, and discussions with the Missouri Department of Conservation to create the survey instrument to be used in this study. A mailing list of Missouri’s NIPFLs was created for distribution from November 2010 to February 2011. Initial postcards informing recipients of the survey’s intentions and future arrival were received in the end of March of 2011 with the actual survey arriving in early April 2011. A follow up/thank you post card arrived two weeks later, with the second survey mailing arriving in early May 2011. In the fall of 2011 all survey data was recorded from the returned surveys and were analyzed. After the concluding results were determined a thank you letter was distributed to every individual who had originally received a survey. Overall results were highlighted within this letter along with information to find this thesis for those individuals interested in the project.

2. Literature Review

2.1 Forestland in the United States Private Ownership

America’s NIPFL’s primary objective for owning woodlands was once to harvest the timber on their property (Pan et al. 2007). Today’s NIPFLs find themselves more concerned with forest health, wildlife, water quality, aesthetics, recreation, long term preservation, and passing the land to their heirs (Matta et al. 2008; Broderick 1994). In
order to conceptualize a NIPFL/family forest owner, some definitions are in order. Davis et al. (2001) defines a forest as being, “(1) An ecosystem characterized by a more or less dense and extensive tree cover, often consisting of stands varying in characteristics such as species compositions, structure, age class, and associated processes, and commonly including meadows, streams, fish, and wildlife.” and “(2) A set of land parcels that has or could have tree vegetation and is managed as a whole to achieve the objectives of the owner” (p 64).

A forest owner is defined as someone who possesses the above said forest. Private forestlands tend to be small parcels of ground which indicates that forest management practices within the area remain small scale. Finally, in order for the forestland to be considered a family forest, the owner can not possess a processing facility (Demarsh et al. 2004). These small scale landowners come from a wide variety of backgrounds with diverse experiences, no two of their motivations or goals are exactly the same (Pan et al. 2007). It can be quite overwhelming from a professional forester’s standpoint trying to manage an entire forested ecosystem when there are multiple parties all with diverse goals and mindsets (Matta et al. 2008).

2.2 Trends in Forestland Ownership

Forest land is having large turnover rates in the past few years, and will continue to do so for many more (Butler and Leatherberry 2004). Parcelization of land is becoming very widespread as people find themselves wanting to connect back with the land and believe the only way in doing so is to own a few acres in rural America (Richerbach and Kittredge 2008). As these new landowners move in they bring ideas and
values that differ with the previous generation (Richerbach and Kittredge 2008). Their objectives for the land may be the same, e.g. proper land management, but they put greater emphasis on recreational activities than economic value. These new landowners tend to mirror what the general public believes should occur with the land instead of what they think would benefit themselves the most (Erickson et al. 2002). These landowners also find high value in what the forest has to offer (i.e. woody products, food sources, clean air and water) they do not feel they are knowledgeable enough to properly manage it. So they generally decide not to do anything. Those that do decide to manage tend to prefer a “soft technology” which indicates they are greatly interested in renewable energy technologies (Kendra and Hull 2005).

2.3 Forestland in Missouri

Missourians have utilized wood for energy (i.e. heating, cooking) since first inhabiting the region in the 1700s (Lazzerini 2005). Since that time, citizens have expanded their timber use to include dimensional lumber, barrels, flooring, pallets and pulp to make paper. With renewable energy becoming more prominent in Missouri, as well as the United States, it is imperative to focus our attention on how to maximize potential renewable fuels.

There are approximately 44 million acres located in Missouri, 33 percent of these acres are identified as forestland. NIPFLs own 82 percent of these forested acres (Moser 2006). This large acreage is essential to Missouri not only because they provide wood products, but also because they sustain rural communities by providing jobs (Iffrig 2004). The forests biggest impact in Missouri however is their value in mitigating erosion,
improving water quality, moderating storm flow events, providing habitat for wildlife, improving structural integrity, recreation, and cultural/spiritual values (Treiman and Dwyer 2004; Matta et al. 2008).

Although Missouri’s forests are already under intensive management practices, statistics show that the growth rate of Missouri’s forests is 267 million cubic feet per year while current harvesting rates are only 140 million cubic feet per year for the entirety of Missouri’s forests, public and private alike (USDA 2007). Although harvesting the additional 127 million cubic feet of forest growth would not be beneficial, harvesting a percentage of this excess could prove advantageous for Missouri (Romitti 2010; USDA 2007).

Timber does not seem to be a priority for most NIPFLs in the state when less than 42 percent of these owners reported having even some harvest experience (Kurtz and Lewis 1981; Kurtz 2004). To further stress this significance, 66 percent of NIPF land does not possess a written forest management plan and numerous people are in agreement that Missouri’s NIPFLs forests are currently poorly managed (Dorst 2010). This information only further indicates how important Missouri’s forests potentially could be for renewable fuels (Kurtz 2004).

The usage of biomass for bio-energy couldn’t be coming in at a better time for Missouri. When analyzing landowner demographics for 2006 it shows that almost 70 percent of NIPF forest land is in current ownership of citizens 55 years of age or older (Butler et al. 2007; Butler and Leatherberry 2004). This data portrays that Missouri’s forests will soon be handed down to a younger generation for its management and care. With this transfer of ownership Missouri Department of Conservation (MDC) believes
they can help positively influence these young landowners to create Best Management Practices (BMPs) on their property suited for both the state requirements as well as their personal land management goals. With these BMPs will come the requisite for removal of woody biomass material (Smith et al. 2007).

2.4 Public Policy to Promote Fuel Management in Forestlands

The 20th Century was noted for drastic changes in technology and policy. The World Wars and the Great Depression brought a change in peoples’ viewpoints and thus a change in politics. These changes were diverse in nature and included everything from the invention of the automobile, to civil rights, to forest management. Until midway through the 1900’s, U.S. citizens associated forest management with wood production (Serbruyns and Luyssaert 2006). In 1976, the National Forest Management Act (P.L. 94-588) was passed. This act allowed citizens the right to verbalize their opinions and create a consensus together which lead towards better managed national forests.

Along the same time as the National Forest Management Act of 1976, forest management broadened its scope to include biodiversity maintenance, carbon sequestration, ground water protection, environmental monitoring, and recreational services. This was done using the Multiple-Use Sustained Yield Act of 1960 (P.L. 86-517). When the public was granted the privilege of helping discern national forest choices for forest management, very often foresters found the property and plans being managed on the national forest in gridlock with minimal management capable of occurring for many years (Argow 1994; Serbruyns and Luyssaert 2006). With the broadening of forest management objectives and reduction of timber harvested from
public lands, society and industry began to focus towards non industrial private lands to provide essential forest products. From that point policies for forest lands took a drastic shift to help cultivate and sustain proper management within the private sector (Cubbage and Newman 2006; Zhang and Flick 2001).

Governmental and private entities have provided informational incentives to NIPFL’s with the premise that by educating landowners about forest management they will become more willing to properly manage their timber (Serbruyns and Luyssaert 2006). The Society of American Foresters (SAF) have made numerous statements reaffirming their commitment to the private sector of forestry, believing that showing such respect will help induce confidence with landowners and aid in proper forest management (Coufal 1994). SAF also believes it is the responsibility of the landowner to properly manage their own land because the fate of the entire nation could depend upon NIPFL’s forests for its future (Joshi and Arano 2009). To further aid educational incentives for NIPFL’s, the National Woodland Owners of America (NWOA) sends out publications emphasizing the importance of private property owners being aware of their Rights, Regulations, and Responsibilities as a forest landowner with hopes that these individuals will take their own initiative to manage the land in a way that sustains forestry (Argow 1994).

Other major policy forms included financial and voluntary instruments to motivate landowners. The American Tree Farm System (ATFS) began in the 1940s and introduced sustainable forestry to landowners in a form they were familiar with at that time, farming. By incorporating forestry into farming techniques the ATFS found a method in which NIPFL’s could connect with the land. NIPFL’s understood that for
farming to be prosperous they must be stewards of the land to create continuous crop production throughout the years. By linking land stewardship the landowner’s forests ATFS helped alleviate the problem of “cut out” and “get out”. ATFS found that by using a certification process they could continue to help landowners properly manage their woodlands for extended periods of time (American Forest Foundation 2010).

Forest certification is another incentive that rewards private forests for their upstanding forest management. Research found certified timber with a distinguishable logo created a market reward for those landowners enrolled in the program because consumers were more willing to purchase products certified; green. Programs like the Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI), provide a third party certification which helps establish a baseline for landowners and producers alike with the intention of raising standards (Cubbage and Newman 2006).

Throughout the nation there are various land management incentives and disincentives that each state has provided for landowners to help promote proper forest management. Forms of these programs include; tax deductions, government regulations, assistance programs, cost sharing, education, technical assistance, and voluntary programs (Wicker 2002). An example of the voluntary program approach would be the use of the Farm Bill, also known as the Food, Conservation, and Energy Act of 2008 (Pub.L. 110-243). This bill is redeveloped every five years to ensure optimal support. The Farm Bill contains voluntary, regulatory and subsidy provisions to aid private landowners maintain and improve their property. Examples of these incentive programs include but are not limited to the Conservation Reserve Program (CRP), Wildlife Habitat Incentives Program (WHIP), Wetlands Reserve Program (WRP), Environmental Quality
2.5 Prospects for Woody Biomass Energy Utilization

Creating efficient policy is just as essential for renewable energy as it has been for forest management to ensure the sustainability of our resources. The Renewable Fuel Standard mandates that by 2022 the United States should be producing 16 billion gallons of cellulosic fuels, increasing by 8.5 billion gallons from the 2012 regulations (P.L.110-140). The “Missouri Qualified Fuel Ethanol Producer Incentive Fund” and the Biomass Crop Assistance Program (BCAP) incentive payments are providing financial and research support for woody biomass harvesting towards bioenergy fuel production (P.L. 107-171 and P.L. 110-246). In order to reduce coal usage and meet renewable portfolio standards at the state level power plant facilities are beginning to use wood biomass as a fossil fuel replacement (Aguilar et al.2012).

It is estimated that the United States is capable of producing 368 million dry tons of woody biomass on a yearly basis (Perlack et al. 2005). The United States currently uses three and one half percent of its primary energy from renewable energy sources and as of 2008 approximately 51 percent of the United States renewable energy used is derived from biomass (Perlack et al. 2005). This data is backed by the U.S. Energy Information Administration (EIA) which stated that in 2008 7.367 quadrillion British thermal units (Btu’s) were consumed of which 3.852 quadrillion Btu’s were sourced from biomass (EIA 2008). It is essential we establish a guideline for management practices for harvesting available woody biomass, to ensure there is no degradation to our forests as
these baseline percentages for renewable energy continue to increase with time (Aguilar and Garrett 2009).

Woody biomass also creates some unique advantages when considering the current state of the economy. Implementation of woody biomass plants would create more jobs for citizens and with the industry incorporate facilities where the material is not currently being used there would be little market competition (Gruenwald 2007). The selling of biomass could also generate additional income for landowners, helping boost the economy (Ashton 2007). Once the biomass is harvested, it can be sold to produce thermal energy, electricity or liquid transportation fuels (Hall 1997). Finally, environmental benefits can include decreasing forest management costs, diminishing climate change in comparison to other energy sources, minimizing the risk towards people’s life or property, decreasing our dependence to fossil fuels, reducing our fire hazard, and allowing landowners to maintain their forests and farm properties (Bartuska 2010).

Some of the most noted woody biomass disadvantages is carbon dioxide emissions. Studies have been conducted to calculate the effects of biomass plants and determine if they actually maintain a carbon neutral standing. Results show that biomass initially creates a higher carbon emission, explaining the negative connotation with woody biomass. However, the carbon debt is paid through time as the new forests grows, which stores the carbon until the next harvest. Over time this creates a carbon neutral setting, proving beneficial to the environment (Kinsley 2010).

Another implication to woody biomass is that most loggers are not willing to harvest biomass with such minimal returns. Until a baseline price is formed enabling
loggers to harvest biomass only, collection methods must be joined with a conventional
timber harvest (Ashton 2007). An integrated harvest discourages landowners willing to
harvest biomass but not willing to harvest sawlogs from participating. Other potential
risks with the utilization of woody biomass would be due to improper harvesting
techniques or over harvesting an area. Erosion, water pollution, nutrient cycling, species
biodiversity, and energy input/output ratios are included with these risks. Policies are
being created to protect these commodities to help ensure trouble does not arise with
biomass (Hall 1997).

3. Methods

3.1 Survey Development

A survey instrument was developed by the University of Missouri’s Forestry
Department in cooperation with the Missouri Department of Conservation (MDC) to
gather NIPFL perceptions of woody biomass harvesting. The survey was organized into
multiple sections; the first section gathered general information regarding the
landowner’s management practices. The second section provided a brief introduction of
woody biomass and then queried these landowners’ perceptions about renewable energy.
The final section presented various woody biomass and timber harvesting options and
then inquired upon the landowners to choose which options they would likely accept
(Table 1).

Timber price parameters were established based on past stumpage prices for
Missouri through the MDC Missouri Timber Price Trends Quarterly Report (MDC,
2012). Prices found in the southeast and southwest regions were used when analyzing
the average price per board foot to correspond with the geographic location of interest for the survey. Due to the recent decline in timber prices, average prices for oak species in the past three years were used to determine a mid level price per board foot for the survey (Woodall et al., 2012). MDC’s prices per board foot are based on a 2,000 board foot average. The survey proposed removing only 2,000 board feet per acre thus a conversion from dollars per board feet to dollars per acre was estimated. An average price of $200 per acre was determined to be the current market price. A minimum and maximum of $100 per acre and $300 per acre for timber were included to determine potential sensitivity to price as well as represent variability in market prices (Markowski-Lindsay et al. 2012).

Average price levels for woody biomass were determined with a comparison to the price the University of Missouri Power Plant was willing to pay for woody biomass at the time of the study against coal. Without there being neither pulp nor bioenergy market in Missouri for woody biomass this was the only feasible price reference possibility. An average biomass price level in equivalence to coal energy was determined to be $50 per green ton per acre (Saunders et al. 2010). In order to maintain a biomass price it was decided the price per ton of $25 per green ton per acre and $75 per green ton per acre were to be selected as minimum and maximum woody biomass prices. These prices assumed a harvesting removal of 15 green tons of biomass per acre from the possible 30 green tons calculated to be on one acre of woodland (Saunders et al. 2010).

Public incentives were established using BCAP regulations. The United States Department of Agriculture (USDA) matches eligible owners dollar-for-dollar per dry ton being paid for woody biomass up to $45 per dry ton so the average public incentive
payment was $25 per green tons (USDA 2012). Converting from dry to green ton per acre one assumes a 50 percent reduction due to weight differences associated between dry and green tons after rounding up for survey simplicity the average price was determined. Minimum incentive prices of $0 per green ton per acre, the landowner received no incentive, and a maximum of $50 per green ton per acre were selected to create a balanced research design (Elfenbein and Ambady 2002). This design enables a minimum willingness to accept price for timber harvests, woody biomass, and public incentives to all be individually determined. By having an equal number of option in all three variables, no individual variable possesses more weight than the other two minimizing bias (Elfenbein and Ambady 2002).

<table>
<thead>
<tr>
<th>Timber Harvest</th>
<th>Woody Biomass</th>
<th>Public Incentive</th>
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Inquiries were made as to recipients’ preference for an incentive payment or a tax reduction, if the only requirement was a forest management plan for their land. Other topics included why the landowner owned their woodlands as well as general demographical questions about the individual. Multiple variables included in the survey replicated questions used in the NWOS survey for validation and comparison purposes (Butler 2008; Butler and Leatherberry 2004; Butler et al. 2007).
Focus groups were held with forest landowners in Boone and Dent County, potential sites for future woody biomass electrical plants, after the initial survey was created with the intention of having NIPFLs provide suggestions to improve overall comprehension of the surveys. The landowner’s were randomly selected from a data base generated by the Top of the Ozarks a year prior identifying landowners in the county whom possessed a minimum of 20 forested acres. During the focus group meetings, forest landowners were asked to complete the survey with no pre-knowledge of the survey’s contents, so as not to influence the landowners’ normal survey completion response behavior (Dillman 2000). No questions, comments, or suggestions were made until all participants finished the survey. Once completed, focus group leaders discussed each question with the participants to inquire upon their thoughts and opinions. These recommendations were taken, analyzed, and used to revise the survey instrument with the intent of creating a more user-friendly survey.

3.2 Data Collection

Over 55 percent of Missouri’s forests are located in the southeastern part of the state, rationalizing the focus of the survey in this area. There were approximately 30 counties within the targeted area from which 14 counties were randomly selected to participate in the survey. Funding allocation dictated approximately 2,000 surveys would be mailed with 150 surveys per county totaling to 2,100 surveys to be mailed to NIPFL’s. (See Figure 1)
To select 150 recipients for each county the Center for Applied Research and Environmental Systems (CARES) was used to filter those sections within the county that were greater than or equal to 85% forest cover. For those counties with available online geographical information systems (ArcGIS), landowners households were chosen from each section based upon the number of acres the landowner had and how much of their property appeared forested on the map. This ensured collecting landowners who possessed 20 acres or more of forested land which is the minimum amount of acreage required for a timber harvest to be economically feasible by Missouri’s loggers (Aguilar and Saunders 2010). It was not possible to collect all the chosen counties landowner information using ArcGIS so the use of county assessors for seven counties was required. The County Assessors were contacted and a sunshine request was made for all landowners whom possessed agricultural lands over 20 acres within their county. A
sunshine request is a request for public information such as a landowner's name, address, city, state, zip, number of acres owned, a legal description, and whether the land is designated as commercial, agricultural, or residential. Table 2 lists the counties used for the survey and how information was gathered from each of them.

Table 2 Counties used for the survey corresponding to the type of information used to gather NIPFL data.

<table>
<thead>
<tr>
<th>County Data Collected Using</th>
<th>County Data Collected Using</th>
</tr>
</thead>
<tbody>
<tr>
<td>ArcGIS*</td>
<td>County Tax Assessors</td>
</tr>
<tr>
<td>Laclede</td>
<td>Phelps</td>
</tr>
<tr>
<td>Cole</td>
<td>Ripley</td>
</tr>
<tr>
<td>Pulaski</td>
<td>Shannon</td>
</tr>
<tr>
<td>Butler</td>
<td>McDonald</td>
</tr>
<tr>
<td>Oregon</td>
<td>Ozark</td>
</tr>
<tr>
<td>Lincoln</td>
<td>Howell</td>
</tr>
<tr>
<td>Douglas</td>
<td>Iron</td>
</tr>
</tbody>
</table>

*ArcGIS (Geographical Information Systems) Counties. This technique utilized satellite imagery to record parcel information including name of owner, address, and number of acres in each parcel.

A mail-based survey was chosen in an attempt to capture a more accurate representation of Missouri’s NIPFL’s. Following the Tailored Design Method, introductory postcards were mailed to all recipients informing them of the survey’s intentions; making them feel more comfortable, knowledgeable, and overall to let the NIPFL’s know that without their input, the project would be impossible. The postcard was followed by the actual questionnaire, which included a cover letter and prepaid return envelope. A reminder postcard and second wave of surveys followed. Table 13 in the appendix outlines the different steps followed for survey deployment that took place between March and May of 2011.
3.3 Non-survey Information

To compare the physically available sawtimber and biomass within a state against NIPFLs willingness-to-harvest these commodities, the U.S. Forest Service Forest Inventory Analysis (FIA) database (USDA 2012) was used to derive estimates of the following attributes for private timberland in the counties covered by the Missouri NIPFL survey.

1. Net volume of sawtimber in board feet (International ¼-inch rule.
2. Dry weight (short tons) of tops and limbs for live sawtimber trees. Sawtimber trees are commercial species with tree quality and form classified as growing stock (i.e., non-cull) that are at least 11 inches d.b.h. for hardwood or 9 inches d.b.h. for softwoods.
3. The aboveground dry weight (short tons, excluding stumps) of live rough and/or rotten cull trees at least 1 inch d.b.h. combined with aboveground dry weight (short tons, excluding stumps) of live growing stock trees (i.e., non-cull) between 5 and 11 inches d.b.h. for hardwoods and between 5 and 9 inches d.b.h. for softwoods.
4. The combined values from items 2 and 3 above which correspond to total biomass (short tons, excluding stumps) in tops, limbs, rough and rotten cull trees and small diameter trees.
4. Multivariate Analysis of Missouri’s Non-Industrial Private Forest Landowner’s and their Willingness-to-Harvest Woody Biomass

4.1 Introduction

The Energy Independence and Security Act (EIA) of 2010 (P.L. 110-140) mandates that U.S. transportation fuels contain 36 billion gallons of renewable fuels, including at least 16 billion gallons of cellulosic biofuels by 2022. Forest productivity calculations estimate Missouri’s annual forest growth rate to be near 267 million cubic board feet per year with forest harvesting rates roughly at 140 million cubic board feet per year (Romitti 2010; USDA 2007). The high potential of harvest in the state is a result of 33% or approximately 14.5 million acres in the state of Missouri are forested (Moser et al. 2006). 78% of these forested acres are privately owned and of this percentage 95% is possessed by NIPFLs (Smith et al. 2007). Private forestlands tend to be small parcels of ground suggesting that forest management practices within the state remain small scale which results in just over half of the potential acreage within the state being harvested (Demarsh et al. 2004).

Missouri possesses the potential to be a significant provider of cellulosic biomass with approximately 127 million cubic board feet per year available to be harvested however the number of Missouri’s NIPFLs actively managing their woodlands is extremely small. In order to increase this population of landowners, and hence the cellulosic feedstock supply, it is imperative to understand why NIPFL’s possess of these woodlands. NIPFLs interest in woody biomass from NIPFL woodlands could potentially secure a considerable quantity of feedstock to produce renewable fuels. These fuels could assist in boosting Missouri’s economy as well as improving Missouri’s
forest’s health and management (Wicker 2002). If the interest is not present, however, Missouri’s assistance in renewable fuels through woody biomass will be severely limited.

In order to enhance social acceptance of woody biomass, the U.S. Department of Agriculture’s Farm Service Agency (FSA) created the Biomass Crop Assistance Program (BCAP). BCAP was originally introduced in the 2002 Farm Bill (P.L. 107-171) and later amended under the 2008 Farm Bill (P.L. 110-234). This program allows forest landowners to receive matching payments for qualified biomass crops. Qualified woody biomass crops are defined as, “the trees and woody plants, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment, that are the by-products of forest management” (USDA 2008).

Examples of these eligible crops include but are not limited to: organic material which can be made available on a recurring basis, materials being harvested within forest management regulations, woody matter which would not be used for a higher value product normally, byproducts from timber removal to promote hazardous fuel reduction, decease disease potential, or restoration of an ecosystem. Over a two-year period landowners could potentially receive $1.00 for every $1.00 per dry ton is paid to them by a qualified BCAP facility, up to a maximum of $45.00 per dry ton. There are many purposes for BCAP: restoring ecosystems; reducing hazards; minimizing diseases and infestations; to producing heat, power, advanced bio-fuels, or other bio-based products (USDA 2010).

Numerous studies have been conducted in Missouri to study NIPFLs’ objectives, attitudes, and motivations for owning woodlands (Lewis 1979; Kurtz and Lewis 1981; Trokey 1981). These studies identified four main attitude types for Missouri’s
landowners and classified their objectives and motivations for forest management within each one (Kurtz and Lewis 1981). These landowners were identified as: timber agriculturist, timber conservationist, forest environmentalist, and the range pragmatist. Timber agriculturist NIPFLs managed their forests in a similar manner to that of a farmer with an agricultural crop, looking at short term sustainable production. NIPFLs timber conservationists managed timberland in a sustainable manner. NIPFLs forest environmentalists aspired for proper timber management but disliked the aesthetics of logging. NIPFLs range pragmatists would harvest trees but were not interested in timber management. In 1981 when Kurtz and Lewis conducted their study, 40 percent of Missouri’s landowners tended to be categorized as either a timber conservationist or forest environmentalists due to their favoritism towards the recreational aspects of woodland ownership (Kurtz and Lewis 1981).

Other past NIPFL surveys delineated that a majority of these landowners may be classified as part of the baby boomer generation. They are well educated, maintain an annual income comparable to the U.S. National average, have harvested timber in past years from their woodlands, and are potentially interested in future harvests (Butler et al. 2007; Butler and Leatherberry 2004; Kurtz 2004). These studies have also indicated that in Missouri; only about two percent of those individuals are involved in public programs (Butler et al. 2007). An example of such public programs is the Emergency Forest Restoration Program (EFRP) designed to assist landowners restoring their lands if damaged by a natural disaster (FSA 2012).

Although past studies have provided detailed information concerning NIPFL’s views on timber harvests, little research has been conducted on the landowner’s opinions
of utilizing woody biomass as a renewable energy resource. Gaining insight of these viewpoints would allow for a better understanding of Missouri’s potential participation in renewable fuel production, what the best method for encouraging landowner participation is, and if any modification is needed in Missouri’s public policy/incentives to encourage involvement in woody biomass utilization.

4.1.2 Objectives

This project was designed to gather information from Missouri’s NIPFL’s regarding their current level of forest management; their knowledge of woody biomass harvesting; the benefits they foresaw, and concerns they perceived associated with woody biomass harvesting. This information was then used to estimate the percentage of Missouri NIPFLs willing to harvest trees for renewable energy purposes. Specifically, objectives include to:

1. Explore NIPFLs current and past woodland management by (a) analyzing current percentages of forest management and past harvest from Missouri’s NIPFL land, (b) evaluating potential future timber harvests and intent on maintaining ownership of forestland, (c) investigating landowner’s primary reasons for forest ownership.

2. Evaluate public program and bioenergy perceptions by (a) determining the percentage of NIPFL participation in public programs, (b) examining agreement/disagreement preferences concerning woody biomass utilization as renewable energy, (c) exploring public incentive preferences between incentive payments and tax reductions,
3. Classify Missouri NIPFLs into homogeneous clusters to advise project managers and policymakers upon the potential percentage of forestland NIPFLs willing to harvest versus the actual percent of forestland available to be harvested for energy feedstock.

4.1.3 Theoretical Framework

The study analyzed variables reported in the literature and ongoing studies which influence NIPFLs woodland management. Kurtz and Lewis (1981) concluded that Missouri Ozarks NIPFLs’ decisions to participate in forest management were correlated with their motivations, objectives, and constraints for that parcel of woodland. NIPFLs may have been concerned about generating a profit from woodland management; however, maximizing monetary return was not necessarily their primary concern. Rather, NIPFLs tend to be better satisfied with maximizing overall utility (Amacher et al. 2003). Overall utility reflects a multi-purpose dimension of NIPFLs’ reasons for woodland ownership. For example, a landowner may choose to own woodlands for aesthetic reasons rather than the monetary benefits (Butler 2008).

Past studies indicated demographical parameters, landowner perceptions on bioenergy, ownership characteristics, management characteristics, and reasons for land ownership all limit a landowner’s ability for maximum utility and management (Table 3). Demographics were defined as age, education, income, sex, and children under the age of 18 (Amacher et al. 2003; Butler and Leatherberry 2004; Joshi and Arano 2009; Young and Reichenbach 1987). NIPFLs’ perceptions on bioenergy queried the landowners view of the impacts of harvesting woody biomass (Joshi and Mehmood 2011; Gruchy et al. 2011). Ownership characteristics that may influence management include parcel size,
wooded parcel size, year acquired, and primary residence (Romm et al. 1987; Bliss and Martin 1989; Joshi and Arano 2009; Erickson et al. 2002). Management characteristics pertained to having sold timber since owned, potential for future harvests, percentage of land that will never be cut, programs involved in, and professional advice received (D’Amato et al. 2010; Greene and Blatner 1986; Joshi and Arano 2009). Finally, reasons for owning land that could play an important role on woodland management by NIPFLs included to: enjoy beauty, protect nature, land investment, as part of my home, privacy, for hunting, for firewood, cultivation on non-timber products, pass on to heirs, or as inheritance (Butler et al. 2007; Marty et al. 1988; Broderick et al. 1994; Finley and Kittredge 2006).

Once these initial factors were determined, latent factors were constructed to better analyze NIPFLs’ management techniques and views. Generation of factors simplified the interpretation of NIPFLs cluster analysis by reducing the number of variables analyzed on the basis of similar traits (Aguilar 2008). After conducting an exploratory factor analysis on both the landowners’ perceptions on bioenergy and their reasons for owning land, the number of variables within each category was condensed to two and four factors respectively.
<table>
<thead>
<tr>
<th>Category</th>
<th>Variables</th>
<th>Scale</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographics</td>
<td>Age</td>
<td>Categorical (1-7)</td>
<td>Amacher et al., 2003;</td>
</tr>
<tr>
<td></td>
<td>Education</td>
<td>Categorical (1-7)</td>
<td>Butler and Leatherberry 2004;</td>
</tr>
<tr>
<td></td>
<td>Income</td>
<td>Categorical (1-8)</td>
<td>Joshi and Arano, 2009;</td>
</tr>
<tr>
<td></td>
<td>Sex</td>
<td>Categorical (1-2)</td>
<td>Young and Reichenbach, 1987</td>
</tr>
<tr>
<td></td>
<td>Children under 18</td>
<td>Continuous</td>
<td></td>
</tr>
<tr>
<td>Bioenergy Views</td>
<td>Landowner views of the</td>
<td>Rating (1-5)</td>
<td>Grunchy et al. 2011;</td>
</tr>
<tr>
<td></td>
<td>impacts of harvesting</td>
<td></td>
<td>Galik et al. 2009;</td>
</tr>
<tr>
<td></td>
<td>woody biomass</td>
<td></td>
<td>Joshi and Mehmood, 2011</td>
</tr>
<tr>
<td>Land Characteristics</td>
<td>Parcel size</td>
<td>Categorical (1-7)</td>
<td>Romm et al., 1987;</td>
</tr>
<tr>
<td></td>
<td>Wooded parcel size</td>
<td>Categorical (1-7)</td>
<td>Bliss and Martin, 1989;</td>
</tr>
<tr>
<td></td>
<td>Year acquired</td>
<td>Categorical (1-8)</td>
<td>Joshi and Arano, 2009;</td>
</tr>
<tr>
<td></td>
<td>Primary residence</td>
<td>Binary (0-1)</td>
<td>Erickson et al., 2002</td>
</tr>
<tr>
<td></td>
<td>Sawtimber volume</td>
<td>Continuous</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Biomass volume</td>
<td>Continuous</td>
<td></td>
</tr>
<tr>
<td>Ownership Characteristics</td>
<td>Having sold timber</td>
<td>Binary (0-1)</td>
<td>Joshi and Arano, 2009;</td>
</tr>
<tr>
<td></td>
<td>since owned</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Potential future harvests</td>
<td>Binary (0-1)</td>
<td>D’Amato et al. 2010;</td>
</tr>
<tr>
<td></td>
<td>Public programs involved in</td>
<td>Binary (0-1)</td>
<td>Greene and Blatner, 1986</td>
</tr>
<tr>
<td></td>
<td>Professional advice received</td>
<td>Binary (0-1)</td>
<td></td>
</tr>
<tr>
<td>Reasons for Owning Land</td>
<td>Landowner reasons of</td>
<td>Rating (1-5)</td>
<td>Butler et al. 2007;</td>
</tr>
<tr>
<td></td>
<td>owning woodlands</td>
<td></td>
<td>Marty et al, 1988;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Broderick et al, 1994;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Finley and Kittredge, 2006</td>
</tr>
</tbody>
</table>
4.2 Methods

The returned surveys were input into Microsoft Excel using a binary system to code categorical responses and actual data for continuous variables. For example, if the recipient answered “yes” a “1” was recording in the proper cell whereas if they answered “no” a “0” was recorded instead. Once the data were recorded they were uploaded into STATA 10.0 for analysis. The data was first filtered to include only NIPFLs who possessed 20 or more woodland acres on their property. This is because in most cases no fewer than 20 acres can be harvested economically, limiting loggers’ interest in conducting harvests at such a small scale (Saunders et al. 2010).

T-tests were conducted on each variable within bioenergy views and reasons for forest ownership to determine if the hypothesized mean was found to be statistically different from the average rating of 3. Principal component factor analyses were completed over these same categories to determine potential groupings of similar variables. A principle component analysis utilizes orthogonal, or uncorrelated transformations, to group similar variables together. These grouped variables assist in explaining an overall common theme amongst themselves. This results in fewer variables to be defined and explained than before the principle component factor analysis is conducted (Bartholomew et al 2008).

A Varimax orthogonal rotation was conducted on the factor component to reveal a redistribution of variances between groupings. Varimax rotation is the most common type of rotation option. It utilized orthogonal rotation analysis to overall rotate the axes of the variable in order to determine where the greatest variation combination lies within the possible factors for that specific variable (Hair et al. 2010).
A kmeans cluster analysis was conducted for categories, specifying four clusters and a Euclidean similarity measure. The $k$-means cluster analysis grouped NIPFLs based on mean responses for bioenergy views and you and your woodland variables (Hair et al. 2010). $K$-means cluster analysis is a form of cluster analysis that groups variables into a selected cluster based on the variables mean. Those variables whose mean is closest to a specific cluster are categorized within that cluster. This continues until all variables are designated in the pre-determined number of clusters desired (Hair et al. 2010).

General descriptive statistical tests were completed to gather all other information by utilizing the summary statistics function in STATA which provided a mean, minimum, maximum, number of observations, and standard deviation for each variable indicated. These findings were then compared to the NWOS for validation purposes. The Results section labels the results of our survey “MO NIPFL” to ease comparison.

4.3 Results

Deleting undeliverable addresses and landowners possessing less than 20 acres of woodlands yielded an adjusted response rate of 34 percent. Of the fourteen counties surveys were sent to, Laclede county recipients completed the highest percentage of surveys at an eight percent respondent. Pulaski, McDonald, Cole, Iron, and Oregon Counties all had over a seven percent of the total responses. All other counties besides Butler maintain between four to six percent response rates. Overall, 85 percent of the total response rates were explained by these fourteen main counties. Only 21 percent of NIPFL’s who responded indicated they possessed land in more than one county and of this percentage only six percent owned land in three or more. Landowners owning land
in more than one county as well as absentee landowners assisted in explaining the NIPFLs who responded from counties other than the chosen fourteen.

Approximately 85 percent of respondents owned between 10 to 500 acres of land total in both the NWOS and MO NIPFL surveys (Figure 2). Almost 45 percent indicated their total land holdings were between 100-500 acres in MO NIPFLs survey while only 38 percent possessed this amount of acreage in the NWOS survey. When respondents were questioned about possession of woodland acres, over 60 percent of NWOS indicated their holdings were between one and ten acres. MO NIPFL survey’s recipients could be grouped into three main categories which accounted for 80 percent of the total woodland acres surveyed; 26 percent being between 20-50 acres, 22 percent between 50-100 acres, and 32 percent between 100-500 acres.

![Figure 2 Percent of woodland acres owned by Missouri NIPFL’s.](image)

Figure 2 Percent of woodland acres owned by Missouri NIPFL’s.
4.3.1 Demographics

Over 70 percent of the survey respondents in the NWOS survey and almost 80 percent of the MO NIPFL survey were male. When asked their age, almost 95 percent of the respondents indicated they were 45 years or older in both surveys with almost 75 percent being 55 years or older. When analyzing MO NIPFLs’ education, 48 percent have received at least a two year college degree or some additional form of training past high school. Forty-one percent received an annual income of at least $50,000, 18 percent between $25,000 to $50,000, 9 percent less than $25,000, and 28 percent preferred not to answer this question in the MO NIPFL survey. These results differ from that of the NWOS survey in that MO NIPFL survey had more respondents prefer not to answer and less individuals within the $25,000-$50,000 annual income range. 85 percent of the MO NIPFL survey individuals indicated that no children under the age of 18 were residing within their household.

4.3.2 Past, Current, and Future Woodland Management

Landowners were then asked the number of years they owned their land, 15 percent responded less than ten years, 31 percent between 10 and 24 years, 41 percent between 25 and 50 years, and 11 percent over 50 years with the MO NIPFL survey. 54 percent of the respondents indicated that their primary household resided within their woodlands as well as that they had sold timber from their land since coming into possession of it (Figure 3).
When questioned on the probability of selling timber in the future 32 percent of MO NIPFLs indicated they would not harvest, 29 percent positively they would harvest, and 38 percent were unsure. On the alternative, MO NIPFL’s were then asked the percentage of woodlands that would never be cut for income generating purposes only 23 percent indicated that 60 percent or more of their woodlands would remain uncut and 33 percent indicated that 80 percent or more would remain uncut, however, 45 percent of the respondents indicated that they were unsure of the percentage of land that would remain uncut (Figure 4).
The greatest reason reported for owning woodlands in Missouri was “other.” Numerous individuals responded specifically that the land had been in the family for generations or they cherished having the right to own private property (Figure 5). The second most important reason to own land was for beauty. It received a 3.97, very important, on a 5-point Likert scale with privacy coming in third with a score of 3.80. Landowners who chose to own their land for hunting purposes and to enjoy nature next both received a moderately important score of 3.70. It should be noted that some of the lowest variables of importance to the NIPFL’s were forest cultivation (1.78); timber products (2.2); firewood and no management (2.50) and (2.66). All variables were found to be significant at the < 0.01alpha level.
Analysis of NIPFLs willingness to harvest timber from their woodlands resulted in 37 percent of the respondents indicating they were not willing to harvest regardless of the price they were offered (Figure 6). Approximately 4 percent indicated they would harvest at $100 per acre, 9 percent at $200 per acre, and 15 percent at $300 per acre. 22 percent of NIPFLs declared they would be willing to harvest their timber at a higher price per acre with over half of these respondents indicating $500 per acre would be the minimum price necessary to harvest.
Figure 6 Average lowest price NIPFLs are willing to consider being paid for a timber harvest.

The exploratory factor analysis conducted for “reasons for owning your woodlands” resulted in four overall factors. These groupings were chosen based on the variance distribution between possible factor groupings. The un-rotated factor component for reasons for owning land displayed four main groupings in which the first factor favored questions pertaining to the landowners view in possessing woodlands for protection. The second factor grouped those questions related to a landowners’ privacy, the third to production, and the final to leaving a legacy. Hunting and land investment were too evenly distributed between all four factors so were not found to be significant.

A Varimax orthogonal rotation was conducted on the factor components to reveal a redistribution of variances between groupings. Table 4 depicts the rotated factor loadings for the four factors, their total variance for each variable, and uniqueness. Factor groupings were based on those variables with a 0.40 or greater variance to determine significance due to the large sample set (Hair et al. 2010).
The initial factor “protection” grouped variables “own land for beauty or scenery”, “to protect nature”, “protect land from development”, to “leave unmanaged”, and “other” together. To “protect nature and biological diversity” possessed the highest significance at 0.73, to “enjoy beauty or scenery” 0.71, “protect land” 0.49, “leave unmanaged” 0.47, and “other” at 0.45. The factor “Privacy” grouped as “part of my home” with the highest significance at 0.72, as “part of my farm” at 0.62, and for “privacy” at 0.55. For the “production” factor, the “collection of non-timber products” was 0.53, for “firewood” was 0.64, and for “sawlog production” was 0.66. Finally, the factor “Legacy” rated to “pass land on to my heirs” at 0.58 and as “part of my inheritance” as 0.55 significances. Overall, the higher the factor variance for each specific variable the lower the overall uniqueness was found to be with by factor analysis.
Table 4 Varimax rotated factor matrix of the effects of clusters “reasons for owning land” viewpoints (n=495)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Protection</th>
<th>Privacy</th>
<th>Production</th>
<th>Legacy</th>
<th>Uniqueness</th>
<th>Eigenvalue</th>
</tr>
</thead>
<tbody>
<tr>
<td>To protect nature</td>
<td>0.73</td>
<td>0.14</td>
<td>0.07</td>
<td>0.10</td>
<td>0.43</td>
<td>1.34</td>
</tr>
<tr>
<td>To enjoy beauty</td>
<td>0.71</td>
<td>0.27</td>
<td>-0.01</td>
<td>0.02</td>
<td>0.41</td>
<td>3.32</td>
</tr>
<tr>
<td>To protect land from development</td>
<td>0.49</td>
<td>0.15</td>
<td>0.10</td>
<td>0.36</td>
<td>0.59</td>
<td>-0.21</td>
</tr>
<tr>
<td>To leave unmanaged</td>
<td>0.47</td>
<td>-0.07</td>
<td>-0.14</td>
<td>0.33</td>
<td>0.64</td>
<td>-0.25</td>
</tr>
<tr>
<td>As part of my home</td>
<td>0.23</td>
<td>0.72</td>
<td>0.05</td>
<td>0.02</td>
<td>0.42</td>
<td>0.46</td>
</tr>
<tr>
<td>As part of my farm</td>
<td>0.05</td>
<td>0.62</td>
<td>0.18</td>
<td>0.17</td>
<td>0.55</td>
<td>0.17</td>
</tr>
<tr>
<td>For privacy</td>
<td>0.39</td>
<td>0.55</td>
<td>0.08</td>
<td>0.14</td>
<td>0.52</td>
<td>0.14</td>
</tr>
<tr>
<td>For sawlog production</td>
<td>-0.17</td>
<td>0.08</td>
<td>0.66</td>
<td>0.07</td>
<td>0.52</td>
<td>-0.16</td>
</tr>
<tr>
<td>For firewood or bio-fuel production</td>
<td>0.14</td>
<td>0.09</td>
<td>0.64</td>
<td>0.13</td>
<td>0.55</td>
<td>-0.06</td>
</tr>
<tr>
<td>For collection of non-timber products</td>
<td>0.26</td>
<td>0.12</td>
<td>0.53</td>
<td>0.19</td>
<td>0.60</td>
<td>-0.02</td>
</tr>
<tr>
<td>To pass land to my heirs</td>
<td>0.12</td>
<td>0.24</td>
<td>0.18</td>
<td>0.58</td>
<td>0.56</td>
<td>0.05</td>
</tr>
<tr>
<td>As part of my inheritance</td>
<td>0.15</td>
<td>0.04</td>
<td>0.23</td>
<td>0.55</td>
<td>0.62</td>
<td>-0.27</td>
</tr>
<tr>
<td>For hunting</td>
<td>0.17</td>
<td>0.18</td>
<td>0.22</td>
<td>0.27</td>
<td>0.82</td>
<td>-0.19</td>
</tr>
<tr>
<td>For land investment</td>
<td>-0.02</td>
<td>0.21</td>
<td>0.33</td>
<td>0.11</td>
<td>0.83</td>
<td>0.80</td>
</tr>
</tbody>
</table>

% Variance 1.91 1.49 1.45 1.08

Extraction method: principal component analysis; rotation method: Varimax

4.3.3 Public Program Participation

Table 5 provides a percentage for NIPFL’s participating in conservation programs. Within the MO NIPFL survey, landowners were questioned on whether they were currently enrolled in the Missouri Department of Conservation’s State Forest
Cropland Program. Approximately 95 percent indicated they were not enrolled in the program (Table 5). They were then asked if they possessed a professionally written forest management plan where 92 percent responded they did not have a written plan.

Next, they were asked if they were enrolled in the American Tree Farm Program or any cost share programs for management activities to which respondents declared 95 percent and 92 percent no. When those landowners who had sold timber were asked if the sale was administered by a forester, 91 percent said no. Finally, 97 percent of the participants responded no to the inquiry if their woodlands were under a conservation easement prohibit future development.

<table>
<thead>
<tr>
<th></th>
<th>Forest Cropland Program</th>
<th>Forest Management Plan</th>
<th>American Farm Program</th>
<th>Cost Share Programs</th>
<th>Timber Sale Since Owned</th>
<th>Conservation Easement</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>95%</td>
<td>92%</td>
<td>95%</td>
<td>92%</td>
<td>91%</td>
<td>97%</td>
</tr>
<tr>
<td>Yes</td>
<td>2%</td>
<td>6%</td>
<td>2%</td>
<td>5%</td>
<td>5%</td>
<td>1%</td>
</tr>
<tr>
<td>No Answer</td>
<td>3%</td>
<td>3%</td>
<td>4%</td>
<td>3%</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Missouri’s NIPFL’s were then asked if they had ever conducted a timber stand improvement (TSI) upon their property and if not would they be interested in paying for one. Ninety-seven percent indicated they had never conducted a TSI on their land. Of that percentage 50 percent were not interested in paying and 44 percent were undecided. When asked which type of public incentive they would rather receive; 25 percent stated they would prefer neither an incentive payment nor a tax reduction, 38 percent were
unsure, 28 percent preferred the incentive payment, and only 9 percent preferred the tax reduction.

4.3.4 Utilizing Woody Biomass as a Renewable Energy Resource

When NIPFL’s rated their level of agreement to the questions pertaining to bioenergy, analysis determined that most landowners held the highest agreement to the statement, “waste wood from forest harvests should be used for energy/fuel generation.” See Figure 7. These ratings reached a 3.90 “agree” on the five point Likert scale explained by Dillman. The second highest statement, “harvesting woody biomass for energy/fuel is likely to benefit local economies” received an average score of 3.56. The next three statements; “I support harvesting woody biomass for energy” “Forest health is likely to be improved by harvesting woody biomass” and “Woody biomass is a viable alternative to fossil energy” were all rated around the 3.40 scale. The only variable that resulted negatively was the statement, “harvesting woody biomass is likely to result in water pollution.”
In regard to harvesting woody biomass, 33 percent of NIPFLs indicated they would not harvest their biomass regardless of price (See Figure 8). This percentage is 4 percent less than those individuals who responded similarly to harvesting timber. If offered $25 per acre to harvest the woody biomass from their property, only 4 percent responded positively. 10 percent indicated they would be willing to harvest biomass at $50 per acre, a one percent increase from timber when considering the average price parameter. Results observed a three percent increase in NIPFLs willingness to harvest biomass, given the highest price parameter, at 18 percent for $75 per acre. Finally, 20 percent of the respondents indicated they would be willing to harvest at a higher price.
The exploratory factor analysis conducted on “bioenergy views” resulted in two total factors. These numbers were chosen based on the variance distribution between possible factor groupings. The un-rotated factor component for bioenergy views displayed two main groupings, in which the first factor favored questions pertaining to the landowners view in how bioenergy can support the economy. The second factor grouped those questions related to how a woody biomass harvest would affect the environment. Forest health improvement was found to be included in both factors. Note these questions are the same as those seen in Figure 7.

A Varimax orthogonal rotation was conducted on the factor components to reveal a redistribution of variances between groupings. Table 6 depicts the rotated factor loadings for two factors, their total variance for each variable, and uniqueness. Factor groupings were based on those variables with a 0.40 or greater variance to determine significance due to the large sample set (Hair et al, 2010). Variables found within the “bioenergy support” factor; “viable fossil fuel alternative”, “enhance national security”,...
“wastewood used for energy”, “benefit local economies”, “overall biomass support”, and “forest health improvement” were all found to be significant at a 0.66 or higher level. For the “environmental effects” variables; “woody biomass does not instigate soil erosion” was found to be significant at a 0.79 (very significant), “woody biomass harvest does not result in water pollution” was found significant at 0.75, both “woody biomass harvests not being harmful to forests” nor “woody biomass harvests do not degrade wildlife habitat” were significant around 0.65. “Improve forest health” was significant at 0.50 for “bioenergy support” and 0.45 for “environmental effects”.

4.3.5 Missouri’s NIPFL Types

The k-means Cluster Analysis of both Bioenergy Views and Reasons for Owning Land resulted in four-group clusters. These were labeled “Woodland Retreat Landowners” (27 percent “Apathetic Landowners” (19 percent) “Forest Enthusiasts” (30 percent), and “Woodland Preservationists” (24 percent). In general, “Woodland Retreat Landowners” believed protection and privacy to be of greater importance than any other factor. At the average, these NIPFLs tended to agree with bioenergy support but neither agree nor disagree with environmental effects. For “Apathetic Landowners”, protection and legacy were moderately important while all else was found to be only slightly important. “Forest Enthusiasts” found everything but production to be very important. Production was still found to be moderately important and they neither agreed nor disagreed with the environmental effects. Finally “Woodland Preservationists” were found to believe privacy and protection were very important but production were slightly
important and they neither agreed nor disagreed with environmental effect and bioenergy support

“Woodland Retreat Landowners” was found to be statistically significant from
“Woodland Preservationists”, in every bioenergy characteristic view. “Woodland Retreat Landowner’s” were found to be statistically significant from “Forest Enthusiasts”, with all but four variables but when analyzing “Apathetic Landowners”, only half of the variable components in bioenergy views were statistically significant. Overall “Woodland Retreat Landowners” clustered 27 percent landowner responses to create this group making it the second largest cluster.

“Apathetic Landowners” were found to be statistically significant in only five variable components from “Forest Enthusiasts” but in all but one against the “Woodland Preservationists” with the bioenergy views. “Apathetic Landowners” were the smallest in the cluster groupings with only 19 percent individuals. Similar to the comparison between the “Apathetic Landowners” and “Woodland Preservationists”, the “Forest Enthusiasts” and “Woodland Preservationists” were also found to be statistically significant in all bioenergy views except harvesting woody biomass will not create competition for raw materials (Table 7).

When comparing the reasons for owning woodlands with both ANOVA and paired t-tests results indicated “Woodland Retreat Landowners” were statistically significant from “Apathetic Landowners” in all but four variables components, from forest enthusiasts in all but one, and woodland preservationists in all but three variables (Table 8). “Apathetic Landowner’s” were statistically significant from forest enthusiasts in every aspect of reasons for owning woodlands, and all but three variables components
with woodland preservationist. Four variables were found to not be significant when comparing forest enthusiasts with woodland preservationist in the reasons for owning woodlands.

The comparison of the four woodland owner types with the factor components revealed that “Woodland Retreat Landowners” and “Apathetic Landowners” considered protection moderately important while “Forest Enthusiasts” and “Woodland Preservationists” found this factor very important (Table 8). In regards to privacy every owner type but “Apathetic Landowners” found privacy to be very important, who found it only slightly important. Production was only slightly important to all but the “Forest Enthusiasts” who determined it to be moderately important on average. Leaving a legacy was slightly important to “Woodland Retreat Landowners”, moderately important to both “Apathetic Landowners” and “Woodland Preservationists”, and very important to the “Forest Enthusiasts”. All owner types agreed with the bioenergy support statements except “Woodland Preservationists” who neither agreed nor disagreed (Table 9). Environmental effects found all four clusters to be neither agree nor disagree with its statement variables.
Table 6 Varimax rotated factor matrix of the effects of clusters bioenergy viewpoints (n=520)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Bioenergy</th>
<th>Environmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woody biomass is a viable alternative to fossil energy (e.g. coal/oil/gasoline/diesel).</td>
<td>0.76</td>
<td>0.14</td>
</tr>
<tr>
<td>National security can be enhanced by using woody biomass for energy rather than fossil fuels.</td>
<td>0.76</td>
<td>0.11</td>
</tr>
<tr>
<td>I support harvesting woody biomass for energy.</td>
<td>0.73</td>
<td>0.35</td>
</tr>
<tr>
<td>Waste wood from forest harvests should be used for energy/fuel generation.</td>
<td>0.67</td>
<td>0.14</td>
</tr>
<tr>
<td>Harvesting woody biomass for energy/fuel is likely to benefit local economies.</td>
<td>0.66</td>
<td>0.20</td>
</tr>
<tr>
<td>Forest health is likely to be improved by harvesting woody biomass.</td>
<td>0.50</td>
<td>0.45</td>
</tr>
<tr>
<td>Harvesting woody biomass is not likely to result in soil erosion.</td>
<td>0.16</td>
<td>0.79</td>
</tr>
<tr>
<td>Harvesting woody biomass is not likely to result in water pollution.</td>
<td>0.15</td>
<td>0.75</td>
</tr>
<tr>
<td>Commercial harvesting woody biomass is not likely to be harmful to forests.</td>
<td>0.25</td>
<td>0.66</td>
</tr>
<tr>
<td>Harvesting woody biomass is not likely to degrade wildlife habitat.</td>
<td>0.25</td>
<td>0.64</td>
</tr>
<tr>
<td>Harvesting woody biomass will not create competition for raw materials used in other wood product industries (lumber, composites, etc.)</td>
<td>-0.11</td>
<td>0.27</td>
</tr>
</tbody>
</table>

% Variance | 3.00 | 2.54 |

*Extraction method: principal component analysis; rotation method: Varimax
Table 7 Mean comparison of NIPFL cluster types and their views on Bioenergy Characteristics.
(423 Total Observations)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Viable Fossil Fuel Alternative**</td>
<td>3.62 (B,C,D), 0.82</td>
<td>3.35 (A,C,D), 0.95</td>
<td>3.83 (A,B,D), 0.78</td>
<td>2.64 (A,B,C), 1.02</td>
</tr>
<tr>
<td>Enhance National Security**</td>
<td>3.42 (C,D), 0.83</td>
<td>3.18 (C,D), 0.96</td>
<td>3.74 (A,B,D), 0.87</td>
<td>2.36 (A,B,C), 1.01</td>
</tr>
<tr>
<td>Waste wood used for Energy**</td>
<td>4.18 (B,D), 0.66</td>
<td>3.82 (A,C,D), 0.85</td>
<td>4.28 (B,D), 0.64</td>
<td>3.35 (A,B,C), 1.11</td>
</tr>
<tr>
<td>Not Harmful to Forests**</td>
<td>3.39 (B,C,D), 0.77</td>
<td>3.11 (A,D), 0.89</td>
<td>3.14 (A,D), 0.97</td>
<td>2.18 (A,B,C), 0.87</td>
</tr>
<tr>
<td>Benefit Local Economies**</td>
<td>3.82 (C,D), 0.72</td>
<td>3.63 (C,D), 0.71</td>
<td>4.04 (A,B,D), 0.57</td>
<td>2.96 (A,B,C), 0.91</td>
</tr>
<tr>
<td>Improve Forest Health**</td>
<td>3.68 (D), 0.75</td>
<td>3.54 (D), 0.80</td>
<td>3.75 (D), 0.77</td>
<td>2.69 (A,B,C), 0.97</td>
</tr>
<tr>
<td>Will not Degrade Wildlife Habitat**</td>
<td>3.32 (B,C,D), 0.87</td>
<td>2.95 (A,D), 0.84</td>
<td>3.08 (A,D), 0.96</td>
<td>2.1 (A,B,C), 0.81</td>
</tr>
<tr>
<td>Not Instigate Soil Erosion**</td>
<td>3.31 (C,D), 0.74</td>
<td>3.13 (D), 0.87</td>
<td>3.02 (A,D), 0.91</td>
<td>2.05 (A,B,C), 0.82</td>
</tr>
<tr>
<td>Not Result in Water Pollution**</td>
<td>3.64 (B,C,D), 0.64</td>
<td>3.32 (A,D), 0.86</td>
<td>3.22 (A,D), 0.95</td>
<td>2.45 (A,B,C), 0.90</td>
</tr>
<tr>
<td>Not Create Competition</td>
<td>2.86 (D), 0.88</td>
<td>2.70 (A,D), 0.83</td>
<td>2.69 (A,D), 0.90</td>
<td>2.57 (A), 0.89</td>
</tr>
<tr>
<td>Overall Biomass Support**</td>
<td>3.79 (B,D), 0.75</td>
<td>3.56 (A,C,D), 0.83</td>
<td>3.95 (B,D), 0.69</td>
<td>2.43 (A,B,C), 0.90</td>
</tr>
</tbody>
</table>

**Indicates that at least one segment mean is different from the others at p<0.05; Parentheses identify consumer segments with significantly different means; M = mean; S.D. = Standard Deviation; n = number of respondents within cluster.
Table 8 Mean comparison of NIPFL cluster types and their reasons for owning woodlands.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n = 114$ (27%)</td>
<td>$n = 82$ (19%)</td>
<td>$n = 127$ (30%)</td>
<td>$n = 100$ (24%)</td>
</tr>
<tr>
<td>To enjoy beauty or scenery**</td>
<td>M 3.65 (B,C,D) S.D. 0.92</td>
<td>M 3.24 (A,C,D) S.D. 0.96</td>
<td>M 4.32 (A,B) S.D. 0.73</td>
<td>M 4.32 (A,B) S.D. 0.76</td>
</tr>
<tr>
<td>To protect nature**</td>
<td>M 3.29 (C,D) S.D. 0.92</td>
<td>M 3.02 (C,D) S.D. 1.09</td>
<td>M 4.18 (A,B) S.D. 0.81</td>
<td>M 4.11 (A,B) S.D. 0.82</td>
</tr>
<tr>
<td>For land investment</td>
<td>M 3.41 (B,D) S.D. 0.99</td>
<td>M 2.89 (A,C) S.D. 1.14</td>
<td>M 3.66 (B,D) S.D. 1.12</td>
<td>M 2.91 (A,C) S.D. 1.31</td>
</tr>
<tr>
<td>As part of my home**</td>
<td>M 3.82 (B,C) S.D. 0.94</td>
<td>M 1.77 (A,C,D) S.D. 0.99</td>
<td>M 4.07 (A,B) S.D. 1.04</td>
<td>M 3.83 (B) S.D. 1.16</td>
</tr>
<tr>
<td>As part of my farm**</td>
<td>M 3.75 (B,C) S.D. 1.07</td>
<td>M 1.77 (A,C,D) S.D. 1.00</td>
<td>M 4.056 (A,B,D) S.D. 1.12</td>
<td>M 3.42 (B,C) S.D. 1.35</td>
</tr>
<tr>
<td>For privacy**</td>
<td>M 3.86 (B,C,D) S.D. 0.84</td>
<td>M 2.32 (A,C,D) S.D. 1.17</td>
<td>M 4.41 (A,B) S.D. 0.72</td>
<td>M 4.35 (A,B) S.D. 0.88</td>
</tr>
<tr>
<td>To pass land on to my heirs**</td>
<td>M 2.75 (C,D) S.D. 1.28</td>
<td>M 2.76 (C,D) S.D. 1.35</td>
<td>M 4.35 (A,B,D) S.D. 0.77</td>
<td>M 3.43 (A,B,C) S.D. 1.30</td>
</tr>
<tr>
<td>For collection of non-timber forest products**</td>
<td>M 1.64 (B,C) S.D. 0.87</td>
<td>M 1.24 (A,C,D) S.D. 0.60</td>
<td>M 2.36 (A,B,D) S.D. 1.21</td>
<td>M 1.53 (B,C) S.D. 0.87</td>
</tr>
<tr>
<td>For production of firewood or bio-fuel**</td>
<td>M 2.37 (B,C,D) S.D. 1.09</td>
<td>M 1.89 (A,C) S.D. 1.01</td>
<td>M 3.27 (A,B,D) S.D. 1.14</td>
<td>M 2.06 (A,C) S.D. 1.06</td>
</tr>
<tr>
<td>For production of timber products**</td>
<td>M 2.39 (B,C,D) S.D. 1.23</td>
<td>M 1.85 (A,C) S.D. 1.06</td>
<td>M 2.80 (A,B,D) S.D. 1.30</td>
<td>M 1.57 (A,C) S.D. 0.97</td>
</tr>
<tr>
<td>For hunting or fishing**</td>
<td>M 3.44 (B,C,D) S.D. 1.28</td>
<td>M 3.00 (A,C,D) S.D. 1.48</td>
<td>M 4.35 (A,B,D) S.D. 0.91</td>
<td>M 3.94 (A,B,C) S.D. 1.22</td>
</tr>
<tr>
<td>To protect land from development**</td>
<td>M 2.82 (C,D) S.D. 1.23</td>
<td>M 2.55 (C,D) S.D. 1.32</td>
<td>M 4.23 (A,B,D) S.D. 0.87</td>
<td>M 3.91 (A,B,C) S.D. 1.29</td>
</tr>
<tr>
<td>To leave land unmanaged**</td>
<td>M 1.75 (B,C,D) S.D. 0.90</td>
<td>M 2.20 (A,C,D) S.D. 1.02</td>
<td>M 2.80 (A,B,D) S.D. 1.27</td>
<td>M 3.27 (A,B,C) S.D. 1.24</td>
</tr>
<tr>
<td>As part of my inheritance**</td>
<td>M 1.95 (B,C,D) S.D. 1.19</td>
<td>M 2.35 (A,C) S.D. 1.30</td>
<td>M 3.64 (A,B,D) S.D. 1.15</td>
<td>M 2.41 (A,C) S.D. 1.42</td>
</tr>
<tr>
<td>Other</td>
<td>M 3.79 (C) S.D. 1.42</td>
<td>M 3.50 (C,D) S.D. 1.79</td>
<td>M 4.73 (A,B,D) S.D. 0.46</td>
<td>M 4.06 (B,C) S.D. 1.34</td>
</tr>
</tbody>
</table>

**indicates that at least one segments mean is different from the others at $p<0.05$; Parentheses identify consumer segments with significantly different means; M = mean; S.D. = Standard Deviation; $n$ = number of respondents.
Table 9 Comparison of overall means for MO NIPFLs types grouped by factor analysis.

<table>
<thead>
<tr>
<th></th>
<th>Woodland Retreat Landowners</th>
<th>Apathetic Landowners</th>
<th>Forest Enthusiasts</th>
<th>Woodland Preservationists</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reasons Own Land</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection</td>
<td>3.06</td>
<td>2.90</td>
<td>4.05</td>
<td>3.93</td>
</tr>
<tr>
<td>Privacy</td>
<td>3.81</td>
<td>1.95</td>
<td>4.18</td>
<td>3.87</td>
</tr>
<tr>
<td>Production</td>
<td>2.45</td>
<td>1.97</td>
<td>3.02</td>
<td>2.02</td>
</tr>
<tr>
<td>Legacy</td>
<td>2.35</td>
<td>2.56</td>
<td>4.00</td>
<td>2.92</td>
</tr>
<tr>
<td><strong>Total Average</strong></td>
<td>2.92</td>
<td>2.34</td>
<td>3.81</td>
<td>3.18</td>
</tr>
<tr>
<td><strong>Bioenergy Views</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bioenergy Support</td>
<td>3.766</td>
<td>3.508</td>
<td>3.968</td>
<td>2.748</td>
</tr>
<tr>
<td>Environmental Effects</td>
<td>3.304</td>
<td>3.042</td>
<td>3.03</td>
<td>2.504</td>
</tr>
<tr>
<td><strong>Total Average</strong></td>
<td>3.535</td>
<td>3.275</td>
<td>3.499</td>
<td>2.626</td>
</tr>
<tr>
<td><strong>Overall Total Average</strong></td>
<td>3.23</td>
<td>2.81</td>
<td>3.66</td>
<td>2.91</td>
</tr>
</tbody>
</table>

*hunt not included

4.5 Discussion

Survey respondents were found to be within the older age classes, with over half (54 percent) of the landowners coming from the Baby Boomer Generation (born 1942 to 1964). These landowners are well educated with college degrees and are able to sufficiently provide for their families with their annual occupational income. Associated to the age of the landowner’s, children under the age of 18 are no longer in the household, allowing money to be spent elsewhere. Over one half of Missouri’s NIPFL’s surveyed own between 50-500 acres of woodlands. These data indicate parcel size should not be a major inhibiting factor for the potential to harvest biomass upon NIPFL land.
These landowners have possessed their land for a long period of time, typically reside within their woodlands, and have harvested the timber in past years. When surveyed, almost 30 percent of the respondents indicated they were willing to harvest in the future while 38 percent indicated they were unsure of potential future harvests. When questioned to the percentage of land to remain un-harvested while the woodlands were in their ownership, 45 percent indicated there were unsure. This information indicates potential for future timber and biomass harvests on NIPFL land.

When asked as to the motives for woodland ownership, one of the highest responses indicated was that the land had been in the family for generations. Missouri NIPFL’s intend to continue the tradition of bequeathing their land to their offspring and do not wish to see it destroyed. These woodland owners do not maintain possession of the woodlands for timber harvests or for timber management but rather because they enjoy being in nature and viewing its beauty. They relish their privacy and their ability to hunt wildlife in the area rather than generating income from the woodlands forest products. If prices for timber increased to an amount a majority of landowners were believed was sufficiently high enough, an increase in willingness to harvest timber would likely occur. Almost 40 percent of the NIPFLs indicated if timber prices ranged between $300/$500 per acre they would be more interested in harvesting timber.

Over 90 percent of the survey respondents were not enrolled in any government programs. When asked which public incentive a landowner would most prefer, 25 percent indicated neither and 38 percent were unsure. This information assists in supporting the statement to which claims southern Missouri citizens do not wish to have government assistance provided to them. While this declaration does not hold true for all
individuals, a significant number of landowners are of this mentality. Providing more public incentives to harvest woody biomass may not be as effective of a strategy as previously believed nor is it an efficient use of public monies.

The NIPFL’s do believe that waste wood should be utilized, but they are unsure if it they want it to come from their land or not. In general, when dealing with bioenergy concerns the landowners are neither in agreement nor disagreement with statements made pertaining to woody biomass’s effects on the environment and its potential as a renewable resource. Perhaps with more information and education pertaining to woody biomass and bioenergy NIPFL’s would become more interested and involved. In the same regard almost 40 percent of NIPFLs indicated if biomass prices were at $75 per acre or higher they would harvest their woody biomass.

Creation of four main landowner profiles were created below based upon six important factors found within the survey: owning woodlands for privacy, protection of the woodlands, production of woodland products, owning woodlands to leave a legacy, overall bioenergy support, and environmental effects.

**Woodland Retreat Landowners**

On average, privacy was considered to be very important to these NIPFL’s. Protection of aesthetics and ensuring minimal amounts of management were conducted in the woodlands was found to be moderately important for these landowners. Owning land to continue a legacy or for production of both timber and non-timber products was only slightly important for these individuals. Overall the landowner found reasons for owning his land to be of moderate importance to him/herself. NIPFL’s within this cluster
typically were in agreement and support for bioenergy, however neither agreed nor disagreed with the environmental effects statements. On average, landowners were in overall agreement with the bioenergy viewpoints.

**Apathetic Landowners**

For landowners within this category both protection of aesthetics and leaving a legacy were found to be of moderate importance. Personal privacy and forest production were found to be only slightly important. Overall reasons for possessing woodlands were of slight importance to the landowner. The bioenergy viewpoints found landowners to be in agreement with bioenergy support, but neither agreed nor disagreed with the environmental effects section. Overall bioenergy views were found to be neither positive nor negative.

**Forest Enthusiasts**

NIPFL’s found all categories except forest production to be very important when analyzing reasons for owning woodlands. Production was still found to be of moderate importance which left the overall average for land ownership reasons to be very important. Just as previously found in the clusters “Forest Enthusiasts” were in agreement and gave bioenergy support, neither agreed nor disagreed with the environmental effects statements, and would also overall neither agree nor disagree to the bioenergy views.
Woodland Preservationists

Landowners within this category found protection of nature and privacy to be very important to the reason why they possess their woodlands with production only being slightly important and leaving a legacy moderately important. Overall these landowner’s found the reasons given to own land of moderate importance to them. When analyzing both bioenergy support and environmental effects, neither agree nor disagree was found to be the average response.

4.6 Conclusion

Similar to Kurtz’s findings in the 1980’s, Missouri NIPFLs are still generally found to be within the older age classes however these individuals now tend to be highly educated and are able to generate a modest income to sufficiently provide for their families. These landowners have been in possession of their woodlands for a considerable amount of time and a majority has harvested timber from their woodlands in the past. Unlike the NWOS survey results, over half of Missouri’s NIPFLs own between 50-500 acres of woodlands indicating inability to harvest due to parcel size is not restricting loggers and landowners from harvesting their woodlands. In general, NIPFLs are not opposed to future harvests however the price must be relatively high otherwise these landowners’ willingness-to-harvest may be hampered. Rather, externality factors such as leaving a legacy, aesthetics, privacy, and protection are greater concerns for these landowners.
Over 90 percent of the survey respondents were not enrolled in any government programs. This figure may reflect on a general attitude among Missouri NIPFLs who do not wish to have government assistance or a formal relation with a government agency that may limit their ability to harvest their land. Providing more public incentives to harvest woody biomass may not be as effective of a strategy as previously believed nor is it an efficient use of public monies.

In general, when dealing with bioenergy concerns the landowners are overall in support for bioenergy. They do not believe the proclaimed environmental effects are a relevant issue to be concerned. If stumpage prices would increase to an average of $300 to $500 per acre and woody biomass prices were $75 per acre or higher, two fifths of NIPFLs would be willing to harvest timber as well as woody biomass. The overriding issue would then become the lack of NIPFLs with forest management plans. The state issued guidelines will require landowners interested in harvesting woody biomass to have a professionally written management plan to protect Missouri’s forests from degradation. With only six percent of Missouri’s NIPFLs in current possession of a forest management plan this could prove to be a major deterrent.

“Woodland Retreat Landowners”, “Apathetic Landowner”, and “Woodland Preservationist Landowners” willingness to harvest their land was depicted as probably accept while “Forest Enthusiasts” were shown to be likely to accept during cluster and factor analysis comparisons. It should be noted however only the “Forest Enthusiast” believed production was moderately important to reasons for owning land while the other landowner types saw this trait as only slightly important. Protection of the land is significantly important to all four landowner types, and privacy is very important to all
but the “Apathetic Landowners” who viewed this trait as only slightly important. The variable concerning landowner’s interest in hunting on their land was removed from the analysis because it was equally important throughout all components during the factor analysis.

Kurtz (1981) categorized Missouri’s NIPFLs in 1981; the “Timber Agriculturist”, the “Timber Conservationist”, “Forest Environmentalist”, and the “Range Pragmatist”. Based on the results of the MO NIPFL survey the “Forest Enthusiast” is best related to the “Timber Agriculturist” in Kurtz’ study. These individuals are most willing to harvest timber and most likely to be involved in forest production activities. The “Woodland Retreat Landowner” is best compared to the “Timber Conservationist” in the fact that they are not opposed to harvesting however there aesthetics and privacy are a primary concern. The “Woodland Preservationist” is found to be most similar to the “Forest Environmentalist” in the sense that they are willing to harvest only if it is found to be beneficial to their woodlands and the environment.

Finally, the “Apathetic Landowner” is compared to the “Range Pragmatist” in the sense that neither has strong feelings for their woodlands or its proper management. Today’s landowners however, are even less concerned with timber than they were thirty years ago. Instead aesthetics and environmental concerns are prevalent in the landowners. A majority of the current woodland owners are in agreement that utilizing woody biomass would be beneficial to the economy however they are unsure as to its environmental effects caused by harvesting. At this point, Missouri NIPFL’s need to be offered public education opportunities concerning renewable energy, rather than public incentives to best encourage participation in woody biomass utilization.
5. Conjoint Analysis of Missouri Non-industrial Private Forest Landowners’

Willingness-to-Harvest Woody Biomass Removals

5.1 Introduction

Previous research has presented a general understanding for who non-industrial private forest landowners (NIPFLs) are and where their interests lie with regards to forest management in Missouri (Kurtz and Lewis 1981; Butler et al. 2007). Butler et al. (2007) found that demographical factors such as age, education, and income play a significant role in the likelihood of a landowner harvesting their woodlands. The older and/or higher paid forest woodland owners tend to be less inclined to harvest than those individuals who are younger or with lower incomes. It was determined that if the landowners were advanced in age they became more focused on bequeathing their property to their children and less concerned about the income that could potentially be generated from their property (Butler et al 2007). Amacher et al. (2003) determined that higher levels of education among respondents were associated with an increased willingness-to-harvest (WTH) timber. It has also been noted that if a NIPFL was considered to be “working class” he/she tended to be less averse to harvesting and more likely to manage for income generating purposes (Joshi & Arano 2009).

Almost 70 percent of Missouri’s NIPFLs are citizens 55 years of age or older with less than 42 percent of these owners having reported having harvest experience (Kurtz and Lewis 1981; Smith et al. 2007). An estimated 66 percent of NIPFLs indicated their land did not possess a written forest management plan (Kurtz 2004). Butler and Leatherberry (2004) also determined that nine out of every ten of NIPFLs in Missouri
controlled 1-49 acres of forestland and only 9 percent thought that timber was an important investment.

By analyzing attitudes towards their land Butler et al. (2007) classified U.S. NIPFLs into four main groups: woodland retreat landowners, working the land owners, supplemental income landowners, and ready to sell forest landowners. *Woodland retreat owners*, approximately 40 percent of U.S.’s NIPFLs, are classified as landowners who possess the forests for privacy, recreation, and aesthetic value (Butler et al. 2007). The next two largest categories, *working landowners* and *supplemental income*, are generally found to be already engaged in one or more management activity and so it is relatively easy to include them in forest stewardship (Butler et al. 2007; Joshi & Arano 2009).

Similarly, Kurtz and Lewis (1981) identified four main landowner types in Missouri on the basis of the NIPFLs attitudes towards their land. These landowners were described as the timber conservationist, timber agriculturist, forest environmentalist, and the range pragmatist. Comparable to the *working the land owners* as defined by Butler et al. (2007), the *timber agriculturist* managed their forests as an important source of revenue. The *timber conservationist*, like the *supplemental income owner*, managed for sustainable timber production and possessed an overall long-term stewardship mentality. Like the *woodland retreat owner*, the *forest environmentalist* aspired for proper timber management however disliked the aesthetics of logging. The *range pragmatist* was also similar to the *ready to sell landowner*, in that both NIPFLs types were willing to sell or convert their woodland if it seemed economically feasible. A majority of Missouri’s NIPFLs tended to be categorized as either a *timber conservationist* or forest
environmentalists due to their preference of the recreational aspects of woodland ownership.

While there have been numerous studies on landowner attitudes towards timber harvesting there have been few studies on WTH woody biomass (Joshi and Mehmood 2011; Gruchy et al. 2011; Becker et al. 2010). Those studies that have been piloted found that currently collection methods for woody biomass harvests must be conducted in the form of an integrated harvest, harvesting commercial timber and biomass simultaneously, because the cost associated with harvesting for woody biomass singularly is not presently economically feasible (Ashton 2007; Hall 1997; Saunders et al. 2010). Commercial timber can be defined as “standing timber that can be sold at a profit for wood products and is available for harvest.” (Klemperer 2003). According to the United States Department of Agriculture (2008) woody biomass is defined as “the trees and woody plants, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment, that are the by-products of forest managements”.

Woody biomass harvests could potentially play an important role in Missouri where 83 percent of the states forestlands are privately owned (Moser et al. 2006). Small and undesirable trees would be removed from the forest ecosystem creating healthier and more merchantable trees (Bartuska 2010). Missouri’s socioeconomic status could potentially improve with the creation of additional work and jobs for citizens, along with the state becoming more energy efficient (Daniel et al. unpublished). At the national level, the utilization of woody biomass could potentially reduce the need for fossil fuel dependence (Bartuska 2010). It is therefore essential to determine the social availability
of woody biomass from Missouri’s NIPFLs so the potential role Missouri can play in renewable energy generation from this resource can be realized.

5.1.2 Objectives

This study aimed to calculate Missouri’s NIPFLs WTH their woodlands. Specific objectives included: (1) determining the average minimum acceptance price for harvesting timber, (2) analyzing the average minimum acceptance price for biomass using an integrated timber and biomass harvests, (3) discern those factors with the greatest influence in a NIPFLs’ decision to harvest, and (4) evaluate the impact of market prices in support for bioenergy feedstock removals to the landowners to determine WTH payment values.

Econometric models were utilized to answer our queries by providing an approximation of NIPFL’s WTH payments for their timber and woody biomass feedstock. These models determined how site conditions (landowner currently possesses a management plan, plot size, species composition) as well as profiles (residence status, age, gender) affected the landowners minimum price they were willing to accept for harvest.

5.1.3 Theoretical Framework

The study analyzed variables that influence a landowner’s WTH timber and woody biomass from their woodlands. Factors were determined from a review of past literature. Kurtz and Lewis (1981) suggested that Missouri Ozarks NIPFL’s decisions to participate in forest management were correlated with their motivations, objectives, and
constraints for a parcel of woodland. It was assumed NIPFL’s intents were to produce a profit upon their woodland; however maximizing monetary return is not necessarily a primary concern. Rather a landowner is better satisfied with maximizing overall utility not just financial returns (Amacher et al. 2003).

In order to determine maximum utility for Missouri’s NIPFLs in relation to harvesting woody biomass, specific factors were required for comparison. Past studies indicated that demographics, landowner perceptions on bio-energy, ownership characteristics, management characteristics, and reasons for land ownership all limit a NIPFL’s ability for maximum utility and management. Demographics were defined as age, education, income, sex, and households with children under the age of 18 within the residence [demographics] (Amacher et al. 2003; Butler and Leatherberry 2004; Joshi and Arano 2009; Young and Reichenbach 1987).

Landowner perceptions on bio-energy inquired upon the landowner’s view of the impacts of harvesting woody biomass [bioenergy]. Land characteristics included parcel size, wooded parcel size, year acquired, primary residence, amount of volume sawtimber that was on the land, and the amount of woody biomass upon the land [ownership] (Romm et al. 1987; Bliss and Martin, 1989; Joshi and Arano 2009; Erickson et al. 2002) Ownership characteristics pertained to having sold timber since owned, potential for future harvests, percentage of land that will never be cut, programs involved in, and professional advice received [management] (D’Amato et al. 2010; Greene and Blatner 1986; Joshi and Arano 2009). Finally reasons for owning land were described as; to enjoy beauty, protect nature, land investment, as part of my home, privacy, for hunting
Maximum utility is then perceived as:

\[ U_i = f \{D_iB_iO_iM_iR_i\} \]

where \( U_i \) is the resulting utility gained by the \( i \)th NIPFL from harvesting his/her woodlands. \( U \) is a function of a set of characteristics that affect the NIPFLs’ interest in harvesting which include: \( D \) (demographics), \( B \) (landowner perceptions on bio-energy), \( O \) (ownership characteristics), \( M \) (management characteristics), and \( R \) (reasons for owning land). In order to calculate \( U \), I must be determined. I is then best described as a NIPFLs’ WTH and can be expressed as seen below:

\[
WTH = B_0 + B_1 \text{Price} + B_2 \text{Demographics} + B_3 \text{Bioenergy} + B_4 \text{Land} + B_5 \text{Ownership} + B_6 \text{Reasons} + e
\]

a stochastic model with random deterministic variables and a random error term.

The dependent variable WTH is measured with an ordinal scale with a 1 to 5 rating where 1 equals “I would definitely not accept this offer”, 2 “I would probably not accept this offer”, 3 “I would probably accept this offer”, 4 “I would very likely accept this offer” and 5 “I would definitely accept this offer.” This scale was utilized for questions related to price parameters, bioenergy, and reasons for owning land to allow the respondent the option of rating their level of agreement with the statement. The ordinal scale made it possible to capture individuals varying degrees of agreement with a statement allowing for a more realistic determination of WTH. Those variables for which
an ordinal scale was not used included; demographics, ownership, and land management. These variables were recorded using either a binary scale where 0 equaled “no” and 1 indicated “yes” or a categorical scale where answers were grouped together (Table 10).

Actual utility is not explained in the previous model, however they can be estimated from the deterministic variables above using a latent variable model. Since this research utilized an ordinal WTH model with 1-5 ratings to describe different harvesting likelihoods, an ordered response model assumed the following where WTH is the ith NIPFL’s rating for a specific harvest option. \( \mu_s \) represent cutting points between the multiple levels of preference (Aguilar 2009). The ordinal probit regression generated “cut points” from the ordinal rating to explain the range between ratings a NIPFL has available to them. These cut points also assist in determining the cumulative probability of a NIPFL’s acceptance in a harvest as seen in Figure 9.

\[
\begin{align*}
\text{WTH} = 1 & \text{ if } U_i \leq \mu_1; \\
\text{WTH} = 2 & \text{ if } \mu_1 < U_i \leq \mu_2; \\
\text{WTH} = 3 & \text{ if } \mu_2 < U_i \leq \mu_3; \\
\text{WTH} = 4 & \text{ if } \mu_3 \leq U_i
\end{align*}
\]
Figure 9 Cumulative probability model with threshold cuts for the ordinal probit model.
<table>
<thead>
<tr>
<th>Category</th>
<th>Variables</th>
<th>Scale</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographics</strong></td>
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<tr>
<td></td>
<td>Age</td>
<td>Categorical (1-7)</td>
<td>Amacher et al., 2003;</td>
</tr>
<tr>
<td></td>
<td>Education</td>
<td>Categorical (1-7)</td>
<td>Butler and Leatherberry 2004;</td>
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<tr>
<td></td>
<td>Income</td>
<td>Categorical (1-8)</td>
<td>Joshi and Arano, 2009;</td>
</tr>
<tr>
<td></td>
<td>Sex</td>
<td>Categorical (1-2)</td>
<td>Young and Reichenbach, 1987</td>
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<tr>
<td></td>
<td>Children under 18</td>
<td>Continuous</td>
<td></td>
</tr>
<tr>
<td><strong>Bioenergy Views</strong></td>
<td>Landowner views of the impacts of harvesting</td>
<td>Rating (1-5)</td>
<td>Grunchy et al., 2011; Galik et al., 2009; Joshi and Mehmood, 2011</td>
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<tr>
<td></td>
<td>woody biomass</td>
<td></td>
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<tr>
<td><strong>Land Characteristics</strong></td>
<td>Parcel size</td>
<td>Categorical (1-7)</td>
<td>Romm et al., 1987; Bliss and Martin, 1989; Joshi and Arano, 2009; Erickson et al., 2002</td>
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<tr>
<td></td>
<td>Wooded parcel size</td>
<td>Categorical (1-7)</td>
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<tr>
<td></td>
<td>Year acquired</td>
<td>Categorical (1-8)</td>
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<td></td>
<td>Primary residence</td>
<td>Binary (0-1)</td>
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<td></td>
<td>Sawtimber volume</td>
<td>Continuous</td>
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<td></td>
<td>Biomass volume</td>
<td>Continuous</td>
<td></td>
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<tr>
<td><strong>Ownership Characteristics</strong></td>
<td>Having sold timber since owned</td>
<td>Binary (0-1)</td>
<td>Joshi and Arano, 2009; D’Amato et al. 2010; Greene and Blatner, 1986</td>
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<tr>
<td></td>
<td>Potential future harvests</td>
<td>Binary (0-1)</td>
<td></td>
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<td></td>
<td>Public programs involved in</td>
<td>Binary (0-1)</td>
<td></td>
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<td></td>
<td>Professional advice received</td>
<td>Binary (0-1)</td>
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<tr>
<td><strong>Reasons for Owning Land</strong></td>
<td>Landowner reasons of owning woodlands</td>
<td>Rating (1-5)</td>
<td>Butler et al. 2007; Marty et al, 1988; Broderick et al, 1994; Finley and Kittredge, 2006</td>
</tr>
</tbody>
</table>
5.2 Methods

The returned surveys were inputted into Microsoft Excel. Ordinary and binary codes were developed to capture NIPFL survey answers in analysis. For example, if the recipient answered “yes” a “1” was recording in the proper cell whereas if they answered “no” a “0” was recorded instead. Once the data was recorded they were uploaded into STATA 10.0 to be analyzed. Data was then filtered to include only NIPFL’s who possessed ≥20 woodland acres on their property by creating a sample variable within Stata. If fewer than 20 acres are harvested, majority rule dictates there will be no economic return for the logger or the landowner. Therefore, a 20 acres minimum baseline was established for this study.

Descriptive statistical tests were completed to gather reference information concerning NIPFLs age, education, amount of woodland acres possessed, past harvests, enrollment in public programs, views concerning bioenergy, and reasons for owning their woodlands. To analyze landowner’s priorities for owning forests an ordinal probability regression analysis was conducted. Ordinal scales are used to capture preferences and potential demands individuals may have concerning specific topics, in this case NIPFLs’ WTH (Getzner and Grabner-Krauter 2004; Beggs et al. 1981). The regressions used the sample created above to limit the regression to those individuals with 20 acres of woodlands or more. The regression was also clustered using the respid variable so that landowner responses to all questions were grouped together. Rating was used as the dependent variable.

There were two models created in the analysis. The initial model, Model 1, regressed price for timber, woody biomass, and public incentives against the dependent variable (WTH rating). This created a baseline for Model 2 which included socio-
economic and physical descriptions mentioned above in Table 12. Goodness-of-fit measures were also determined in both models using a Chi² test.

A comparison of the marginal effects between cuts one through four were conducted on WTH in Model 1 using a non-linear equation in Stata equal to:

\[
\text{nlcom}(( \text{norm}(_b[/cut2]-( _b[\text{timberp}]*300+_b[\text{biomas}]*75+_b[\text{incentive}]*0)) - \text{norm}(_b[/cut1]-( _b[\text{timberp}]*300+_b[\text{biomas}]*75+_b[\text{incentive}]*0))))
\]

Each cut was compared against all other cuts for each independent variable to determine statistical significance and the marginal probability of each variable between cuts. Each independent variable; timber price and biomass price were analyzed based on all price parameters included within the survey (Table 1). It should be noted marginal effects for public incentives were not included since there is minimal current funding for woody biomass public incentives and future prospects are not promising. The comparison between cuts assisted in determining those prices NIPFLs were more probable of accepting in a given ordinal rating.

The marginal probability comparison of timber prices and biomass prices were also analyzed within each cut to assist in determining NIPFLs maximum likelihood in harvesting based upon price parameters given. When conducting between and within cut’s for marginal analysis both independent variables were tested by analyzing a specific price within one variable against all prices within the other variable. This resulted in an understanding for the price NIPFLs were more willing to accept within a specific ordinal rating. For example, harvesting timber at $200 per acre was compared against all three price options offered for woody biomass harvests. Once the analysis was completed
significance and marginal probability was analyzed resulting in which harvesting price options NIPFLs were more likely to accept.

5.3 Results

5.3.1 Descriptive Statistics

The survey had an adjusted response rate of 34 percent after filtering for those landowners who possessed 20 or more forested acres and those surveys which were undeliverable. About 80 percent of survey respondents indicated they were male. When asked their age, almost 95 percent of the respondents indicated they were 45 years or older with almost 75 percent being 55 years or older. 48 percent of Missouri’s NIPFLs have received at least a two year college degree or some additional form of training past high school. In terms of income, 41 percent indicated they generate a minimum of $50,000 per year, 18 percent between $25,000 to $50,000, 9 percent $25,000 or less, and 28 percent preferred not to answer. 85 percent of the respondents indicated that no children under the age of 18 resided within their household.

Approximately 85 percent of Missouri’s NIPFL’s responded to owning between 10 to 500 acres of land total with almost 45 percent indicating their total land holdings were between 100-500 acres. Recipients could be filtered into three main categories which accounted for 80 percent of the total woodland acres surveyed; 26 percent being between 20-50 acres, 22 percent between 50-100 acres, and 32 percent between 100-500 acres. Table 11 includes summary information for explanatory variables of NIPFL’s WTH rating included in the ordinal probability regression models 1 and 2. Sawtimber
volume and biomass volume were both measured in short tons with sawtimber volume being divisible by 100,000 and biomass volume divided by 1000 for the regression.

<table>
<thead>
<tr>
<th>Table 11 Descriptive Statistics for variables analyzed in ordinal probability regression models.</th>
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<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>WTH Rating</td>
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<tr>
<td><strong>Independent variable</strong></td>
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<tr>
<td>Timber Price</td>
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<tr>
<td>Biomass Price</td>
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<td>Incentive Price</td>
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<tr>
<td>Tax Incentive</td>
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<td><strong>Demographics</strong></td>
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<td>Education</td>
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<td><strong>Land Characteristics</strong></td>
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<td>Years Owned</td>
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<td>Woodland Acres</td>
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<tr>
<td>Sawtimber Volume*</td>
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<tr>
<td>Biomass Volume*</td>
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<tr>
<td>Primary Residence</td>
</tr>
<tr>
<td><strong>Ownership Characteristics</strong></td>
</tr>
<tr>
<td>Ever Harvested</td>
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<tr>
<td>Prefer Not to Harvest</td>
</tr>
<tr>
<td>Will Harvest in Future</td>
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<tr>
<td>Professional Management Plan</td>
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<tr>
<td><strong>Reasons for Owning Land</strong></td>
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<tr>
<td>Part of my Farm</td>
</tr>
<tr>
<td><strong>Bioenergy Views</strong></td>
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<tr>
<td>Support Biomass</td>
</tr>
</tbody>
</table>

* Sawtimber Volume (expressed in short tons 1 short ton = 1,000 pounds) expressed in 100,000 pound units.
* Biomass Volume (expressed in short tons 1 short ton = 1,000 pounds) expressed in 1,000 pound units.
5.3.2 Conjoint Analysis

Results of Models 1 and 2 are presented in Table 12. Model 1 used a total of 1,233 responses. Log-likelihood was -1,588.3 with a Wald $\chi^2$ of 92.83, and a probability $> \chi^2$ of <0.001. This initial model shows a direct relationship between the prices for timber, woody biomass, and public incentives and NIPFLs WTH rating. Higher prices for all three of these explanatory variables would result in a higher WTH rating as expected (i.e. NIPFL exhibited greater willingness-to-harvest woodlands as prices increase). This is depicted in the statistical significance and positive relationship of all three variables. It should be noted that timber price showed the greatest level of statistical significance of the three price variables in both Models 1 and 2.

Model 2 used 1,043 observations and yielded a Wald $\chi^2$ of 135.09 with an associated probability $> \chi^2$ of <0.001 and a log-likelihood of -1241.07. Similar to Model 1, timber and biomass were found to be statistically significant at the 0.05 Type-I error level. Both of these variables had a positive relationship with WTH rating, indicating higher prices in timber and biomass increase overall WTH rating. While public incentives showed a positive relationship with WTH, it was not found to be statistically significant indicating public incentive prices may not influence WTH rating for NIPFLs when other explanatory variables are controlled. Tax incentive was found to be statistically significant at the 0.10 Type-I error level with a positive relationship.
Table 12 Results of ordered probit regression on WTH ratings for Missouri NIPFLs.

| Variable                  | Coef. | Std. error | P>|z|   | Coef. | Std. error | P>|z| |
|---------------------------|-------|------------|------|-------|------------|------|
| Timber Price              | 0.003 | <0.001     | <0.001| 0.003 | 0.000      | <0.001|
| Biomass Price             | 0.003 | 0.001      | 0.009| 0.003 | 0.001      | 0.017 |
| Incentive Price           | 0.002 | 0.001      | 0.066| 0.002 | 0.001      | 0.156 |
| Tax Incentive             | 0.089 | 0.052      | 0.091|       |            |      |
| **Demographics**          |       |            |      |       |            |      |
| Age                       | -0.153| 0.060      | 0.012|       |            |      |
| Education                 | 0.120 | 0.036      | 0.001|       |            |      |
| **Land Characteristics**  |       |            |      |       |            |      |
| Sawtimber Volume          | 0.000 | 0.000      | 0.114|       |            |      |
| Biomass Volume            | 0.000 | 0.000      | 0.005|       |            |      |
| Years Owned               | 0.196 | 0.076      | 0.010|       |            |      |
| Woodland Acres            | -0.100| 0.055      | 0.070|       |            |      |
| **Ownership Characteristics** |     |            |      |       |            |      |
| Primary Residence         | -0.218| 0.119      | 0.066|       |            |      |
| Ever Harvested            | 0.114 | 0.126      | 0.364|       |            |      |
| Prefer Not to Harvest     | -0.241| 0.062      | <0.001|      |            |      |
| Will Harvest in Future    | 0.373 | 0.157      | 0.017|       |            |      |
| Professional Management   | -0.263| 0.201      | 0.192|       |            |      |
| **Reasons for Owning Land** |     |            |      |       |            |      |
| Part of My Farm           | -0.124| 0.045      | 0.005|       |            |      |
| **Bioenergy Views**       |       |            |      |       |            |      |
| Support Biomass           | 0.110 | 0.069      | 0.113|       |            |      |

When analyzing demographics, age was statistically significant at the 0.05 Type-I error level with a negative relationship indicating the older NIPFLs are the less likely they are WTH. Education also had a positive effect on WTH at the 0.05 level indicating the higher educated NIPFLs were more willing to harvest than those with a lower
education level. Land characteristics resulted with the number of years a landowner has owned their woodlands was found to be statistically significant at the 0.05 Type-I error level with a positive relationship. This indicated the longer a NIPFL has been in possession of their woodlands the more willing they will be to harvest which counters results found with age. It was observed that the amount of available sawtimber and biomass volume (measured in short tons) found within the NIPFL’s county had a positive relationship of NIPFL’s WTH. It should be noted however biomass volume was found to be statistically significant at the 0.05 Type-I error level rather than sawtimber volumes which was not significant.

Ownership characteristics found NIPFLs preference to not harvest timber or woody biomass from their land was found to be statistically significant at the <0.001 Type-I error level with a negative relationship. The stronger NIPFLs feel against harvesting their woodlands also decreases their WTH. NIPFLs whose primary residence was within their woodlands were found to be less likely to harvest than those whose residence was elsewhere. This relationship was significant at the 0.10 type-I error level. As expected, NIPFLs who responded to be willing to harvest in the future also showed a positive relationship to WTH rating at a 0.05 significance level.

Within the reasons for owning land category, respondents who indicated their woodlands were part of their farm had an inverse correlation with WTH ratings as indicated by the negative sign of the corresponding coefficient. This was significant at a 0.05 Type-I error level. Finally, for NIPFLs who support woody biomass harvesting a positive effect on WTH rating however this relationship was not statistically significant.
Marginal probability analyses of woody biomass prices were analyzed in conjunction with timber prices by comparing timber prices against a variety of biomass prices. At $25 per acre for woody biomass cut 1/2 depicted a marginal probability of 35 percent for $100 per acre, 33 percent at $200 per acre, and 29 percent at $300 per acre (Figure 10). Cut 2/3 resulted in 23 percent at $100 per acre, 26 percent at $200 per acre, and 31 percent at $300 per acre. Cut 3/4 observed an increase in probability of seven percent for $100 per acre, 10 percent for $200 per acre, and 14 percent for $300 per acre. These results indicated NIPFLs are still most likely to shift cuts between cut 1 “definitely not accepting” and cut 2 “probably not accepting” although the difference between probabilities in cut 1/2 and cut 2/3 are minimal. Overall, given the woody biomass payment amount WTH is unlikely at the given timber prices.

![Figure 10 Marginal effect comparison between timber price when biomass price is $25 per acre.](image)

At $50 per acre for woody biomass cut 1/2 depicted a probability of 35 percent for $100 per acre, 32 percent at $200 per acre, and 27 percent at $300 per acre (see Figure 11). Cut 2/3 resulted in 24 percent at $100 per acre, 29 percent at $200 per acre, and 31
percent at $300 per acre. Cut 3/4 observed an increase in probability of seven percent for $100 per acre, 11 percent for $200 per acre, and 15 percent for $300 per acre. Results indicated there is minimal difference between cut 1/2 and cut 2/3, thus NIPFLs may be WTH if given an additional $50 per acre to harvest their woody biomass. It should be noted however overlap between cut 1/2 and cut 2/3 is only within $200 and $300 per acre so the landowner would not be willing to receive less than $200 per acre for their timber in conjunction with the $50 per acre for their woody biomass payment.

![Figure 11 Marginal effect comparison between timber price when biomass price is $50 per acre.](image)

*Indicates marginal probabilities statistically significant from 0 at p-value <0.1

At $75 per acre for woody biomass cut 1/2 depicted a probability of 34 percent for $100 per acre, 31 percent at $200 per acre, and 26 percent at $300 per acre (Figure 12). Cut 2/3 resulted in 26 percent at $100 per acre, 29 percent at $200 per acre, and 31 percent at $300 per acre. Cut 3/4 observed an increase in probability of 9 percent for $100 per acre, 12 percent for $200 per acre, and 15 percent for $300 per acre. Results indicated there is minimal difference between cut 1/2 and cut 2/3, thus it maybe probable
NIPFLs are WTH if given $75 per acre to harvest their woody biomass. At $75 per acre for woody biomass NIPFLs are found to be interested in increasing their probability of shifting to the next WTH rating even if timber prices are at $100 per acre. It should be noted however this statement only holds true between cut 1 to cut 2 and cut 2 to cut 3.

Figure 12 Marginal effect comparison between timber price when biomass price is $75 per acre.
*Indicates marginal probabilities statistically significant from 0 at $p$-value $<0.1$

A comparison of the marginal effect of timber harvest prices when biomass price was constant at $25 per acre resulted in all price comparisons being statistically significant within cuts 1 “I would definitely not accept this offer” and 2 “I would probably not accept this offer”. The price comparison between receiving $300 per acre versus $200 per acre was also significant in cut 3 “I would probably accept this offer” however no other price comparisons were found to be significant within this cut or cut 4 “I would very likely accept this offer”. Figure 13 depicts the marginal probability was highest between $200 per acre and $100 per acre within cut 1, between $300 per acre and
$200 per acre within cut 2 and cut 3. This indicated NIPFL’s WTH ratings were more likely to be within the category “I would definitely not accept this offer” if offered $100 to $200 per acre for their timber. If offered between $300 and $200 per acre NIPFLs were found to have a greater likelihood of being categorized in the “I would probably not accept this offer” given biomass prices were $25 per acre.

Analyzing timber price comparisons when woody biomass prices are constant at $50 per acre depicted statistical significance throughout cut 1, cut 2, and with the price comparison between $300 per acre and $200 per acre for cut 3 (Figure 14). The marginal probability was highest for the price threshold option of $200 to $100 per acre for cut 1, $300 to $200 per acre for cut 2 and cut 3. This indicated the probable likelihood of NIPFLs WTH ratings being within “I would definitely not accept this offer” when presented with a price option between $200 and $100 per acre for their timber was high.
NIPFLs within the probably not accept this offer or probably would accept this offer were offered between $300 and $200 per acre for their timber.

![Figure 14 Marginal effect comparison within timber price’s when biomass price is $50 per acre.](image)

*Indicates marginal probabilities statistically significant from 0 at $p$-value <0.1

A comparison of timber prices within categories when biomass prices were $75 per acre resulted in both cuts 1 and 2 being statistically significant as well as the comparison between $300 and $200 per acre for cut 3 (Figure 15). Marginal probability for cut 1 observed a greater likelihood for NIPFLs if offered $200 to $100 per acre, cut 2 and cut 3 at $300 to $200 per acre. This indicated the probable likelihood of NIPFLs WTH ratings being within “I would definitely not accept this offer” when presented with a price option between $200 and $100 per acre for their timber was high. NIPFLs within the probably not accept this offer or probably would accept this offer were offered between $300 and $200 per acre for their timber.
Analyzing the effect of timber prices over a variety of biomass prices provides a more comprehensive understanding of the marginal effect of woody biomass prices on NIPFLs’ WTH. Figure 16 shows at $100 per acre for timber, biomass prices of $25 and $50 per acre had a 35 percent greater probability of shifting from cut 1 to cut 2 with $75 per acre having a 34 percent chance. From cut 2 to cut 3 resulted in $75 per acre for woody biomass having a 26 percent likelihood of shifting cuts, $50 per acre with a 24 percent, and $25 per acre with 23 percent likelihood. Cut 3/4 depicted a 8.6 percent probability of shifting cuts for $75 per acre woody biomass, 7.7 percent for $50 per acre, and 6.8 percent for $25 per acre. Cut 1/2 was statistically significant at the 0.001 level, cut 2/3 was significant at the 0.05 level, and cut 3/4 was significant for $75 per acre. No other biomass price was significant within cut 3/4. NIPFLs are more likely to select a low WTH rating when price for timber is $100 per acre levels rather the higher cuts at the
$100 per acre price for timber. Although cut 1/2 demonstrated a higher probability for the lower biomass prices this percentage was minute. Cuts 2/3 and cut 3/4 both observed $75 per acre with the greatest likelihood of advancing to the next cut level. This indicates given $100 per acre for timber is too low of a price for landowners to be interested in harvesting, even when offered up to $75 per acre for their woody biomass.

![Figure 16 Marginal effects observed between biomass prices per acre when timber price is $100 per acre.](image)

*Indicates marginal probabilities statistically significant from 0 at \( p \)-value <0.1

At $200 per acre for a set timber price, NIPFLs were 33 percent more likely to advance from cut 1 to cut 2 at $25 per acre, 32 percent at $50 per acre, and 31 percent at $75 per acre (Figure 17). Similar to cut 2 to cut 3 with $100 for timber per acre, at $200 per acre for timber and $75 per acre and $50 per acre for biomass NIPFLs probability of shifting cuts increased to 29 percent. For $25 per acre probability is 28 percent. The probability of shifting from cut 3 to cut 4 at $75 per acre for woody biomass is 12 percent, 11 percent at $50 per acre, 10 percent at $25 per acre. All coefficients were found to be statistically significant at the 0.001 level for every cut but cut 3/4 which was
significant at the 0.10 level. Results suggested the greatest probability of shifting landowners WTH rating between cuts was between cut 1 and cut 2 with the least likely of shifting being between cut 3 and cut 4, hence, it might be inferred that NIPFLs are not willing to harvest timber at $200 per acre even when offered up to $75 per acre for their woody biomass. It should be noted that marginal probability between cuts was significantly closer between cut 1/2 and cut 2/3 at $200 per acre than $100 per acre indicating NIPFLs were more likely to harvest at $200 per acre than $100 per acre.

![Figure 17 Marginal effects observed between biomass prices per acre when timber price is $200 per acre.](image)

*Indicates marginal probabilities statistically significant from 0 at $p$-value <0.1

With a $300 per acre for timber marginal effects observed a 26 percent increase in probability of advancing from cut 1 to cut 2 at $75 per acre, a 27 percent increase at $50 per acre, 29 percent increase in probability from $25 per acre. Figure 18 observed from cut 2 to cut 3, $75, $50, and $25 per acre for biomass observed a 31 percent increase in
likelihood to shift cuts. Cut 3/4 resulted with a 15 percent increase with both $75 and $50 per acre and a 13 percent increase with $25 per acre provided for woody biomass. Overall cut 1/2 was statistically significant at the 0.05 level, cut 2/3 at the 0.001 level, and cut 3/4 at the 0.05 level. Results indicated NIPFLs had the highest probability of shifting from cut 2 to cut 3 at $300 per acre. This signifies at $300 per acre landowners are willing to harvest their timber. Given the probabilities for biomass prices landowners are more WTH if given an additional sum for woody biomass, however only by one percent. Although NIPFLs are willing to shift from probably of “Definitely not accepting” the offer to probably of accepting, there is still not enough monetary incentive for landowners to shift to “Will definitely accept the offer”.

![Figure 18 Marginal effect comparison between biomass prices when timber is $300 per acre.](image)

*Indicates marginal probabilities statistically significant from 0 at p-value <0.1

A comparison of the marginal effect of biomass harvest prices when timber price was constant at $100 per acre resulted in all price comparisons being statistically significant within cuts 1 “I would definitely not accept this offer” and 2 “I would
probably not accept this offer” (Figure 19). No other price comparisons were found to be significant within cut 3 “I would probably accept this offer” or cut 4 “I would very likely accept this offer”. The marginal probability was the same between $75 per acre and $50 per acre and $50 per acre and $25 per acre within cut 1, and higher for between $75 per acre and $50 per acre within cut 2. This indicated the price for woody biomass did not have an effect on NIPFLs when timber prices were at $100 per acre within cut 1. For those NIPFLs who chose “probably not accept” for their WTH rating, having a biomass price between $50 per acre to $75 per acre increased the marginal probability within the cut. This signifies at $100 per acre for timber and $50 to $75 per acre for biomass a landowner will probably not accept the offer.

*Indicates marginal probabilities statistically significant from 0 at p-value <0.1

**Figure 19 Marginal effect comparison within biomass price’s when timber price is $100 per acre.**

*Indicates marginal probabilities statistically significant from 0 at p-value <0.1
Analyzing the effect of a $200 per acre price for timber against woody biomass prices within WTH ratings resulted in all of cuts 1 and 2 to be statistically significant (Figure 20). Within the category “would definitely not accept this offer” the biomass price comparison between $50 and $25 per acre were found to have the highest marginal probability, indicating if NIPFLs were found to be in this category they had been offered the above biomass prices. Within “I would probably not accept this offer” NIPFLs were more likely to have been offered between $75 and $50 per acre for their woody biomass. Overall this indicates given $200 per acre for their timber and between $50 and $75 per acre for their woody biomass, NIPFLs would probably not accept the offer.

Figure 20 Marginal effect comparison within biomass price’s when timber price is $200 per acre.

*Indicates marginal probabilities statistically significant from 0 at p-value <0.1

When comparing biomass prices given $300 per acre for timber all of cut 1 and cut 2 were found to be statistically significant with the comparison between $75 to $50 per acre being significant at cut 3. Figure 21 showed within cut 1 “definitely not accept”
the comparison between $50 and $25 per acre were found to have the highest marginal probability, cut 2 “probably not accept” and cut 3 “probably would accept” both found $75 to $50 per acre to have the highest likelihood of being within their categories. Given $300 per acre, if biomass prices are only between $25 to $50 per acre landowners will definitely not accept this offer. If however biomass prices are between $50 to $75 per acre at the same timber price NIPFLs fall between probably not accept and probably would accept this offer.

![Figure 21 Marginal effect comparison within biomass price’s when timber price is $300 per acre.](image)

*Indicates marginal probabilities statistically significant from 0 at p-value <0.1

**5.6 Discussion**

Descriptive statistics found a majority of the survey respondents to be males who are 55 years or older, almost half of them having received an education past high school, and just under half indicating they generate an income of >$50,000 per year. When questioned on the number of woodland acres they possess 26 percent indicated they
possess between 20-50 acres, 22 percent 50-100 acres, and 32 percent owned between 100-500 acres.

The initial ordinal probit regression model depicted a direct relationship between the prices for timber, woody biomass, and public incentives with NIPFLs WTH rating. NIPFLs exhibited greater willingness-to-harvest woodlands as prices increased. Model 2 resulted in a direct relationship between timber and biomass prices and NIPFLs WTH rating. Public incentives were not found to influence WTH rating when other explanatory variables were controlled however tax incentives were positively significant. The amount of available biomass volume found within the NIPFLs county tended to increase their WTH rating as did having an overall support for harvesting woody biomass. NIPFLs with higher education levels were found to be more willing to harvest than those with lower levels of education.

NIPFLs willing to conduct a commercial timber harvest from their property in the future also depicted a positive relationship with WTH rating. The longer a NIPFL was in possession of their woodland and the stronger NIPFLs felt against harvesting their woodlands the less willing they were to harvest. Individuals whose primary residence was within their woodlands were found to be less likely to harvest than those whose residence was elsewhere. NIPFLs who’s woodlands were connected to part of their farm were less likely to be WTH from their land. With regard to overall harvesting prices, statistical significance indicated timber prices were the driving force for increasing WTH ratings. Education and preference not to harvest woodlands also proved to be important factors in determining NIPFLs WTH preference.
Marginal effects comparisons of timber prices when biomass prices were held constant concluded that at $25 per acre for woody biomass overall NIPFLs are not interested in harvesting their woodlands. If offered $100 per acre for their timber there is a definite decline to harvest, if offered $200 NIPFLs fall between definitely not accepting the offer and probably not accepting the offer, and at $300 respondents generally responded that they would probably not accept given the offer. Comparison of timber prices when the biomass price was $50 per acre indicated overall that when offered a minimum of $100 per acre landowners were definitely not willing to harvest and at $200 per acre for their timber with the additional biomass prices NIPFLs were likely to probably not accept the offer. If offered $300 per acre, many NIPFLs would still probably not accept the offer but some would cross the threshold to probably accepting the offer. Given $75 per acre for woody biomass, NIPFLs were still definitely not willing to harvest if they only received $100 per acre for timber harvests. At $200 per acre, individuals were within the probably not accept this offer, and at $300 per acre NIPFLs shifted to probably accepting the offer.

The marginal probability of NIPFLs harvesting woody biomass given a set price for timber harvests resulted in similar findings to that of the marginal effects for timber harvesting. One hundred dollars per acre was found to be too low of a price for landowners to be interested in harvesting their woodlands, even at $75 per acre for woody biomass. At $200 per acre, if the NIPFL received $50 to $75 per acre for their woody biomass their likelihood of harvesting was “probably not accept”. While this still indicated a no harvest response it was an improvement from that of $100 per acre to harvest timber. Finally, at $300 per acre for timber if a landowner received $50 per acre
for biomass their response was “probably not accept.” However, if the biomass price was
$75 per acre in conjunction with the $300 per acre for timber WTH increased to
“probably accept”.

Although results indicated that increasing the dollar amount for timber and woody
biomass affected landowners by persuading them to be more likely to harvest, the highest
dollar amount for both prices failed to shift NIPFLs to make a strong harvest response.
Until market prices increase, being offered more money for both timber and woody
biomass, primarily timber, is unlikely to persuade NIPFLs to harvest unless timber
production is already an objective.

5.7 Conclusion

The prices for timber and woody biomass did indeed affect NIPFLs WTH, the
higher the dollar amount received the more likely they were to harvest. As expected,
findings suggest NIPFL’s WTH was highest when offered $300 per acre to harvest
timber and $75 per acre to harvest woody biomass. There appeared to be minimal
difference however, between a landowner who received $200 per acre for timber versus
$300 or $75 per acre versus $50 for woody biomass. Although NIPFLs WTH rating was
at its highest when offered the highest dollar amount to harvest, their overall WTH was
still only “probably accept this offer” which indicated that market prices need to increase
substantially before price truly affects a landowner’s willingness to harvest for timber or
woody biomass.

Public incentives did not significantly interest the landowner which indicates
there is little need for government monies to be vested towards woody biomass harvests
at this point regardless of what the incentive type is. Other factors to increase WTH were if NIPFLs were willingness to harvest in the future, amount of biomass volume within the county, the total number of years owned, and the more education an individual had received. Owning woodlands as part of the farm, on the primary residence, or the number of woodland acres owned, age, and preferring not to harvest resulted in a decrease in interest to harvest.

Overall, there is interest from Missouri’s NIPFLs to harvest their woodland for timber and woody biomass. Until market prices improve aesthetics and privacy objectives will likely prove to be stronger factors in determining a landowner’s willingness to harvest timber and woody biomass. Analysis of Missouri’s current woodland owner types suggests a large percent of individuals are not willing to harvest their woodland. However, for the majority of these NIPFLs if the price and benefits perceived are high enough the willingness to harvest is there.

6. Summary, Conclusions and Recommendations

6.1 Summary and Conclusions
Data suggests a majority of respondents were male and 65 years or older, well educated, and generate a sufficient income to provide for their families. About 45 percent of respondents own at least 100 acres in the state of Missouri indicating parcel size is not a pressing factor in terms of the economic feasibility of harvesting. Over half of Missouri’s NIPFLs have their primary residence located within their woodlands which assists in explaining externality factors such as leaving legacy, aesthetics, protection of woodlands, and environmental effects. Only 6 percent of respondents have adopted a professionally written management plan. This low percentage is observed throughout all
public programs offered to the NIPFLs which reflects a general attitude among NIPFLs within that region of the state towards government assistance.

NIPFLs likelihood in accepting a harvest on their property is correlated to prices received for their timber, woody biomass, and potential public incentives. If timber prices do not provide any financial motivation to also harvest biomass, the latter can be severely affected. In fact, timber prices may be the primary driver of biomass harvesting. The effects of a public incentive payment such as BCAP on biomass harvesting within the state would be minimal.

NIPFLs believe there is potential for wood biomass harvesting to generate energy, benefit local economics and overall express a general support to woody biomass harvesting. Price levels for biomass in the Southeastern Missouri area at the time of the study were at about $50 per acre for the removal of 15 tons of biomass. At this price level, about 17 percent of NIPFLs with 20 acres or more of woodlands will be willing to harvest their land for woody biomass. Even with a price support level that would raise revenues to $75, that would result in an increase of 22 percent in the number of NIPFLs interested in harvesting. Major constraints to the sustainable adoption of woody biomass harvesting remain: (a) low adoption of professionally written forest management plans, and (b) depressed timber prices.

The state of Missouri could benefit from the harvesting of overstock forestlands and the potential market for woody biomass could potentially provide the opportunity to generate additional stream of revenues for NIPFLs. Our main findings based on the survey of NIPFLs from 14 counties in Missouri include:
NIPFLs in general believe there is potential for wood biomass harvesting to provide several benefits to their lands. Although a considerable proportion of NIPFLs (32 percent) would not harvest biomass regardless of price, about five percent would harvest when price is $50 per acre with this number increasing to about 22 percent when price is $75.

Price levels for biomass in the Southeastern Missouri area at the time of the study were at about $50 per acre for the removal of 15 tons of biomass. At this price level, about 17 percent of NIPFLs with 20 acres or more of woodlands will be willing to harvest their land for woody biomass. Even with a price support level that would raise revenues to $75 would result in an increase in the number of NIPFLs interested in harvesting raising the total number to 39 percent of landowners.

Woodland retreat, apathetic, and woodland preservationist landowners willingness to harvest their land was depicted as “probably accept” and forest enthusiasts were shown to be “likely to accept” based on cluster and factor analysis comparisons. It should be noted however only the forest enthusiast believed production was moderately important to reasons for owning land while the others saw this trait as only slightly important. Protection of the land is significantly important to all four landowner types, and privacy is very important to all but the apathetic landowners who viewed this trait as only slightly important. The variable concerning landowner’s interest in hunting on their land was removed from the analysis because it was equally important throughout all components during the factor analysis. Given the fact that forest enthusiasts represent about a third of our sample, the land that might be available for biomass harvesting from privately-owned lands may be significantly limited.
Landowners likelihood in accepting a harvest on their property is correlated to prices received for their timber, woody biomass, and potential public incentives. As expected, the more money the landowner receives the more likely they are to allow a harvest to occur. With current market prices for both timber and biomass at low level, however, few landowners may have little interest in conducting a harvest. Timber prices are the main driving force in acceptance of harvesting due to the significantly higher dollar amount received for timber of woody biomass or a public incentive. Until timber prices increase it will prove difficult to establish a woody biomass market in Missouri. Without a dynamic woody biomass market the effect of a public incentive payment such as BCAP within the state would be minimal.

6.2 Recommendations

Continued research on this study would allow for a greater number and variety in responses potentially altering the results currently depicted. If the survey was re-conducted researchers could gauge a change in attitudes towards WTH both timber and woody biomass in the state over a period of time. Once NIPFLs become more responsive to the prices received for timber and woody biomass actions can be taking towards implementing these harvests. Also if there is perceived interest towards woody biomass a market could be created within the Missouri resulting in an increase in price and overall an increase in harvesting.

Modifications to this project include altering price per acre for both timber and woody biomass to the standard price per board foot. The original price per acre was included for unknowledgeable landowners however comments from the survey indicated NIPFLs are fully aware of price per board feet and prefer this terminology for
comprehension purposes. A potential modification to collecting NIPFL’s addresses includes gathering all data from the county GIS websites if available in the future. If the county assessors do not have available GIS information on NIPFLs purchasing a current platt book may prove more cost effective than a sunshine request as was done with this study. Finally, NIPFLs seemed more willing to speak about their woodlands in person than through a survey. Perhaps hosting more focus groups and allowing for landowners to voice their opinions verbally would prove more enlightening. These individuals could still be provided with questions to answer with regards to acceptance of harvest based on particular price parameters however they would also be able to explain their reasoning behind their answer afterward.
7. Literature Cited


Production Efforts to Ensure sustainability and Minimize Damage Described.” Mark Twain Forest Watchers. 1-9.


8. Appendix A: Additional Tables & Figures

Table 13 Survey mailing activities and corresponding timeline

<table>
<thead>
<tr>
<th>Survey Mailing Activity</th>
<th>Month/Year</th>
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<td>Initial Postcard</td>
<td>March 2011</td>
</tr>
<tr>
<td>Cover letter/Survey</td>
<td>April 2011</td>
</tr>
<tr>
<td>Thank you/Follow-up Postcard</td>
<td>April 2011</td>
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<td>Second Mailing of the Cover letter/Survey</td>
<td>May 2011</td>
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Please circle one number for each item.

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<th>Moderately Important</th>
<th>Very Important</th>
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<td>a) To enjoy beauty or scenery</td>
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<td>2</td>
<td>3</td>
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Figure 22 Example of an ordinal question asking NIPFLs to rate the importance of owning their woodland for beauty or scenery.

Figure 23 Landowner with a Professionally Written Management Plan.
Figure 24 Gender of Missouri NIPFLs.

Figure 25 Age of Missouri's NIPFLs.
Figure 26 Missouri’s NIPFLs Education Levels.

Figure 27 Missouri’s NIPFLs Annual Household Income.
Figure 28 Number of kids under the age of 18 within the household.

Figure 29 A comparison of the total number of acres owned between MO NIPFL and NWOS survey.
Figure 30 Comparison of woodland acres owned between MO NIPFLs and NWOS surveys.

Figure 31 Number of woodland acres owned by MO NIPFLs
Figure 32 Comparison between MO NIPFLs and NWOS for number of years woodlands had been owned.

Figure 33 When MO NIPFLs first acquired their woodland.
Figure 34 Comparison of if primary residence is on woodlands between MO NIPFLs and NWOS.

Figure 35 Have you ever harvested or removed timber from you land?
Figure 36 Intent of NIPFLs to harvest in the future.

Figure 37 The percent of land NIPFLs believe will never be cut.
Figure 38 Percent of NIPFLs with a professionally written management plan.

Figure 39 Percent of MO NIPFLs enrolled in a cost-share program.
Figure 40 Comparison of NIPFLs and NWOS respondents who had ever had a timber sell organized by a professional forester.

Figure 41 Comparison analyzing if an NIPFL is under a conservation easement.
Figure 42 Amount of money landowners paid for TSI.

Figure 43 Willingness of a NIPFL to pay for a timber stand improvement.
Figure 44 Percent of NIPFLs who prefer never to harvest their woodlands.

Figure 45 Percent of NIPFLs willing to harvest their timber.
Figure 46 Percent of NIPFLs willing to harvest their woody biomass.

Figure 47 Preference of NIPFLs in regards to public incentives.
Figure 48 Percent of landowners with intentions to pass their woodlands on in the future.

9. Survey (See Following Page)
Woodland Management, Bio-energy and Your Views

1. In what counties in Missouri do you own land? _______________________

2. How many total acres of land do you own in Missouri? _______________ acres

3. How much of the total acreage is woodlands? _______________________ acres
   (Excluding: Christmas tree farms, nurseries, or fruit/nut orchards?)

4. In what year did you personally acquire/purchase/inherit your first parcel of woodland in Missouri?______________

5. Is your woodland located on a separate, non-adjoining, parcel of land from your home (primary residence)?
   □ Yes   □ No   □ Some of it is

6. Have you sold timber from your land since you have owned it?
   □ Yes   □ No

7. Do you plan on selling timber from your land in the future?
   □ Yes   □ No   □ Do not know

8. As long as you own it, what percentage of your woodland do you think will never be cut for an income-
   generating purpose?(0 to 100%) ______________ %   □ Do not know

9. Which of the following applies to some or all of your woodland? (check one box for each line)

<table>
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<th>No</th>
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<tr>
<td>Has a professionally written forest management plan ......................</td>
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<tr>
<td>Is enrolled in the American Tree Farm Program..............................</td>
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<tr>
<td>Is enrolled in a cost share program for management activities (CRP).....</td>
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<tr>
<td>Has had a timber sale organized by a forester since you owned it........</td>
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</tr>
<tr>
<td>Is under a conservation easement prohibiting future development .......</td>
<td></td>
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</tr>
</tbody>
</table>

10. Have you ever paid someone to conduct a timber stand improvement on your property?
    □ Yes   ➔ a. IF Yes, how much did you pay? $_______________/acre

    □ No   ➔ b. IF No, would you be willing to pay for a timber stand improvement?
            □ Yes   □ No   □ I don’t know
Bio-Energy: In the following pages, we would like your opinion on woodland management and in particular, woody biomass.

Woody biomass is small-diameter trees (less than 7 inches) traditionally used for firewood as well as portions of trees, such as tree limbs, tree tops, needles, and leaves, unable to be used for other forest products (waste wood). Woody biomass can produce energy such as heat or electricity, or produce fuel substitutes for cars and trucks (ethanol or biodiesel). Commercial timber is sold by board feet; woody biomass is sold by the ton.

Please rate your level of agreement/disagreement with each of the following statements about using woody biomass to produce energy.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woody biomass is a viable alternative to fossil energy (e.g. coal/oil/gasoline/diesel)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>National security can be enhanced by using woody biomass for energy rather than fossil fuels</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Waste wood from forest harvests should be used for energy/fuel generation</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Commercial harvesting woody biomass is likely to be harmful to forests</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Harvesting woody biomass for energy/fuel is likely to benefit local economies</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Forest health is likely to be improved by harvesting woody biomass</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Harvesting woody biomass is likely to degrade wildlife habitat</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Harvesting woody biomass is likely to result in soil erosion</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Harvesting woody biomass is likely to result in water pollution</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Harvesting woody biomass can create competition for raw materials used in other wood product industries (lumber, composites, etc.)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I support harvesting woody biomass for energy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Management Information: Now we would like to introduce examples of timber and woody biomass harvesting options in Missouri woodland. Please read each description and answer accordingly.

An average acre of woodland in Missouri has a mixture of hardwood species. It has a total estimated 4,000 board feet (bf) of commercial timber and about 30 tons of biomass (tops, limbs, needles, etc.) per acre. Please see photo to your left as a reference.

Please rate your level of agreement/disagreement with the following statement:

I prefer not to have my woodlands harvested for timber or biomass

☐ Strongly Agree  ☐ Agree  ☐ Neither  ☐ Disagree  ☐ Strongly Disagree

A harvest of commercial timber only, would harvest on average 2,000 bf/acre and leave all woody biomass on the ground as shown in the photo.

Please select the option that best reflects your opinion:

What is the lowest price you would consider being paid to conduct a commercial timber harvest?

☐ $100/acre  ☐ $200/acre  ☐ $300/acre

☐ I would not harvest regardless of how much money I am offered

☐ I would harvest at a higher amount.

(Please specify: ____________)

A combined commercial timber and woody biomass harvest would remove 2,000 bf/acre & an average of 15 tons/acre of biomass.

Please select an option that best reflects your opinion:

If you have already been paid for the timber harvest (see above), what is the lowest additional price you need to consider a biomass removal?

☐ $25/acre  ☐ $50/acre  ☐ $75/acre

☐ I would not harvest woody biomass regardless of how much money I am offered

☐ I would harvest at a higher amount.
Public Incentives:
11. Imagine that you could receive either a tax reduction or an incentive payment when you conducted a woody biomass harvest. To qualify for either an incentive payment or a tax reduction, a landowner must have a forest management plan in place. A forest management plan is a document prepared by a professional forester to aid you, the landowner, in meeting your objectives for the property.

Which type of payment would you prefer?
☐ Incentive Payment ☐ Tax Reduction ☐ Don’t know ☐ Neither

Harvesting Your Woodlands:
Now you will be given six scenarios - answer each as though the previous one had not occurred. Scenarios describe harvest offers for timber and biomass. Some may also include the offer of a public incentive payment. No tax incentives are included in these scenarios.

12. Think about this scenario: You are approached with an offer from a professional logger to harvest your woodlands following Best Management Practices (BMPs).

The offer is:
- $100 per acre to harvest timber (saw logs).
- An additional $50 per acre to also remove 15 tons per acre of woody biomass from your property.
- An additional $25 per acre as a public incentive payment requiring you to have a forest management plan by the time of harvest.

Would you seriously consider this offer and harvest part or all of your property?
☐ I would definitely not accept this offer ☐ I would probably not accept this offer ☐ I would probably accept this offer ☐ I would very likely accept this offer ☐ I would definitely accept this offer

What percent of your woodlands would you harvest? ________% (0% if definitely not accept offer)

13a. Think about this scenario: You are approached from a professional logger to harvest sawlogs from your woodlands for $100 an acre following BMPs. Would you seriously consider this offer?
☐ Yes
☐ No---IF No please explain why________________________________________________________

13b. You are also offered an additional $25 per acre to harvest woody biomass from the same area. Would you still seriously consider this offer?
☐ Yes
☐ No---IF No please explain why________________________________________________________
Think about this scenario: You are approached with an offer from a professional logger to harvest your woodlands following BMPs.

The offer is:
- $200 per acre to harvest timber (sawlogs).
- An additional $50 per acre to also remove 15 tons of woody biomass from your property.
- An additional $50 per acre for a public incentive payment that requires you to have a professional forest management plan by the time of harvest.

Would you seriously consider this offer and harvest part or all of your property?

<table>
<thead>
<tr>
<th>I would definitely not accept this offer</th>
<th>I would probably not accept this offer</th>
<th>I would probably accept this offer</th>
<th>I would very likely accept this offer</th>
<th>I would definitely accept this offer</th>
</tr>
</thead>
</table>

What percent of your woodlands would you harvest? ______% (0% if definitely not accept offer)

---

15a. Think about this scenario: You are approached from a professional logger to harvest sawlogs from your woodlands for $200 an acre following BMPs. Would you seriously consider this offer?

☐ Yes
☐ No---IF No please explain why______________________________________________________________

15b. You are also offered an additional $75 per acre to harvest woody biomass from the same area you are harvesting timber. Would you still seriously consider this offer?

☐ Yes
☐ No---IF No please explain why______________________________________________________________

15c. Finally, you are offered a $25 per acre public incentive payment for selling your woody biomass to a certified plant. Would you seriously consider this offer?

☐ Yes
☐ No---IF No please explain why______________________________________________________________

16. Think about this scenario: You are approached with a single offer from a professional logger to harvest woody biomass from your woodlands following BMPs.

The offer is:
- $300 to harvest timber (sawlogs) on a per acre basis.
- An additional $50 per acre to also remove 15 tons of woody biomass from your property.

Would you seriously consider this offer and harvest part or all of your property?

<table>
<thead>
<tr>
<th>I would definitely not accept this offer</th>
<th>I would probably not accept this offer</th>
<th>I would probably accept this offer</th>
<th>I would very likely accept this offer</th>
<th>I would definitely accept this offer</th>
</tr>
</thead>
</table>

What percent of your woodlands would you harvest? ______% (0% if Definitely not accept offer)
17a. Think about this scenario: You are approached from a professional logger to harvest sawlogs from your woodlands for $300 an acre following BMPs. Would you seriously consider this offer?
☐ Yes
☐ No---IF No please explain why______________________________________________________________

17b. You are then offered an additional $50 per acre to harvest woody biomass from the same area you are harvesting timber. Would you still seriously consider this offer?
☐ Yes
☐ No---IF No please explain why______________________________________________________________

17c. Finally, you are offered a $50 per acre public incentive payment for selling your woody biomass to a certified plant. Would you seriously consider this now?
☐ Yes
☐ No---IF No please explain why______________________________________________________________

You and Your Woodlands:
18. Are you planning on passing on all or part of your woodland to your children or heirs? (check one)
☐ Yes  ☐ No  ☐ Maybe  ☐ I don’t know

19. People own woodlands for many reasons. How important are the following as reasons for why you own woodlands in Missouri? Please circle one number for each item.

<table>
<thead>
<tr>
<th>Reason</th>
<th>Not important</th>
<th>Slightly important</th>
<th>Moderately important</th>
<th>Very important</th>
<th>Extremely important</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) To enjoy beauty or scenery</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>b) To protect nature and biological diversity</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>c) For land investment</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>d) As a part of my home or vacation home</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>e) As a part of my farm or ranch</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>f) For privacy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>g) To pass land on to my children or other heirs</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>h) For cultivation or collection of non-timber forest products</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(maple syrup, berries)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) For production of firewood or biofuel (energy)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>j) For production of sawlogs, pulp-wood or other timber products</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>k) For hunting or fishing</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Demographics

Please remember your responses will be kept in strict confidentiality and will in no way be tied back to you personally. The final section simply further helps our understanding of potential social availability of woody biomass in Missouri.

20. How old are you?

☐ Under 25 years ☐ 25 to 34 years ☐ 35 to 44 years ☐ 45 to 54 years
☐ 55 to 64 years ☐ 65 to 74 years ☐ 75 years or over

21. What is your gender?

☐ Male ☐ Female

22. What is the highest level of education you have completed?

☐ Some high school or less ☐ High school or GED ☐ Some college or post-high school training
☐ 2-year college degree ☐ 4-year college degree ☐ Graduate or professional training beyond a 4-year college degree
☐ Other (Please specify): ____________________________

23. How many children under 18 live in your household? _________

24. What was your household annual income from all sources?

☐ Less than $15,000 ☐ $15,000 - $24,999 ☐ $25,000 - $34,999
☐ $35,000 - $49,999 ☐ $50,000 - $74,999 ☐ $75,000 – $99,999
☐ $100,000 or more ☐ Prefer not to answer

FINAL COMMENTS: Do you have any final questions or comments for us?

____________________________________________________________________________________

____________________________________________________________________________________

You are done! Please return this survey by placing it in the postage paid envelop and dropping it in the nearest mailbox. THANKS FOR YOUR TIME!