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Social availability of residual woody biomass from nonindustrial private woodland owners in Minnesota and Wisconsin

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ABSTRACT

An important and potentially underused source of biomass that could be utilized in energy production is from nonindustrial private woodlands. We employ the Theory of Planned Behavior to estimate the social availability of woody biomass as a function of landowner behavior intent, landowner characteristics, forest land characteristics, and biomass price on stated willingness to harvest biomass in conjunction with a commercial timber harvest. A mail survey was administered to 1109 nonindustrial private woodland owners in a 26-county region in northeast Minnesota and northwest Wisconsin during the fall of 2009. Using binary logistic regression, we found payment level offered to harvest biomass plays a significant role in landowners' decisions, but that non-monetary factors are also important. Landowner attitudes and opinions regarding soil impacts, aesthetics, and energy independence were important predictors of stated willingness to harvest. Social norms as manifested through the influence of neighbors were also significant. These findings expand existing research and are useful for profiling nonindustrial private woodland owners to identify sustainable sources of biomass to supply a burgeoning bioenergy sector in the Lake States.

1. Introduction

Nonindustrial private woodland owners own approximately 49% (372 million acres) of all forest land in the United States [1]. In Minnesota, they own 39% (6.5 million acres) of forest land [1] and contribute approximately 30% of harvested timber [2]. Previous studies identify important characteristics of nonindustrial private woodland owners such as that recreation, hunting and wildlife habitat are among the primary reasons for ownership, and that timber production is a lower priority [3]. Less is known about landowner preferences for harvesting woody biomass despite its increasing importance for energy production [4], wildfire fuels reduction [5], and carbon mitigation [6]. Biomass production is also increasingly important for economic development and forest products diversification [7]. Assuming a mix of ownerships across a procurement region, and the need for sustainable and consistent delivery of biomass feedstocks from within an economically feasible distance, nonindustrial woodland owners are an increasingly important resource. Because

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woodland owners control a large portion of the nation's forest resources, their forest management decisions are vital for the supply of biomass and growth of the burgeoning bioenergy industry.

The appeal of biomass utilization has generated considerable interest in recent years. Utilizing the residual biomass left after timber harvesting (tops and limbs) or small diameter trees removed in conjunction with hazardous fuels reduction activities, for instance, can increase revenue used to offset treatment costs [7]. Extensive research is emerging on the technical aspects including in-woods harvesting [8], conversion technologies [9], and product feasibility [10]. Much is also known about the physical availability of biomass [4,11]. Much less is known about social availability, which is that portion of total physically availability accessible in the marketplace after accounting for social factors influencing landowner propensity to harvest [12].

The purpose of this study is to investigate how nonindustrial private woodland owner attitudes and beliefs about their forest land affect their propensity to harvest biomass. We use information from a survey of woodland owners in Minnesota and Wisconsin to estimate their willingness to harvest biomass as an indicator of social availability. A recent analysis of the region's biomass resources serves as the basis for our inquiry, which identified more than one million dry tons of unutilized biomass in Minnesota that could be physically available on an annual basis [13]. That proportion that is socially available is likely much less and so being able to accurately predict landowner willingness to remove biomass is critical for projecting industry potential.

2. Landowner preferences for biomass harvesting

The literature describes nonindustrial private woodland owners as having varying attitudes, motivations, and management priorities [1,14]. Previous research, for instance, identifies landowner motivations and preferences for timber production [3,15,16] and recreation [17,18]. Much less is known about their motivations for biomass production. Some research exists on biomass availability relative to policy incentives [19,20], or predicted elasticity of demand based upon market price [21,4], but those studies fail to consider the nonfinancial factors affecting landowner preferences for harvesting biomass.

Recent research validates the importance of landowner attitudes and beliefs in predicting social availability. Butler et al. [12] model indicators from the National Woodland Owner Survey to illustrate how preferences affect timber and biomass supply. They found that landowner attitudes and harvest intentions had a greater impact on availability than did physical factors like site productivity or slope; only 38% of biomass identified as physically available was socially available in their analysis of northern forested states. Joshi and Mehmood [22] employed a market segmentation approach in Arkansas, Florida and Virginia with forest parcels greater than 20-acres in size to identify landowner willingness to harvest biomass in that region. Their cluster analysis indicates that landowners who were more likely to harvest biomass were retired and highly valued using their woodlands for nature, wildlife habitat, and engaging in recreation. More than half (55%) of those landowners also intended on harvesting timber, and among those 63% were willing to supply biomass for energy production. Joshi and Mehmood [23] apply these same data to a logistic regression and found that willingness to harvest was significantly related to ownership objectives, total acreage owned, tree species, and landowner demographics. Contrary to their earlier findings, younger landowners owning large tracts of forest land were more likely to supply biomass for energy production. However, biomass price was not analyzed in conjunction with non-financial factors in any of these studies.

A smaller number of studies model financial as well as non-financial factors influencing biomass availability. Gruchy et al. [24], for instance, incorporate biomass price using a contingent rating approach in Mississippi. They modeled landowner stated willingness to accept payment relative to tradeoffs for wildlife habitat, climate change mitigation, aesthetics and financial benefit, and found that the corresponding harvesting technique (e.g., clear cutting) was a significant indicator of availability. Markowski-Lindsay et al. [25] estimate the probability that Massachusetts landowners would harvest biomass using a logistic regression model with measures of biomass price ($0–$500/acre), forested acres owned (greater than 10 acres), existence of a management plan, and demographic variables. The results indicate the likelihood of biomass harvesting is quite low in Massachusetts, and that willingness to participate is largely inelastic with respect to price offered. The opposite was found in Arkansas, Florida and Virginia where GC and Mehmood [26] examined the likelihood of southern nonindustrial private landowners (greater than 20 acres) participating in biomass markets. Participation ranged from a low of 16% in Virginia assuming 2008 pulpwood prices, up to 74% in Florida when the price was doubled for biomass. They also found significant association between bid acceptance rate and forest parcel size, tree size, absenteeism, landowner age, and previous harvesting experience. These later studies inform our analysis and serve as a reference to compare regional findings.

3. Theoretical framework

3.1. *Landowner behavioral intent*

The methods used in this study are similar to those employed in the Markowski-Lindsay et al. [25] study. However, the theoretical framework is different in that we employed multiple measures of landowner behavioral intent absent from previous studies. Landowner attitudes, which are identified in previous studies as an important predictor of availability [12,25], are but one dimension of behavioral intent [27]. The broader theoretical framework adopted for this study is based on the Theory of Planned Behavior and considers the cumulative effect of landowner *attitudes*, the influence of *social norms* on individual behavior, and the *perceived control* landowners have over their desired outcome [28]. The Theory of Planned Behavior posits that these three factors interact to influence whether an individual will act on their beliefs and