

The Opportunity Cost of Developmental Deed Restrictions for Minnesota Private Forest Owners

An Empirical Analysis

by

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Executive Summary

The cost of an eight-year developmental deed restriction for nonindustrial private forest (NIPF) owners in Minnesota was estimated by examining the property tax records from 1,200 landowners (1,341 parcels) who enrolled in one of two property tax incentive programs that promote sustainable forest management in 2009. The requirements of these two programs, the Minnesota Sustainable Forest Incentive Act (SFIA) and Minnesota 2c Managed Forest Lands (2c), are identical in nearly every respect except for the minimum enrollment period. The SFIA program requires forest landowners to place a covenant on their property deeds, restricting them from developing their land for a minimum of eight years. The 2c program had no such minimum enrollment period. However, landowners are prohibited from developing their properties while enrolled in the 2c program. The coexistence of these two preferential forest property tax programs provided a unique opportunity to analyze the enrollment choices landowners made and the associated property tax consequences.

Each enrolled parcel was classified according to its actual tax savings associated with the landowner's preferred property tax program (the SFIA or 2c program). Then each parcel's potential tax savings (or loss) were calculated by assuming it had been enrolled in the SFIA program. Comparing the potential tax savings (or loss) to actual tax savings (or loss) enabled each forest landowner to be classified according to the enrollment decision it *should* have made if the objective was to minimize its annual property tax liability. While studies have repeatedly shown NIPF ownership motivations include a mix of objectives that are not purely financial (Baughman 1988, Kilgore et al. 2007, Butler 2008). However, this study analyzes a sample of forest landowners' decisions from a purely financial perspective to quantify the opportunity cost of an eight-year covenant recorded on their property deeds. By linking enrollment choices to the parcel-specific annual property tax savings associated with each program, we estimated the value NIPF owners place on the temporary loss of developmental rights.

This study found that a majority of the landowners in our study were willing to forego substantial annual property tax savings (\$422 on average) in order to avoid the deed restriction required by the SFIA program. A logistic regression model was developed to identify significant determinants of choosing the SFIA program over the 2c program and estimate the probability of enrollment in the SFIA program over the 2c program. Developmental pressure, as measured by two proximate variables and the level of annual financial savings offered by each program, were highly significant variables in predicting a landowner's enrollment decision.

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1. Introduction

In the past several decades the attitudes and behaviors of nonindustrial private (NIPF) landowners, and more recently of family forest owners, has been studied extensively. Butler (2008) defines NIPF owners as families, individuals, corporations, and other private groups that own forest land, but do not own and operate a primary wood-processing facility, whereas family forest owners are families, individuals, trusts, estates, family partnerships, and other unincorporated groups of individuals that own forest land. Hence, family forest owners are a subset of NIPF owners. NIPF landowners collectively own approximately 751 million acres, or 49% of forest land in the United States (Butler 2008). As a result, NIPF landowners have long been the focus of myriad financial incentive and assistance programs that promote good stewardship of their land through management. These programs take many forms, the most common being ones that provide information and education, technical assistance, cost-sharing of forest management plans and practices, and tax incentives (Kilgore and Blinn 2004). Many of these programs stipulate that the owners manage their lands to accomplish a particular (or multiple) environmentally beneficial goal(s) such as increased biodiversity, increased timber production, and/or water quality protection.

Financial incentive and assistance programs seek to promote sustainable forest management on NIPF lands, as policy makers and researchers alike have concerns over the long-term health and productivity of these forests. It is estimated that 46% of NIPF owners have conducted timber harvests on their properties (Birch 1996), yet only 4% of the family forest owners interviewed by Butler (2008) had a professionally developed forest management plan. Without guidance from a professional land manager, timber harvesting can result in negative impacts to the local ecosystem in the form of soil compaction, loss of timber productivity, and water quality degradation. Of perhaps greater concern is the increase in number of subdivided NIPF properties over the past 20y years (Butler 2008), which has led to the increase in fragmented, or isolated, forests (Gustafson and Loehle 2006, Mundell et al. 2010, Haines et al. 2011). These fragmented forests can result in diminished ecosystem functions and an overall decline in forest health (Theobald et al. 1997, Wear et al. 1998, Rickenbach and Steel 2006).

Some forestry financial incentive and technical assistance programs require that landowners commit to the program for a specified (minimum) period of time, during which certain land uses are prohibited. For instance, the US Department of Agriculture's Healthy Forests Reserve Program (HFRP) encourages forest landowners to promote the recovery of threatened and endangered species, improve plant and animal biodiversity, and enhance carbon sequestration (USDA FS et al. 2004). Participating landowners are required to sign a contract obligating them to be enrolled in the program for a specified period during which development is prohibited. Landowners have the option of 10-year, 30-year, or permanent "easement" contracts, with increasingly attractive cost-share incentives as contract duration increases. In 2009, 684,708 acres were enrolled in 10-year contracts while only 2,900 acres were enrolled in permanent easements (NRCS 2012). Many states also offer preferential property tax programs to private forest owners. A national review found 48% of these programs require a minimum enrollment period, ranging from 2 to 50 years, during which time landowners are prohibited from certain activities such as building or other forms of land development (Butler et al. 2010).

The effectiveness of policies promoting sustainable forestry practices on NIPF lands is of particular interest to researchers and policy makers (Williams et al. 2004, Kilgore et al. 2008, Butler et al. 2010). For instance, previous research suggests landowners are reluctant to make long-term program commitments that might limit future land use and management options (e.g. Bell et al. 1994, Williams et al. 2004, Kilgore et al. 2008). Studies have attempted to quantify a value NIPF owners place on an encumbrance to their property rights, yet, to our knowledge all of these studies relied on survey data.

Daniels (2001) estimated the average price of permanent developmental deed restrictions (conservation easements) ranged from \$2,000 to \$5,000 per acre. Stevens et al. (2002) surveyed forest landowners in Massachusetts on their preferences towards a hypothetical forest management program. The survey found that owners require between \$21.44 per acre (without nonmotorized recreational access and without conveying timber harvesting rights) and \$56.25 per acre (with nonmotorized recreational access and with conveying timber harvesting rights) to achieve 50% enrollment into an incentives program. They also concluded the owners were impartial to the mechanism for receiving the economic incentive, whether through a tax break, direct payment, or cost-share program. Length of commitment (10, 15, or 20 years) was not a significant deterrent to enrollment. However, the authors concluded that Massachusetts forest landowners are willing to commit to long-term enrollment but require unrealistically high levels of compensation in exchange. Kilgore et al. (2008) analyzed family forest owner willingness to enroll in the SFIA program under varying hypothetical payment amounts. They estimated that family forest owners needed to be compensated \$24 per acre annually in order to achieve a 50% enrollment rate.

In 2009, an opportunity arose in Minnesota to gather empirical data that could describe and quantify NIPF owner resistance to developmental deed restrictions. This opportunity resulted from the coexistence of two preferential forest property tax programs in Minnesota. The enrollment requirements of these programs are virtually identical, with the exception that one of the programs requires the landowner to place an eight-year developmental deed restriction on the enrolled property. These two property tax programs are the Minnesota Sustainable Forest Incentives Act of 2001 (SFIA) and the 2c Managed Forest Lands (2c) property tax classification which began in 2009. The SFIA program requires a landowner to place a covenant, a legal restriction placed on the property deed that legally binds the landowner to specific conditions or uses on their property restricting development for a minimum of eight years. In contrast, the 2c program does not have any term-of-enrollment covenant requirement. In most instances, the 2009 per acre SFIA annual compensation to landowners was greater than the annual per acre compensation provided by the 2c program that year. Knowledge of this per acre compensation differential (SFIA expected to compensate more than 2c in exchange for the covenant requirement) forms the basis for estimating program participants' opportunity cost of encumbering the developmental rights of their forest land for at least eight years.

Data was gathered on all 1,335 parcels that were enrolled in the 2c and SFIA programs in 2009, which comprised of 1,200 NIPF owners, 1,124 (93.6%) of which were family forest owners. Data was limited to the 2009 tax year because it was the first year NIPF owners could choose between the SFIA and 2c programs and it was the most recent available data. To ensure comparable data, only landowners who enrolled up to 1,920 acres in one of the programs that

year were included in the study, as the 2c program restricts a landowner to enrolling up to 1,920 acres while the SFIA program has no acreage limit. This study capitalizes on the unique ability to use empirical data to describe and compare NIPF owner financial decision-making with regard to placing an encumbrance on their developmental rights. To our knowledge, this is the first study of NIPF landowners that used empirical data to describe the opportunity cost of a developmental deed restriction.

2. Literature Review

2.1 Background

The development of public financial incentive and assistance forestry programs has been driven by concerns over the recent increases in parcelization and fragmentation of NIPF lands and the desire to promote sustainable forest management practices on these lands. However, NIPF participation in these programs has been underwhelming. The literature has provided some insight into NIPF landowner attitudes toward incentive and assistance programs as well as the views held by the administrators of these programs (Ellefson et al. 1995, Stevens et al. 2002, Kilgore et al. 2008, Butler et al. 2010).

2.1.1 Parcelization and Fragmentation

The number of NIPF owners in the US has increased over the past 20 years while average size of their holdings has concurrently decreased (Mehmood and Zhang 2001, Butler 2008). These trends reflect the process of parcelization, defined as a single forest land parcel with one owner becoming divided into smaller parcels with multiple owners. Parcelization may lead to reduced timber production, increased disputes between adjacent landowners, loss of recreational access to forested lands, and the permanent loss of forest cover to development (Gobster et al. 2000, Rickenbach and Gobster 2003).

Parcelization has also been linked to forest fragmentation, which occurs when large tracts of forests are dissolved into smaller tracts and become isolated from larger, contiguous forests due to rural and urban development (Gustafson and Loehle 2006, Mundell et al. 2010, Haines et al. 2011). Fragmentation has been described as islands, or a patchwork, of forest cover across the landscape (Mehmood and Zhang 2001, Best 2002). Fragmentation can negatively impact water quality (Wear et al. 1998), wildlife health and habitat (Theobald et al. 1997), timber supply (Rickenbach and Steel 2006, Wear et al. 1999), and recreational opportunities (Gustafson and Loehle 2006). Kline et al. (2004) concluded fragmentation can decrease forest management and investment. By 2030 it is estimated that growth of urban and developed lands in the US will increase between 137 million acres to 144 million acres from 2000 levels (Alig and Plantinga 2004, Nowak and Walton 2005). By 2050, Nowak and Walton (2005) project that approximately 5.3% of the existing forests in 2000 lying outside of urban areas will be subsumed by urban growth.

2.1.2 Sustainable Management of Private Forests

In addition to parcelization and fragmentation, concern has been raised over the sustainable forest management of NIPF lands. Research has shown that timber harvesting is not a primary ownership motivation of most NIPF owners (Baughman 1988, Kilgore et al. 2007), yet 46% of NIPF owners and 46% of family forest owners have conducted timber harvests on their

properties (Birch 1996, Butler 2008). Of the family forest owners surveyed by Butler (2008), only 14% had received advice about managing their forests, and as little as 4% had a written forest management plan that was developed by a professional. Forest landowners generally have a strong land-stewardship ethic (Daniels et al. 2010). However, this has not necessarily translated into the widespread implementation of timber harvesting best management practices (BMPs) that promote sustainable forestry practices. NIPF owners acknowledge the numerous benefits of using BMPs when conducting timber harvests (Husak et al. 2004). Yet without guidance from a professional land manager, timber harvesting can result in many negative environmental impacts such as soil compaction, loss of timber productivity, and water quality degradation.

The Society of American Foresters' Dictionary of Forestry defines sustainable forest management as, "practicing a land stewardship ethic that integrates the reforestation, managing, growing, nurturing, and harvesting of trees for useful products with the conservation of soil, air and water quality, wildlife and fish habitat, and aesthetics" (Helms 1998 p. 181). While sustainable forest management consists of practices that promote multiple goods and services provided by healthy forests, this term has a strong connotation with timber harvesting. Historically, timber harvesting has been the most perceptible forest management activity to the public, with much of the public viewing timber harvests unfavorably (Harmon et al. 1997, Bliss 2000). However, public attitudes toward timber harvesting have been shown to improve when educational efforts about silvicultural methods are implemented (Harmon et al. 1997, Broussard et al. 2001). Many public and private entities attempt to manifest the principles of sustainable timber harvesting through the development of BMPs. BMPs are practices that promote sustainable forest management and may be implemented voluntarily or through regulatory measures. BMPs are directed toward forest management or timber harvesting activities and address things such as protecting water quality at the harvest site, avoiding soil compaction, increasing timber productivity, promoting wildlife habitat, and protecting historical and cultural resources. While one study found that 49 states have developed some form of BMPs for use during timber harvests or forest management activities (Kilgore and Blinn 2004), the extent to which NIPF owners use them when harvesting timber is uncertain.

2.1.3 Participant Attitudes of Private Forest Land Incentives and Assistance Programs

Because of the aforementioned concerns about parcelization, fragmentation, and the application of good land stewardship practices, NIPF owners have long been the target of myriad incentive and assistance programs which include educational programs, technical assistance, cost-share programs, preferential access to contracts, price premiums for products, grant and loan programs, and tax incentive programs (Kilgore and Blinn 2004). Yet widespread participation in these programs has proven elusive (Williams et al. 2004, Kilgore et al. 2008, Butler et al. 2010). Zhang and Flick (2001) found that NIPF owners were less likely to partake in reforestation efforts when faced with the possibility of regulatory intervention and use of government cost-share programs decreased reforestation investment. However, use of forest tax incentives was found to increase reforestation investment. Baughman and Updegraff (2002) observed that NIPF owners in the Midwest preferred tax incentives over low-cost or free educational materials. Among financial incentives, Hibbard et al. 2001 has shown that NIPF owners favor preferential tax policies over cost-share assistance for management undertakings. Kilgore and Blinn (2004) documented landowners' preference toward technical assistance over cost-share programs or grants. In

contrast, Daniels et al. (2010) found that NIPF owners prefer technical assistance to tax incentives.

A nationwide survey found that the views of state forestry managers often contradict those of NIPF owners as to which policies and programs are most effective at influencing private forestry activities (Ellefson et al. 1995). State forestry managers consider educational and technical assistance programs as more effective policy tools in improving timber harvesting methods versus financial incentives. Fifty-six percent of these managers rated voluntary guideline programs as ineffective at improving timber harvesting methods, whereas, 30% of these managers rated tax incentive programs as effective at improving timber harvesting methods. The literature seems to indicate that forest landowners are inconsistent in their preferences toward incentive and assistance programs. While some studies conclude that NIPF owners prefer educational or technical assistance programs to financial incentives, other studies conclude that NIPF owners prefer financial incentives to educational and technical assistance. Meanwhile, state forestry administrators seem to believe education and technical assistance programs are the most effective at engaging NIPF owners.

2.1.4 State Forest Property Tax Policy

States have employed numerous preferential property tax policies to encourage sustainable forestry practices and to discourage the parcelization, development, and fragmentation of forest land (Hibbard et al. 2001, Butler et al. 2010). The most common type of property tax applied in a forestry context is a current-use tax, valuing land according to its current use rather than its highest and best use (Hibbard et al. 2001). In an extensive review of forest property tax programs, Butler et al. (2010) found that 38 states use preferential forest tax programs or classifications; 11 states automatically assess forests at a preferential rate with no action required by the landowner; and Alaska exempts all forest land from property taxation altogether. The number of preferential forest property tax programs in the US increases to 55 if sustainable agricultural, open-space maintenance, and wildlife habitat conservation type programs are included. Twenty-three states (46%) have at least one tax program or classification with a stated objective of encouraging sustainable forestry, and six states have multiple programs with this objective. Twenty-eight (51%) of the reported forest tax programs required the owner to procure a management plan; 24 (44%) include a minimum enrollment period; and 47 (85%) include penalties for early withdraw or violation of the program terms.

2.1.5 Deed Restrictions as a Means to Preserve Forest Cover

A developmental deed restriction is any mechanism, such as a zoning law, covenant, or conservation easement that prohibits a landowner from undertaking an improvement on his or her land (Hughes and Turnbull 1996). The deed restriction runs with the land not the landowner (i.e., the land use restrictions are binding even if ownership changes hand) and can be of limited duration or permanent. A limited duration deed restriction is called a covenant. An easement is an example of a deed restriction that is valid in perpetuity (Daniels 2001). Developmental deed restrictions have typically been employed in an agricultural and forestry context to limit urban sprawl. Owners with agricultural or forested lands in these areas are typically confronted with increased property taxes as a result of encroaching development (Daniels 2001). Because encroaching development usually raises the value of adjacent undeveloped land, forest landowners in these areas experience an increasing property tax liability. Facing increasing

annual property tax liability, these rural landowners are often confronted with the dilemma of whether to sell their lands to developers or to pay higher property taxes.

A recent mechanism used by policymakers to inhibit the development of forested or rural lands is the transfer of developmental rights (TDR). Like the purchase of developmental rights (PDR) such as conservation easements or covenants, a TDR acquires development rights from rural landowners. However, the development rights acquired are subsequently transferred to a developer who is then allowed to build at a higher density on a different parcel than would normally be permitted (Pruetz and Standridge 2009). For instance, a developer participating in a TDR program pays a local unit of government for the developmental rights of a rural landowner. The local unit of government then permits the developer to build in an urban area at a higher density than zoning laws normally permit. TDR programs are typically administered by local units of government, which are usually more efficient at allocating developmental rights than state administrators (Pruetz and Standridge 2009). In 2009, the 20 most effective TDR programs across the US preserved more than 350,000 acres of land (Pruetz and Standridge 2009). These lands include forests, farmland, wetlands, open space, and a variety of other natural lands. The American Farmland Trusts estimated that 22,733 transfers of developmental rights on 129,810 acres of agricultural land had occurred in 2008 (American Farmland Trusts 2008).

PDR programs, such as conservation easements or covenants, are generally considered effective at preserving rural lands; however they are also very expensive to implement and monitor. Using the Delphi process to grade PDRs as a policy tool, Miskowiak and Stoll (2006) assigned the cost of PDRs a “D” letter grade, yet both public and political acceptance of PDRs received an “A.” Daniels (2001) estimated the average price of permanent developmental deed restrictions (conservation easements) ranged from \$2,000 to \$5,000 per acre of agricultural and rural lands. Sullivan et al. (2005) found that NIPF owners would require an annual payment of approximately \$200 per acre to achieve 50% bid acceptance to permanently convey their developmental rights in a conservation easement. Mashour et al. (2005) found that Florida paid \$1,306 per acre for 51 easements on a mix of forest and wetlands.

While these studies estimate the value of developmental deed restrictions, they are generally limited to permanent easements and/or rely on survey data to derive their estimates. These analyses are not confined to forestry, but consider a broad range of land uses from agriculture to wetland conservation. Moreover, these studies often fail to adequately describe the characteristics of the landowners participating in the developmental deed restriction programs.

2.1.6 Studies of Forest Landowner Willingness to Participate in Incentive Programs

Many studies have estimated the probability that forest landowners will enroll in a variety of incentive programs. These studies have generally found poor program enrollment a common theme and that NIPF owners require unrealistically high levels of financial compensation to increase enrollment.

Bell et al. (1994) modeled NIPF owner participation in Tennessee’s Forest Stewardship Program and found that negative attitudes about the program’s goals deterred enrollment and had a greater influence than cost-share assistance. Brockett and Gebhard (1999) compared the forest management practices of NIPF owners enrolled in Tennessee’s Greenbelt tax incentive program

to those of NIPF owners who were not enrolled in the program. The Tennessee Greenbelt program requires the owner to obtain a forest management plan and prohibits forest land from being developed. Yet the program does not have a minimum enrollment term or require the owner to place a covenant on their deed. The authors found no statistically significant differences between enrolled and nonenrolled NIPF owners' management practices, implying the program was ineffective. Further, only 26% of the enrolled owners had obtained the required management plans, implying that lack of enforcement rather than level of tax incentive may be a reason for poor program performance.

Stevens et al. (2002) surveyed forest landowners in Massachusetts on their preferences toward a hypothetical forest management program. The survey found that owners require between \$21.44 per acre (without nonmotorized recreational access and without conveying timber harvesting rights) and \$56.25 per acre (with nonmotorized recreational access and with conveying timber harvesting rights) to achieve 50% enrollment into an incentives program. Owners were impartial to the mechanism for receiving the economic incentive, whether through a tax break, direct payment, or cost-share program. Length of commitment (10, 15, or 20 years) was not a significant deterrent to enrollment. However, the authors concluded that Massachusetts forest landowners are willing to commit to long-term enrollment but require unrealistically high levels of compensation in exchange.

Kilgore et al. (2008) analyzed family forest owner willingness to enroll in Minnesota's SFIA program under varying hypothetical payment levels. They estimated that family forest owners needed to be compensated \$24 per acre annually in order to achieve a 50% enrollment rate into the SFIA program. The most substantial obstacle for landowner participation was the SFIA program's eight-year minimum enrollment commitment as formalized through a covenant placed on the property's deed. The authors hypothesized that landowners with any intention of selling their land are highly opposed to encumbering their property's developmental abilities. The authors also found that landowner knowledge of the SFIA program was a highly significant variable in predicting enrollment, implying that more effort in marketing the program was warranted and perhaps necessary to increase enrollment.

2.1.7 Literature Review Summary

In summary, the literature has found that parcelization and fragmentation of NIPF land is a serious concern that policymakers have had difficulty addressing effectively. Many policy tools have been implemented to prevent the parcelization and fragmentation of NIPF owner lands, and developmental deed restrictions appear to be the most effective policy tool to achieve this end. Many studies have sought to characterize NIPF owner attitudes towards developmental deed restrictions by conducting surveys and modeling those results. The results of the Massachusetts study, as well as the results from the Minnesota and Tennessee studies, were derived from survey data on how NIPF and family forest owners claim they would act given a hypothetical set of circumstances. While surveys provide a reliable source of data, empirical data is typically preferred. There are no known studies that have used empirical data to describe NIPF owner resistance to developmental deed restrictions, yet there is a pressing need to quantify the level of compensation at which these owners will forego their developmental rights for significant periods of time. By determining the opportunity cost of developmental deed restrictions to NIPF landowners, policymakers can develop, implement, and evaluate preferential forest property tax

programs that will be more effective and efficient in preventing and mitigating the parcelization and fragmentation of NIPF lands.

2.2 Study Objectives

This study analyzes empirical data from two property tax incentive programs in Minnesota in 2009, the SFIA program and the 2c Managed Forest Land property tax classification (2c) program. The primary objectives of this study are to identify the level of compensation NIPF owners require to forego their developmental rights for a minimum of eight years and identify the characteristics of NIPF owners that most strongly influence their choice of property-tax incentive program.

2.3 Program Descriptions

2.3.1 History of the SFIA and 2c Programs

In a report commissioned by the 2000 Minnesota Legislature, the Minnesota Forest Resources Council (MFRC) and Minnesota Department of Revenue (MN DOR) concluded, “The steady loss of private forestland resulting from economic development, parcelization, and neglect is creating a supply problem for Minnesota’s third largest manufacturing industry as well as environmental concerns for all Minnesotans” (MN DOR 2000, p. 3). The Minnesota Legislature responded by enacting the SFIA in 2001, with the stated purpose of “encourag[ing] the state’s private forest landowners to make a long-term commitment to sustainable forest management,” (Minnesota Statutes, 2009a). Yet after six years of existence, 2% of eligible NIPF owners were enrolled in the SFIA program (Kilgore et al. 2008). In response to limited NIPF landowner interest in the SFIA program, the Minnesota Legislature created the 2c program in 2008, which does not have a covenant requirement or minimum enrollment term requirement, to increase private forest landowner enrollment into a property tax program that promotes sustainable forest management (T. Kroll per. comm. February 22, 2010).

2.3.2 The SFIA Program

To be eligible to enroll in the SFIA program, a landowner must enroll a minimum of 20 acres, 50% of which is forested, and any landowner enrolling 1,920 acres or more must allow nonmotorized public access on all enrolled land. The owner must have and implement a forest management plan that was prepared by a Minnesota Department of Natural Resources (MN DNR) approved plan writer within the past ten years. Enrolled acres are restricted from agricultural or residential use, and a three-acre exclusion is required for any enrolled parcel with a pre-existing structure. The landowner must be current on their property taxes in order to receive the incentive payment and cannot enroll land that is in any other preferential property tax program.

The SFIA program requires the landowner to place a covenant on the deed, prohibiting development for a minimum of eight years. To withdraw from the SFIA program, a landowner must have been enrolled for four years and submit a request to the MN DOR Commissioner to be removed. Once the request for removal has been processed, the landowner must wait an additional four years before complete removal from the SFIA program. This covenant requirement differs from other types of forest tax program enrollment application because it requires the landowner to complete a contract at the county recorder’s office which is then filed

with their property deed. The covenant remains valid on the property, even if the property is sold. Landowners involuntarily removed from the SFIA program must pay a penalty of the previous four year's incentive payment on the enrolled parcels. In addition, the covenant remains in effect on their enrolled parcels for an additional four years from the time of violation. Thus, the landowner is still bound to the conditions of the covenant for the remainder of the enrollment period.

The SFIA program incentive payment is determined annually by the MN DOR. All landowners enrolled in the SFIA program receive the same per acre SFIA payment in a given year irrespective of the land's market value, location, or size. The MN DOR uses statutorily defined formulae to calculate three potential per-acre incentive payments that are based on an average statewide property tax for timberland. The MN DOR then selects the incentive payment that pays the highest per-acre rate, provided that the payment is at least \$7 per acre. The SFIA payment increased from \$8.16 per acre in 2007 to \$8.74 per acre for forest land enrolled in 2008 and 2009. A landowner enrolled in the SFIA program pays ad valorem property taxes at the normally assessed tax rate, and the incentive payment is dispersed independently of the levy of the owner's property taxes for the forest land. The SFIA incentive payment is taxable income.

2.3.3 The 2c Program

The 2c property tax classification (i.e., 2c program) was enacted by the Minnesota Legislature in 2008, with enrollment beginning in the later part of 2008. The 2c program requires forest landowners to possess a forest management plan written by a MN DNR-approved plan writer, defined as a plan that is no more than ten years old. A landowner must have a minimum of 20 acres to be eligible for enrollment, but they cannot enroll more than 1,920 acres. The 2c program does not require a minimum term of enrollment; parcels enrolled in the program will remain in the program as long as the program requirements are met. The property enrolled cannot be used for agricultural or residential purposes, and any parcels with minor, ancillary structures are required to take a ten acre minimum exclusion. Minor, ancillary structures are defined as "sheds or other primitive structures that add minimal value and are not designed for residential use, the aggregate size of which is less than 300 square feet" (MN DOR, 2009b). Land enrolled in the 2c program cannot be enrolled in another preferential property tax program.

The 2c program is a unique property tax classification that offers an upfront reduction in a landowner's property tax liability. Unlike the SFIA program's incentive payment that provides the same annual benefit for all enrolled lands, the 2c per-acre tax reduction is a function of the land's assessor-estimated market value and the property tax levies imposed by the taxing jurisdictions. Minnesota uses a classification system based on land use to levy property taxes; different land uses are assigned different tax rates. For instance, in 2009 property considered as rural land was assessed 1% of the market value of the property. The 2c program created a new classification that assesses enrolled property at 0.65% of the market value which, in most cases, reduces the taxable value of forest land by 0.35% (i.e., from 1% to 0.65%).

2.3.4 SFIA and 2c Program Similarities

The SFIA and 2c programs have nearly identical requirements for enrollment (Table 1). Both programs require the landowner to enroll a minimum of 20 acres of contiguous land, 50% of which must be forested. Land enrolled in either program cannot be used for agricultural or

residential purposes, and both programs have exclusion provisions for pre-existing structures on enrolled land. Neither program permits enrolled land to be enrolled in another preferential property tax program and both programs require owners to be current with their property taxes.

Both the SFIA and 2c programs require landowners to obtain a forest management plan (less than 10 years old) from a MN DNR-approved plan writer (Table 1). Plans can be written to meet a multitude of landowner objectives, which may include improving wildlife habitat, producing timber income, or reducing the prevalence (or risk) of disease and insect pests. Both programs require any management activities to follow the Minnesota's Voluntary Site Level Management Guidelines developed by the MFRC (MFRC 1999). These guidelines address matters such as the protection of cultural resources, construction of forest roads, silvicultural methods, safeguarding water resources, biomass harvesting, and a host of other harvesting-related issues.

2.3.5 SFIA and 2c Program Differences

The primary difference between the two programs is that the SFIA program requires landowners to place a covenant on the property's deed restricting development on the enrolled parcels for a minimum of eight years, while the 2c program does not have a deed restriction requirement (Table 1). Once enrolled in the SFIA program, a landowner cannot request to withdraw the land from the program for at least four years. Once eligible to request removal from SFIA, the landowner must wait an additional four years before the land is withdrawn. In contrast, the 2c program does not have a term of enrollment requirement, nor does it require landowners to record a covenant on their deed. The level of financial incentive offered also differs, and in most cases, the 2c program offers a lower annual financial incentive than the SFIA program. The level of financial savings offered by the 2c program is a function of the land's taxable value and property tax rate, which vary from tax district to tax district.

Other differences between the two programs are less substantive such as a 10 acre versus three acre exclusion provision in the 2c and SFIA programs, respectively. Additionally, the 2c program limits enrollment to 1,920 acres while SFIA permits enrollment over 1,920 acres provided that nonmotorized access is granted on those lands. The SFIA program imposes an early withdrawal penalty for noncompliance to the terms of the covenant while the 2c program does not have a withdrawal penalty. Owners who violate the SFIA covenant are liable for incentive payments received within the past four years, plus interest, on those payments. The penalty for noncompliance in 2c is removal from the program, and potential prosecution for tax fraud.

Table 1. Comparison of SFIA and 2c major program requirements.

<i>Sustainable Forest Incentive Act (SFIA)</i>	<i>2c Managed Forest Land (2c)</i>
Must file covenant with property deed at county assessor's office	Application acts as a legally binding contract, filed with county assessor
Must possess a MN DNR-approved forest management plan prepared in the last 10 years	Must possess a MN DNR-approved forest management plan prepared in the last 10 years
Must enroll a minimum of 20 acres of 50% forested land	Must enroll a minimum of 20 acres of 50% forested land
Removal from the program requires enrollment for at least four years, approval of request to be removed, and an additional four years waiting period	Removal requires a request to the county assessor to be removed from the program at the end of the tax year
Penalty for early removal/breach of covenant is a fine equal to the total payments received on all enrolled lands for the previous four years and removal from the program ¹	Penalty for breach of contract disqualifies the property from further enrollment, potential civil and criminal penalties for tax fraud

¹ Landowners involuntarily removed from the program do not have the covenant removed for four additional years (i.e., they pay the penalty, lose the SFIA payment benefit, but are still legally bound to the covenant's provisions).

3. Data and Methods

3.1 Data on Enrolled Parcels

Information on the parcels enrolled in the SFIA program in 2009 (and their owners) was obtained from the MN DOR. For each parcel enrolled in the SFIA program, the MN DOR provided the owner's name and address, county where the parcel is located, parcel identification number, and acres enrolled. Variables collected and derived that describe landowner and parcel characteristics for the SFIA program are listed in Table 2.

Obtaining information on forest land enrolled in the 2c program was not as straightforward, as enrollment information had to be obtained from each county. Counties with parcels enrolled in the 2c program during 2009 were identified using the Minnesota Land Economics website (www.landeconomics.umn.edu, accessed 3/24/2010). The assessor offices in these counties were subsequently contacted and information on all 2c program enrollees was requested. Data on 2c enrollments provided by county assessors included the landowner's name and address, parcel identification number, acres enrolled, estimated market value, net taxes payable, and other variables which are listed in Table 2.

From the initial data collected on parcels and landowners enrolled in the SFIA and 2c programs, labeled "baseline data" in Table 2, a more complete dataset was generated (labeled "ancillary data" in Table 2). The selection of ancillary data was based on a review of the relevant literature and availability (Nagubadi et al. 1996, Amacher et al. 2003, Snyder et al. 2008). All ancillary data was gathered from county websites, county assessors, and other publicly available information. The baseline and ancillary data were used to calculate summary statistics on the financial incentives received by NIPF owners enrolled in either program.

We gathered data on all 1,341 parcels that enrolled in either the 2c or SFIA programs in 2009. The parcel is the unit of analysis for this study, as opposed to the landowner, as landowners who own multiple parcels have the option of partitioning their land between the two tax programs.

The 1,341 parcels were enrolled by 1,200 owners, 1,124 (93.6%) of which were family forest owners. Data was limited to the 2009 tax year because it was the most current data available and the first year forest owners could choose between the SFIA and 2c programs. Because the 2c program restricts landowners from enrolling more than 1,920 acres while the SFIA program has no acreage limit, we limited our data to landowners who enrolled up to 1,920 acres in either program. This acreage limit also ensured none of the 2c and SFIA enrollees in our database was subject to the public hunting and fishing access requirement.

Table 2. Baseline and ancillary data collected for parcels enrolled in the SFIA and 2c programs.

Baseline data	
Landowner name and address	Acres enrolled
County where parcel resides	Market value of the land assessed in 2009*
Parcel identification number	Net tax payable in 2010*
Ancillary data	
<i>Landowner/taxation characteristics</i>	
2009 to 2000 % change in population (township)	SFIA equivalent tax per acre
2009 to 2000 % change in households (township)	SFIA tax savings per acre
Family forest owner	SFIA equivalent tax per acre after savings
Absentee landowner	2c equivalent tax per acre
Market value of the parcel	2c equivalent tax reduction per acre
Tax classification and rate	SFIA savings per parcel
Classification if not 2c	2c savings per parcel
State general property tax	SFIA savings minus 2c savings
Market value total	2c savings minus SFIA savings
Taxable value	SFIA savings minus 2c savings (per acre)
Net tax (taxes paid)	2c savings minus SFIA savings (per acre)
Effective tax rate	
<i>Political/proximity characteristics</i>	
Township/city	Five miles to incorporated city
Homestead status	Multiple contiguous parcels
One mile to incorporated city	Multiple noncontiguous parcels
<i>Land characteristics</i>	
Deeded acres	Adjacent to river
Adjacent to lake	All-weather road access

* 2c program parcels only

3.2 Model Estimation

We developed a logistic model to estimate how various factors influence the probability a landowner from our population will enroll a parcel in the SFIA program versus the 2c program. Logistic regression is appropriate when predicting a dichotomous response variable given a set of continuous, dichotomous, or a mix of both continuous and dichotomous explanatory variables. A logistic regression model with multiple explanatory variables has the linear form:

$$\text{logit}[\pi(x_i)] = \log\left(\frac{\pi(x_i)}{1-\pi(x_i)}\right) = \alpha + \beta \mathbf{x}_i' \quad (1)$$

where $\pi(x_i)$ is the probability of the i^{th} landowner enrolling in the SFIA program, α is an intercept variable, β is the vector of explanatory coefficients, and \mathbf{x}_i' is the transposed vector of

explanatory variables for the i^{th} landowner. The primary assumption of logistic regression is that explanatory variables have a linear relationship with the logit of the response variable. If a variable is not linearly related to the logit of the response variable, the explanatory variable can be transformed to satisfy this assumption.

We also calculated the marginal effect for each coefficient and present these values along with the estimates of each coefficient that is statistically significantly different from zero. Marginal effects for continuous variables represent the change in probability of enrollment for a one unit increase at the mean value of the variable. Marginal effects for binary variables represent the change in probability of enrollment when the variable changes from 0 to 1.

3.2.1 Explanatory Variable Selection

We identified explanatory variables based on a literature review and what we hypothesized to be influential variables on a landowner's enrollment decision. Our review included other studies that have used logistic regression to model NIPF owner willingness to participate in a sustainable forest management program (Bell 1994, Stevens et al. 2002, Kilgore et al. 2008). The final set of explanatory variables included in our model was limited to information we were able to obtain from county assessors, the MN DOR, and the US Bureau of Census.

Our process of selecting explanatory variables also included an examination of the variables from Table 2 that characterized the enrolled parcels. Principal components analysis (PCA) and an examination of the data's correlation matrix are two methods that allow for data reduction and covariate selection. A PCA was conducted on the 39 initial and ancillary variables presented in Table 2. The results of the PCA demonstrate that four to nine factor loadings is required to explain 51% and 83% of the variance of the data, respectively (not shown). Thus, PCA does not provide a useful technique for data reduction in this case, as a relatively weak level of variability is explained by a large level of factor loadings.

The weak results from PCA led us to rely on an examination of the correlation matrix to find high levels of collinearity between variables in selecting explanatory variables to include in the logistic regression model. Variables were considered to exhibit high collinearity when the correlation coefficient between them was greater than 0.40. Our examination of the correlation matrix led us to exclude parcel size (acres) as an explanatory variable due to high collinearity between it and the landowner's total annual financial incentive (0.52). Instead, we included a measure of total annual financial benefit provided by each program by including a variable that calculates the difference in savings offered by one program versus the other (see section 3.2.2). The model variables selected from our literature review and data analysis are described below and in Table 3.

3.2.2 Description of Explanatory Variables

We wanted to include a variable that indicated the level of developmental pressure in the immediate area of the parcel, so we examined the percent of population change from 2000 to 2009 within each township that contained a parcel enrolled in one of the two programs (POPCHANGE). Data for this continuous variable was collected from the Minnesota State Demographic Center and the Metropolitan Council at <http://www.demography.state.mn.us>. We hypothesized that parcels would likely face higher developmental pressure as the percent

population change increased within the township (Snyder et al. 2008). The POPCHANGE variable is expected to negatively influence enrollment in the SFIA program.

Table 3. Explanatory variables used in logistic model.

<i>Explanatory variables</i>	<i>Description of variables</i>	<i>Scale</i>	<i>Expected sign</i>
POPCHANGE	Change of population within a township between 2000 and 2009 (%)	Continuous	Negative
FIVECITY	Parcel is within five miles of an incorporated city	Binary	Negative
FAMILY	Enrollee is a family forest owner	Binary	Negative
ABSENT	Absentee landowner: parcel address different from mailing address	Binary	Positive
MULTNONCONT	Landowner owns other parcels that are not contiguous to the parcel of interest	Binary	Positive
LAKE	The parcel directly borders a lake	Binary	Negative
RIVER	The parcel directly borders a river	Binary	Negative
ROAD	Presence of an all-weather road providing access to the parcel	Binary	Negative
LOGSFIAADVANTAGE	Log-base 10 of the per-acre difference in savings for SFIA over 2c had the landowner enrolled in SFIA + 14,000	Continuous	Positive

Another variable designed to test the influence of developmental pressure is the FIVECITY binary variable, which indicates whether a parcel is located within five miles of an incorporated city. We expect parcels closer to urban areas are generally more likely to face developmental pressure than those further from cities (Snyder et al. 2008). For this reason, we hypothesized owners of parcels within five miles of an incorporated city are less likely to encumber their developmental rights for several years.

We also wanted to test whether there was a significant difference in program preference between family forest owners and other private landowners. The binary variable FAMILY indicates whether the owner of the parcel was an incorporated entity (i.e. family forest owner). We hypothesized that incorporated entities are more interested in maximizing their financial returns than family forest owners; hence, the FAMILY variable would negatively influence the probability of enrollment in the SFIA program.

The binary ABSENT variable was used to test whether absentee ownership was a significant indicator for enrollment in the SFIA program. Many studies examining private landowner behavior use absentee ownership as an explanatory variable in their models (e.g., Amancher et al. 2003, Conway et al. 2003, Sullivan et al. 2005). Some of these studies found absentee

ownership to be a significant predictor of behavior, while others did not. We hypothesized absentee owners are more sensitive to their cost of ownership than resident owners, consequently enrolling in the program providing the greatest financial benefit.

We also tested whether owning multiple, noncontiguous parcels influenced a landowner's enrollment decision (MULTNONCONT). Our hypothesis was that owners of multiple parcels are more financially motivated than single parcel owners and, therefore, more responsive to opportunities to reduce their property tax liability. Thus, the binary MULTNONCONT variable was expected to have a positive relationship with enrollment in the SFIA program.

We used separate LAKE and RIVER binary variables as proxy measures of high amenity features associated with undeveloped forest land. We expected landowners whose forest land is adjacent to a lake or river were less likely to enroll in the SFIA program, as waterfront property is generally more desirable for development (Snyder et al. 2008).

The ROAD binary variable indicates whether the landowner enrolled a parcel that contained access to the parcel on an all-weather road. We expect developers to be less interested in forest land that does not have good road access and, hence, less concerned about the SFIA program's prohibition on development for at least eight years. Kline and Alig (2005) found that poor road access decreased development of NIPF lands in Oregon.

The LOGSFIAADVANTAGE variable measures the difference in annual financial benefit offered by the two programs. For each parcel, we subtracted the annual financial benefit offered by the 2c program from the annual financial benefit provided by the SFIA program (SFIA savings differential). Because this variable is not linearly related to the logit of the response variable and many values are negative, we transformed this variable by adding 14,000 (so that all initial values were positive) and then took the logarithm-base 10 of this variable. This transformation satisfied the linearity assumption. As the difference between savings offered by the SFIA program versus the 2c program increases, the financial incentive to enroll in the SFIA program grows larger for a given owner. Therefore, we expected this variable to be positively related to enrollment in the SFIA program.

A number of other variables were tested for collinearity and excluded from our final model. They include acreage enrolled and property tax rate, both of which are highly correlated with difference in payment amount, with correlation coefficients of 0.56 and 0.98 respectively. Other variables that were not included in our model yet found by others to be influential in NIPF decision making include age, income, land tenure, plans to bequeath land, and previous harvest activities (Nagubadi et al. 1996, Majumdar et al. 2008, Ma et al. 2012). These studies have all relied on survey data for analysis of these variables. Due to funding and time constraints, we were unable to conduct a survey in conjunction with our analysis and, therefore, limited to the publicly available data gathered from the MN DOR and individual county assessors. Future research could address the effects of these potentially missing variables in conjunction with the empirical data we obtained. However, our model provides utility to a research area lacking in empirical analyses and could be used as a basis for further research.

4. Results

4.1 Summary Statistics and Parcel Characteristics

In 2009, 1,200 forest landowners enrolled 1,341 parcels totaling 141,106 acres, in the SFIA and 2c programs (Table 4). The 2c program had 827 forest landowners (69%) who enrolled 920 parcels (69%) for a total of 80,783 acres (57%), while 373 forest landowners (31%) enrolled 421 parcels (31%) for a total of 60,323 acres (43%) in the SFIA program (Tables 4 and 5). The average size of parcels enrolled in the SFIA and 2c programs was 143 acres and 88 acres, respectively, with the median values of 100 acres and 63 acres, respectively. The average annual total property tax savings for parcels enrolled in the SFIA program was \$1,252 (\$8.74 per acre), and the average annual total property tax savings was \$526 (\$5.99 per acre) for parcels enrolled in the 2c program. Across all enrolled properties, the average annual total property tax savings was \$754, or \$7.16 per acre.

Table 4. Summary statistics on forest landowner enrollment in the SFIA and 2c programs, 2009 enrollees.

<i>Variable</i>	<i>SFIA (%)</i>	<i>2c (%)</i>	<i>Total</i>
Number of landowners	373 (31%)	827 (69%)	1,200
Acres enrolled	60,323 (43%)	80,783 (57%)	141,106
Average total savings	\$1,252	\$526	\$754
Average per-acre savings	\$8.74	\$5.99	\$7.16

Table 5 provides further descriptions of the 1,341 parcels enrolled in the SFIA and 2c programs in 2009. The percentage of parcels adjacent to a lake or river or had an all-weather road providing access to the parcel was similar for parcels enrolled in either program (Table 5). The 2c program had a larger percentage of parcels located five miles from an incorporated city (56%) versus parcels enrolled in the SFIA program (40%). Parcels in the 2c program also experienced a higher rate of population change between 2000 and 2009 versus parcels enrolled in the SFIA program. The average township containing parcels enrolled in the 2c program experienced a 3.9% increase in the population, whereas the average township containing parcels in the SFIA program experienced a 0.5% decline in the population between 2000 and 2009.

Table 5. Summary statistics on parcels enrolled in the SFIA and 2c programs, 2009.

<i>Parcel variable</i>	<i>SFIA</i>	<i>2c</i>	<i>Total</i>
Number of parcels	421	920	1,341
Average parcel acres	143	88	105
Median parcel acres	100	63	70
Maximum parcel acres	1,227	1,781	1,781
Minimum parcel acres	20	0.07*	0.07*
Number of parcels adjacent to a lake	42	166	208
Number of parcels adjacent to a river	46	125	171
Number of parcels within five miles to an incorporated city	169	513	682
Number of parcels adjacent to an all-weather road	347	781	1,128
Average population change for parcels (percentage)	-0.50	3.90	2.49

*It is possible for landowners to have less than 20 acres enrolled in the 2c or SFIA programs. If an enrolled owners sells part of his or her property that is less than 20 acres, the sold portion remains in the program.

The average and median size of parcels enrolled in the SFIA program in 2009 was 143 acres and 100 acres, respectively; whereas, the average and median size of parcels enrolled in the 2c program was 88 acres and 63 acres, respectively (Table 5). The largest parcel enrolled in the SFIA program was 1,227 acres, and the largest parcel enrolled in the 2c program was 1,781 acres. The difference in average parcel size between the SFIA and 2c programs indicates that parcels enrolled in the SFIA program tend to be larger than parcels enrolled in the 2c program. The distribution of enrolled parcels across Minnesota is shown in Figure 1, with 48 counties containing acreage enrolled in at least one of the programs. Twenty-eight counties (58%) had parcels enrolled in both the 2c and SFIA programs; 16 counties had 2c parcels only; 4 counties had SFIA parcels exclusively. Counties containing only 2c parcels are all located in the southern half of the state, while the majority of counties with SFIA parcel only are located in the northwestern part of the state.

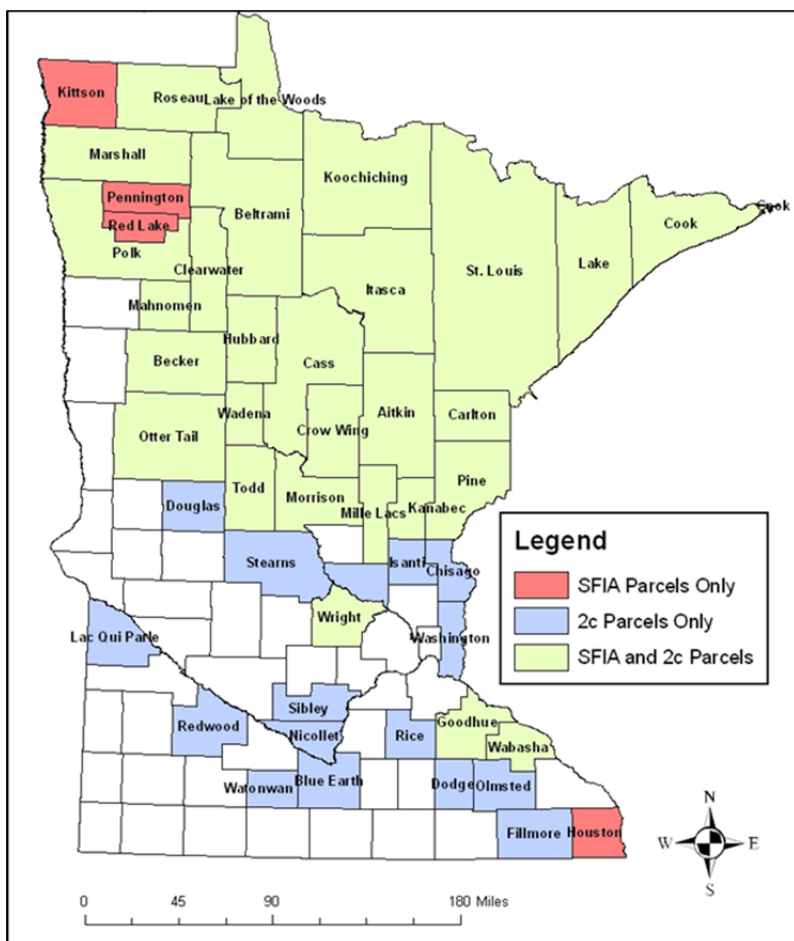


Figure 1. Counties with parcels enrolled in the SFIA and/or 2c programs.

4.2 Financial Implications of Parcels Enrolled in Preferential Tax Programs

4.2.1 Parcel Classification Analysis

To better understand the financial implications associated with a landowner’s enrollment decision in 2009, we examined the difference in property tax savings offered by the SFIA and the 2c programs for each parcel enrolled, hereafter the SFIA savings differential. The value associated with each parcel represents the difference in annual financial benefit provided by the two programs. A positive SFIA savings differential indicates the annual property tax financial incentive for that parcel is largest if enrolled in the SFIA program, whereas a negative value indicates the parcel would generate the largest annual financial benefit if enrolled in the 2c program.

Table 4 considered two types of forested parcels: those which were enrolled in the SFIA program and those parcels enrolled into the 2c program. These two classes of parcels can be further divided in order to gain further insight into the landowner’s decision-making process. Examining the financial ramifications of each forest landowner’s choice of preferential tax program led to four distinct groupings of parcels based on the behavior a cost-minimizing landowner would exhibit.

The optimal preferential tax program to the cost-minimizing landowner is the program that produces the highest financial return. From this perspective, enrolling a parcel in a program that does not minimize the landowner’s financial cost would be irrational. Under this framework, parcels can be grouped according to one of four classifications: parcels that should be enrolled in the SFIA program and were enrolled in the SFIA program; parcels that should be enrolled in the SFIA program but were not enrolled in the SFIA program; parcels that should be enrolled in the 2c program and were enrolled in the 2c program; and parcels that should be enrolled in the 2c program and were not enrolled in the 2c program. Table 6 displays this classification system in a contingency table. The vertical axis on the left (i.e., “SFIA Program” and “2c Program”) represents the tax program in which the parcel should be enrolled in order to minimize the property tax liability, whereas the upper, horizontal axis (i.e., “Did Enroll” and “Did Not Enroll”) represents whether the parcel was actually enrolled in the program that provides the largest tax benefit.

Table 6. Classification of parcels according to financial implications of program choice.

	Did enroll	Did not enroll
SFIA Program	Should enroll in SFIA <i>and</i> Did enroll in SFIA	Should enroll in SFIA <i>and</i> Did not enroll in SFIA
2c Program	Should enroll in 2c <i>and</i> Did enroll in 2c	Should enroll in 2c <i>and</i> Did not enroll in 2c

Parcels are categorized in Table 6 according to the property tax savings achieved (or the savings foregone) from enrollment in the landowner’s preferred tax program. However, the savings and losses shown in each category are *relative* to the savings offered by the other program. To

illustrate with an example, a forest landowner might have enrolled a parcel into the 2c program and thus reduced their annual property tax liability by \$100, however, they might have saved \$350 annually by enrolling the parcel into the SFIA program. Because the landowner chose to enroll the parcel into the 2c program over the SFIA program, they chose to forego \$250 in savings. In other words, they lost \$250 *relative* to the savings offered by the SFIA program. This hypothetical owner is not acting in accordance with the behavior of a cost minimizing owner. In Table 6, this owner would be grouped in the upper-right category “SFIA/Did Not Enroll.” This research assumes that the value of avoiding the covenant required by the SFIA program, or the opportunity cost of the covenant, is \$250 to this hypothetical owner.

Table 7 illustrates the average savings and the average foregone savings for each category of enrolled parcel as described in Table 6. Recall that these savings and losses are relative to the savings offered by the opposite program. Those parcels that should have been and were enrolled in the SFIA program realized an average annual savings of \$907.46 more than they would have had they been enrolled into the 2c program. This translates to \$6.49 per acre. The average annual savings for parcels that should have been and were enrolled into the 2c program was \$607.52 per parcel, or \$14.23 per acre, more than that offered by the SFIA program. Parcels that should have been enrolled in the SFIA program, but were not, chose to forego an average of \$422.08, or \$4.35 per acre. Likewise, parcels that should have been enrolled in the 2c program, but were not, gave up an annual savings that averaged \$192.63, or \$3.57 per acre. Landowners enrolling parcels into the SFIA program when the 2c program offered greater financial incentive are assumed to have been unaware of the 2c program’s existence; otherwise they are choosing to forego financial savings as well as their developmental rights.

Table 7. Average parcel savings/losses according to enrollment categories.

	Did enroll	Did not enroll
SFIA (should enroll)	\$908 per parcel \$6.49 per acre	(\$422) per parcel (\$4.35) per acre
2c (should enroll)	\$608 per parcel \$14.23 per acre	(\$193) per parcel (\$3.57) per acre

*Negative values in parentheses.

Table 8 reveals the number of parcels falling into each enrollment category as described in Table 6. According to the “Row Sum” column of Table 8, 1,205 parcels (90%) should have been enrolled into the SFIA program in order to maximize the tax benefit offered by either tax incentive program. Yet only 414 parcels (34% of the 1,205 parcels) that should have been enrolled in the SFIA program to maximize tax benefits were actually enrolled into the SFIA program. Likewise, 129 parcels (10%) should have been enrolled into the 2c program in order to maximize the financial incentive offered by either program. Only 7 parcels (5% of the 129 parcels that should have been enrolled) were not enrolled in the 2c program. This indicates nearly all parcels that should have been enrolled into the 2c program to achieve the largest financial incentive payment offered by either program were, in fact, enrolled into the 2c program. Table 8 also shows that only 543 (40%) of the parcels were enrolled into the program that would minimize the property tax liability on that parcel. Thus, 798 (60%) of the 1,341 parcels were enrolled in a program that did not achieve the highest level of savings obtainable.

Table 8. Number of parcels achieving a savings/loss within each enrollment category.

	Did enroll	Did not enroll	Row sum
SFIA (should enroll)	414 parcels (31%)	791 parcels (59%)	1,205 parcels (90%)
2c (should enroll)	129 parcels (10%)	7 parcels (< 1%)	129 parcels (10%)
Column sum	543 parcels (40%)	798 parcels (60%)	1,341 parcels

Parcels were grouped according to the number of landowners who enrolled them in one of the two tax incentive programs following the format used in Tables 6 to 8. Of the 373 landowners enrolling in SFIA, 367 (98%) maximized their financial interests by enrolling in the program that provided them the largest annual property tax incentive, while only six owners (2%) opted to forego the greater financial incentive they would have realized had they enrolled in the 2c program. Surprisingly, only 137 owners (17%) of the 827 who enrolled in the 2c program made a financially rational decision by doing so. Six hundred-ninety owners (83%) who enrolled in the 2c program chose to forego annual savings. In total, 514 NIPF landowners (43%) acted as rational economic consumers while 685 landowners (57%) ignored the opportunity to capture additional savings offered by the other tax program. Eighty-eight percent of the 1,200 total landowners should have enrolled in the SFIA program, while only 143 owners (21.9%) should have enrolled in the 2c program.

Table 9. Number of landowners achieving a savings/loss within each enrollment category.

	Did enroll	Did not enroll	Row sum
SFIA (should enroll)	367 landowners	690 landowners	1,057 landowners
2c (should enroll)	137 landowners	6 landowners	143 landowners
Column sum	514 landowners	685 landowners	1,200 landowners

4.2.2 Distribution of Enrolled Parcel Savings/Losses

Another way to understand landowner decision-making in light of each property tax incentive programs' requirements is to examine the distribution of savings offered by each program across all parcels. Because both programs will offer landowners a financial incentive, each program's financial benefit relative to the other program can be compared. Therefore, the SFIA savings differential, defined as the difference between the savings offered by the SFIA program and the savings offered by the 2c program, is calculated for each parcel and displayed in a series of histograms below.

Figure 2 displays the SFIA savings differential assuming all 1,341 parcels enrolled in the SFIA program. The lightly shaded bars indicate those properties in which enrollment into the 2c program, and not the SFIA program, would provide the greatest annual financial benefit. One

hundred thirty-six parcels (10%) have a negative SFIA savings differential, meaning the largest financial benefit would be realized if these forest lands were enrolled in the 2c program. For these parcels, the annual financial benefit provided by the 2c program exceeds the benefit provided by the SFIA program by an average of \$583 per parcel. The remaining 1,205 parcels (90%) have a positive SFIA savings differential, meaning enrolling in the SFIA program would produce a larger annual financial benefit (averaging \$593 per parcel) than the 2c program.

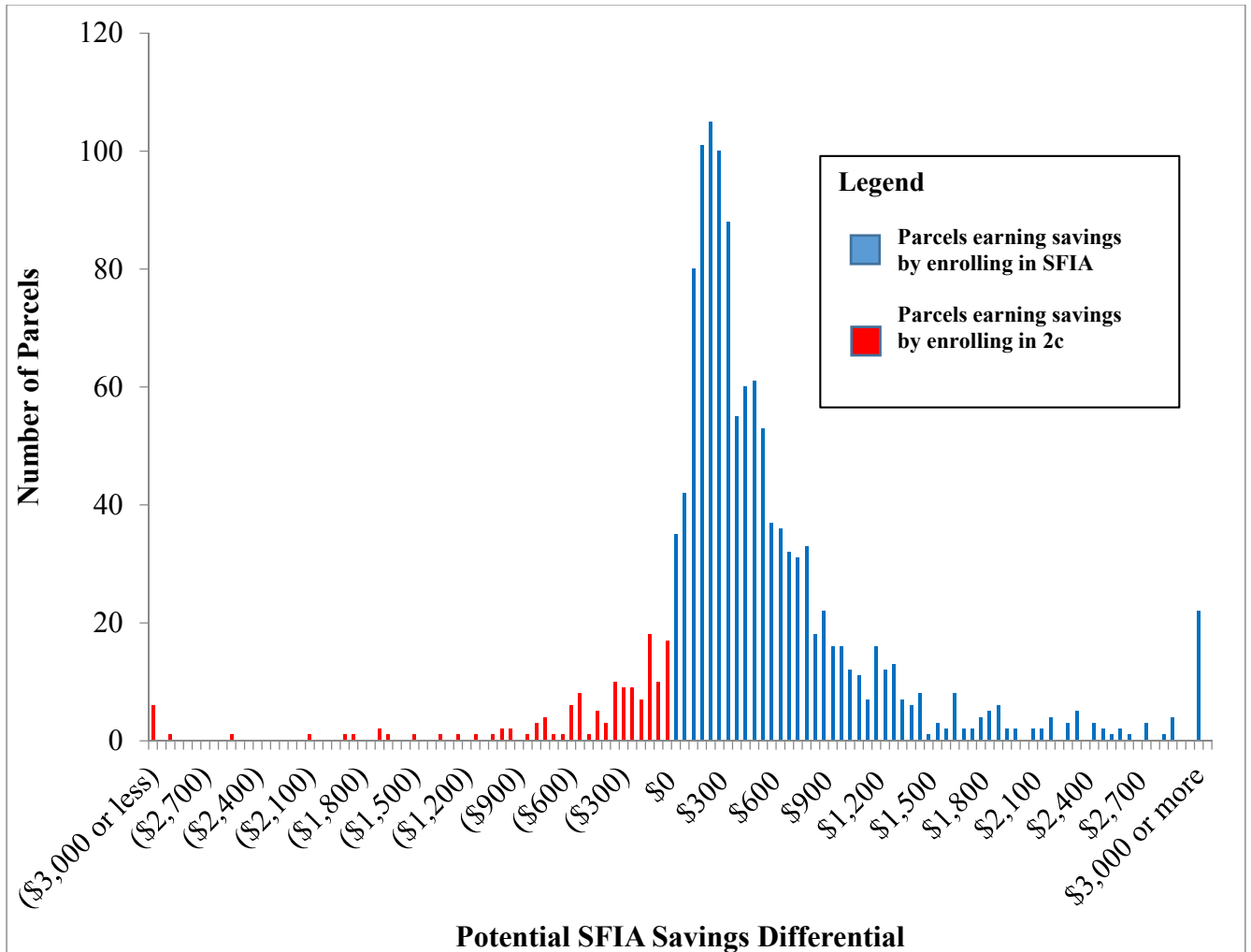


Figure 2. Increased (decreased) annual financial benefit provided by the SFIA program compared to the 2c program.

From this distribution, we observe the vast majority of parcels (90%) should be enrolled in the SFIA program if the landowner is interested in maximizing their financial interest by participating in one of the preferential forest property tax laws. This distribution serves as a baseline for comparison between the property tax incentive program in which landowners should enroll their parcels to maximize their annual financial benefit and the program in which they actually enrolled.

Figure 3 displays the annual financial incentive gain (loss) for those landowners who enrolled in the 2c program in 2009. The lightly shaded bars (negative values) are associated with those parcels that would have received a larger annual financial benefit from enrolling in the 2c program; the dark bars (positive values) represent parcels that would have realized a larger annual financial benefit from enrolling in the 2c program. Of the 920 parcels that were enrolled in the 2c program, 791 parcels (86%) chose to forego the additional annual financial benefit (averaging \$422, or \$4.35 per acre) provided by the SFIA program. The 129 parcels (14%) that generated a larger annual financial benefit by enrolling in the 2c program saved an average of \$607, or \$14.23 per acre, per year over the financial incentive provided by the SFIA program.

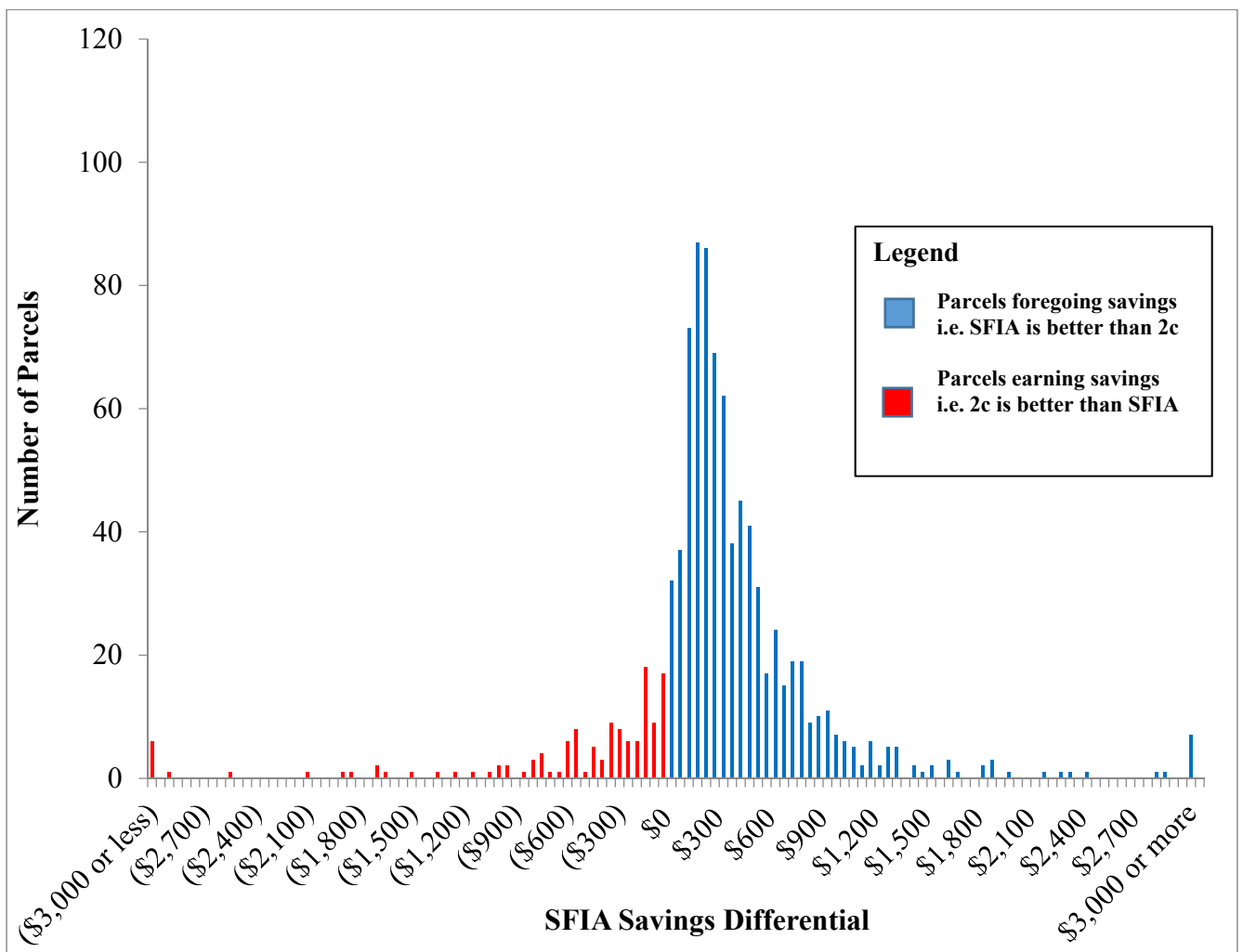


Figure 3. Actual annual financial gain (loss) earned from parcels enrolled in the 2c program.

Figure 4 illustrates the distribution of the SFIA savings differential for the 421 parcels that were actually enrolled in the SFIA program (Figure 4). Seven of these parcels (1.7%) would have achieved a greater annual financial benefit had they enrolled in the 2c program. This finding was unexpected, as these seven parcels' ability to be developed was encumbered while also foregoing

savings from the 2c program. We assume these seven landowners were either unaware of the 2c program or misunderstood the magnitude of the program’s annual financial benefits. The remaining 414 parcels (98.4%) enrolled in the SFIA program realized, on average, an additional annual financial benefit of \$907.46, or \$6.49 per acre, over what would have been realized had they been enrolled in the 2c program.

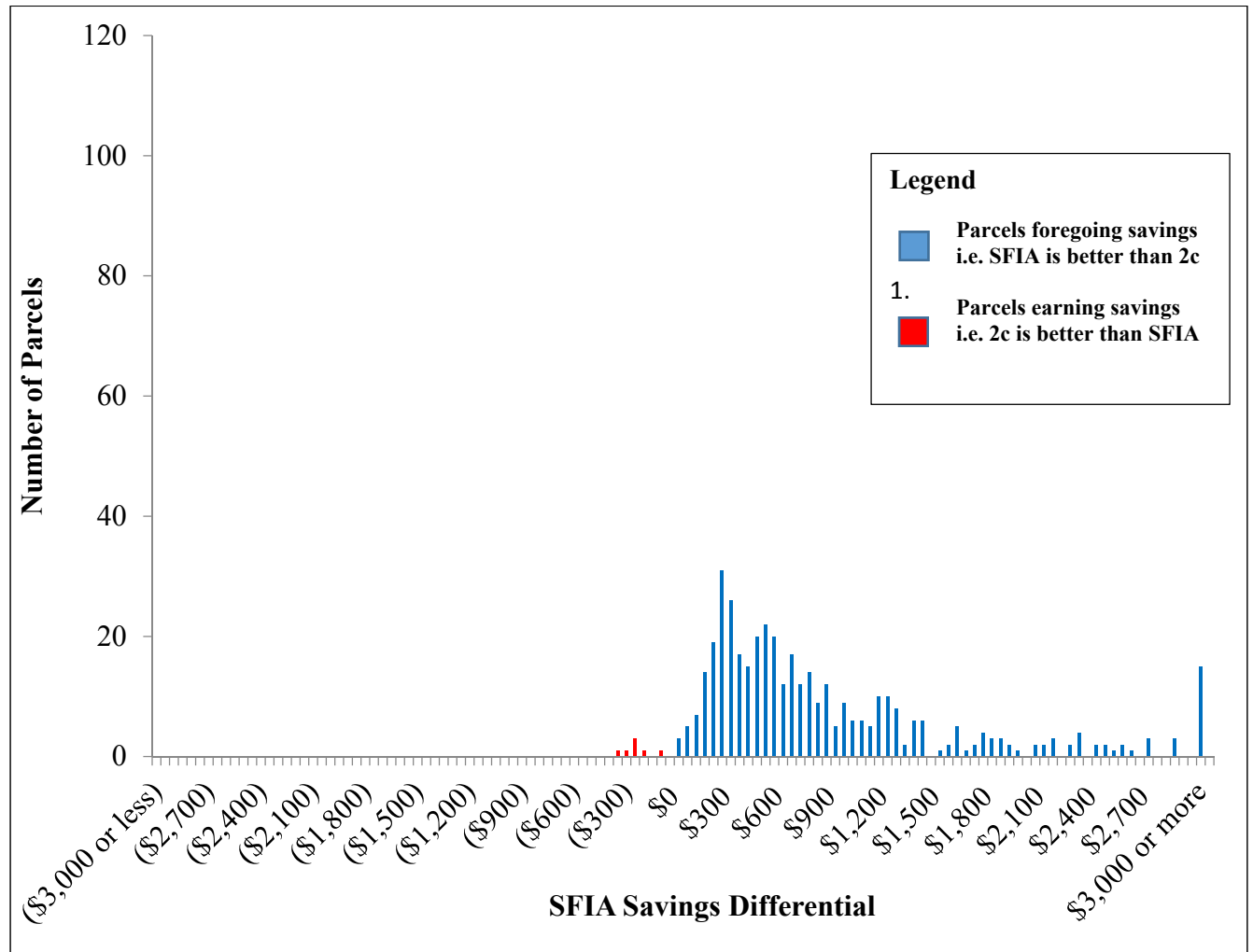


Figure 4. Actual annual financial gain (loss) earned from parcels enrolled in the SFIA program.

4.3 Model Results

The results of our logistic model (run using SAS version 9.2) are presented in Table 10. Seven of the nine explanatory variables used in the model are statistically significant in predicting the probability of enrolling in the SFIA program: POPCHANGE, FIVECITY, FAMILY, MULTNONCONT, LAKE, RIVER, and LOGSFIAADVANTAGE. In addition to the coefficient for each explanatory variable, we also calculated the mean value of the variable and the marginal effect of the variable. The marginal effect describes the resulting change in probability for enrolling in the SFIA program given a one unit change in the explanatory variable. The Hosmer-Lemeshow goodness-of-fit test is a measure of overdispersion and will exhibit a large chi-

squared value (small P-value) when observations do not match their expected values (Hosmer and Lemeshow 1980). The Hosmer-Lemeshow value for our model is small ($P = 0.183$) indicating an adequate model fit. The likelihood value is statistically significant at $P < 0.001$ demonstrating our model results are significantly better than a random guess at predicting enrollment in the SFIA program. At the mean values for all variables (significant and nonsignificant), our model predicts 28% enrollment in the SFIA program which is slightly more than 3% from the actual level of enrollment in the SFIA program (31%).

The POPCHANGE continuous explanatory variable is significant ($P < 0.01$) and has a mean value of 2.52%. The coefficient for POPCHANGE is -2.642 illustrating that increases in the percent of population change between 2000 and 2009 will decrease the probability that a landowner will enroll that parcel in the SFIA program. The marginal effect for the POPCHANGE variable is -0.5296 meaning that a one unit (1%) increase in the POPCHANGE variable will result in a 0.5% decrease in the probability of a landowner enrolling in the SFIA program.

Table 10. Logistic model results.

<i>Explanatory variables</i>	<i>Mean value</i>	<i>Coefficient</i>	<i>Standard error</i>	<i>P-Value</i>	<i>Marginal effect</i>
POPCHANGE	2.52	-2.6420	0.6196	<0.0001***	-0.5296
FIVECITY	0.51	-0.4523	0.1322	0.0006***	-0.0908
FAMILY	0.93	-0.4220	0.2530	0.0988*	-0.0846
ABSENT	0.72	-0.1794	0.1482	0.2273	N/A
MULTNONCONT	0.18	0.8043	0.1715	<0.0001***	0.1612
LAKE	0.16	-0.6646	0.2011	0.0006***	-0.1332
RIVER	0.13	-0.6023	0.2043	0.0023**	-0.1207
ROAD	0.84	-0.1640	0.1748	0.3505	-0.0329
LOGSFIAADVANTAGE	4.15	41.4380	4.5941	<0.0001***	8.3060
Intercept	1	-172.1616	19.1212	<0.0001 ***	N/A
P(SFIA Enrollment mean values) = 27.74%			*P < 0.10	** P < 0.01	*** P < 0.001
		χ^2 Value	DF	$Pr > \chi^2$	
Likelihood ratio		205.86	9	<0.0001***	
Hosmer-Lemeshow GOF Test		11.335	8	0.7833	

The other proxy for developmental pressure, FIVECITY, is also significant at the $P = 0.01$ level. The mean value for the FIVECITY variable is 0.51 indicating that 51% of the landowners enrolled parcels within five miles of an incorporated city. This variable negatively influences the probability of enrolling in the SFIA program; the marginal effect is -0.0908, meaning parcels within five miles of an incorporated city are 9% less likely to enroll in the SFIA program than identical parcels located more than five miles from a city.

The FAMILY binary variable is significant at the $P = 0.10$ level and has a mean value of 0.93. The coefficient for the FAMILY variable is -0.4220 indicating that identifying as a family forest owner has a negative influence on the probability of enrolling in the SFIA program. The

marginal effect of the FAMILY value is -0.0846, meaning that identifying a parcel as owned by a family forest owner decreases the probability that the parcel is enrolled in the SFIA program by 8%.

The MULTNONCONT variable is significant at the $P = 0.01$ level and has a mean value of 0.18. The coefficient for the MULTNONCONT variable is 0.8043, demonstrating a positive influence on the probability of enrolling in the SFIA program. The marginal effect for the MULTNONCONT variable is 0.1612 which reveals that a parcel owned by a landowner that has owns other enrolled parcels increases the probability that the parcel is enrolled in the SFIA program by 16%.

The LAKE binary variable is significant at the $P = 0.01$ level and has a mean value of 0.16. The coefficient for the LAKE variable is -0.6646 indicating a negative influence on the probability of enrolling in the SFIA program for properties adjacent to a lake. The marginal effect for the LAKE variable is -0.1332, indicating enrollment in the SFIA program is less likely if the forest land is adjacent to a lake. A parcel with lake frontage decreases the probability of enrolling in the SFIA program by 13%.

The RIVER binary variable ($P < 0.01$) has a mean value of 0.13. The negative coefficient for the RIVER variable indicates a decreased probability of enrolling in the SFIA program if the parcel is adjacent to a river. Forest land with river frontage is 12% less likely to enroll in the SFIA program than an identical track not adjacent to a river. The LAKE and RIVER explanatory variables have very similar mean, coefficient, and marginal values illustrating their similar effect on the probability of enrolling in the SFIA program.

The LOGSFIAADVANTAGE variable is significant ($P < 0.01$) has a positive coefficient, as expected, indicating the greater the financial attractiveness of the SFIA over the 2c program, the greater the probability the landowner will enroll land in the SFIA program instead of the 2c program. To interpret this variable, it has to be transformed back to its original form (i.e., the SFIA savings differential) by taking the anti-log then subtracting 14,000. For example, the 4.16 mean SFIA savings differential value from our sample represents a \$309 annual financial advantage of the SFIA program over the 2c program. Following a similar procedure with the marginal effect estimate, we found that the effect of a \$1 increase in the SFIA savings differential at the \$309 mean, results in a 0.025% increase in the probability of enrolling in the SFIA program. Likewise, a \$100 increase in the mean SFIA savings differential is estimated to increase the probability of enrollment in the SFIA program by 2.5%.

We modeled the probability of enrolling in the SFIA program as a function of SFIA savings differential as estimated by our model (Figure 5). In order to achieve 50% enrollment in the SFIA program, our model estimates that the average SFIA savings differential for all landowners would need to be \$1,279 per parcel. Recall that the mean SFIA savings differential observed for our population of enrolled landowners is \$390. Our model predicts that the average annual SFIA savings differential needs to increase by \$969 in order to get half of the landowners in our dataset to enroll in the SFIA program and the other half to enroll in the 2c program.

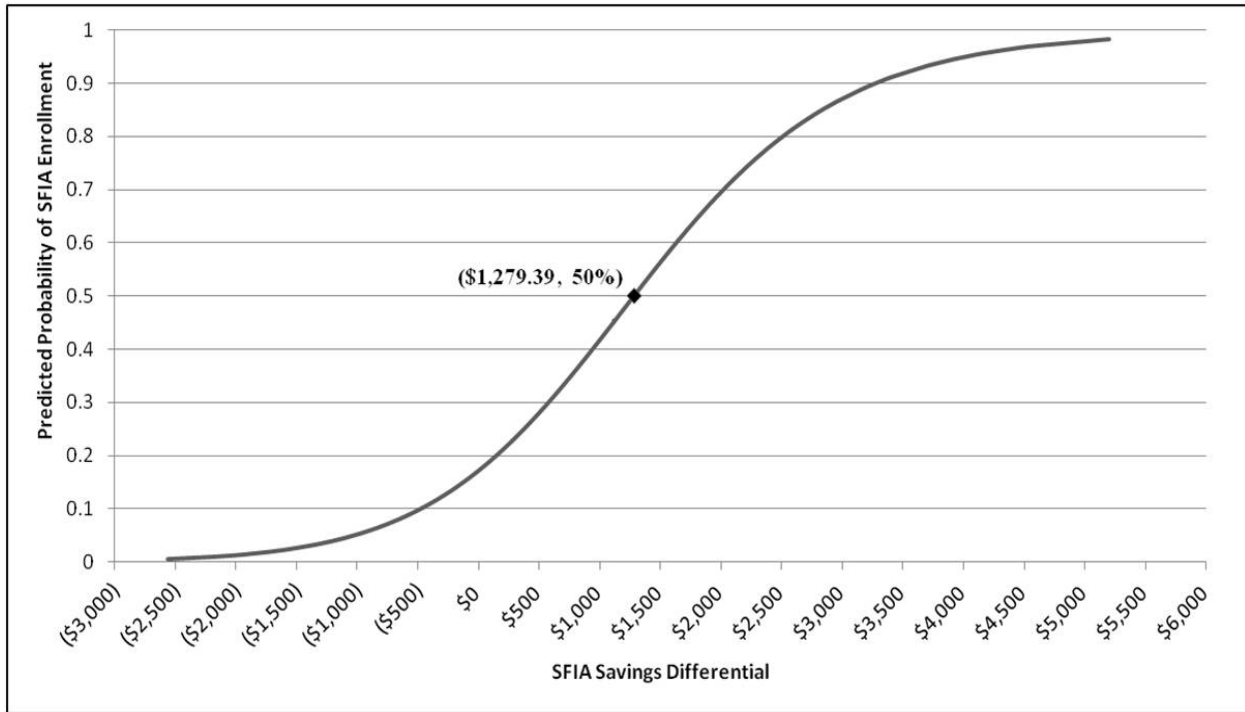


Figure 5. Estimated probability of enrollment in the SFIA Program as a Function of the SFIA Savings Differential

5. Discussion

5.1 Opportunity Cost of Developmental Deed Restriction

One of the primary objectives of this study was to identify the value forest landowners in Minnesota place on a developmental deed restriction from empirical data. Forest landowners who enrolled parcels in the 2c program when they would have achieved greater property tax savings by enrolling those parcels into the SFIA program are indicative of the value of the eight-year minimum covenant required by the SFIA program. The minor differences between requirements of the SFIA and 2c programs, besides the covenant requirement, allows us to deduce the monetary value of the covenant requirement from observational data. Tables 7, 8, and 9 revealed that 690 landowners who enrolled 791 parcels into the 2c program were willing to forego an average of \$422 (\$4.35 per acre) per parcel in annual savings in order to avoid the SFIA covenant requirement. In other words, the average forest landowner who enrolled a parcel(s) into the 2c program, and did so at a loss, would have required an additional \$422 in annual savings per parcel from the SFIA program in order to accept the covenant requirement. Therefore, we estimate the average opportunity cost of an eight-year covenant to NIPF and family forest landowners in Minnesota is an annual payment of \$422 per parcel. Over the period of eight years, the average annual undiscounted opportunity cost of NIPF and family forest owners totals to \$3,377 per parcel. Assuming a discount rate of 4%, the opportunity cost per parcel over the eight-year minimum enrollment period sums to \$2,842.

One can reasonably argue this foregone tax savings represents the value these landowners place on preserving the option to develop their properties, suggesting this is an important right they are not quickly willing to relinquish. A portion of landowner reluctance to enroll in the SFIA program is also likely tied to the SFIA requirement that a developmental deed restriction is

placed on the property for at least eight years. Recall that relinquishing the property's development rights for at least eight years is formalized by a legal covenant recorded with the property title. It is likely some landowners are willing to forego the land's development rights for the foreseeable future, but are not willing to formalize this loss of right through the recording of a legal instrument. Two other hindrances to enrollment in the SFIA program could be the program's four year in advance request-for-removal requirement and the penalty for early removal. Landowners may view these stipulations as additional factors that contribute to the loss of their property rights. Others have identified landowner hesitancy in participating in government programs as an important concern, with many believing program participation could lead to additional regulation or loss of land use or management rights (e.g., Brunson et al. 1996, Creighton et al. 2002, Leahy et al. 2008). We suspect for some owners, the covenant requirement is the major barrier to participating in the SFIA program, and it is likely some landowners who have no intention of developing their lands are not willing to formally relinquish these rights. Given the limitations of our data set, we are not able to apportion how much of the annual foregone tax savings landowners attach to the eight year (minimum) loss of development rights and how much is attributable to the covenant recording requirement, the penalty for early removal, or the request-for-removal requirement.

5.2 Relevance of Model Results

Our model of landowner program choice includes population change in the immediate area and the parcel's proximity to an incorporated city as measures of development pressure. Although both variables were significant and inversely related to enrollment in the SFIA program, the influence of both was modest. For example, the estimated probability a landowner will enroll in the SFIA program only decreased 1% when the 2000 to 2009 percent change in township population varied from -52% to 107% (the minimum and maximum values in our dataset). Similarly, the model estimates only a small increase in the probability of enrolling in the SFIA program (from 25% to 33%) for forest land located more than, versus within, five miles from an incorporated city. These results are encouraging in that they suggest policy tools requiring landowners to give up development rights have some appeal even in areas where development pressure is high. Even though a minority of Minnesota forest landowners opted for the SFIA program, those that did owned forested land in areas representing a gradient of development pressure.

Our model included two variables that describe two seemingly dissimilar cohorts of landowners. We hypothesized family forest owners, in general, are not as motivated by finances as incorporated entities, which the literature supports (Baughman 1988, Butler 2008, Daniels et al. 2010). Our model confirmed this hypothesis and found that family forest owners were less likely to enroll in the SFIA program than the 2c program. This effect was moderate and implies that increasing family forest owners' enrollment into a program like the SFIA program may require a larger incentive payment or increased educational efforts. The MULTNONCONT variable was used as a proximate measure of the degree to which a landowner is financially motivated, the assumption being that landowners enrolling multiple, noncontiguous parcels tend to view landownership as a financial investment with the objective of maximizing returns. This hypothesis is largely speculative, but the model confirmed this tendency. A parcel that is owned by a landowner with other, noncontiguous parcels enrolled into a program increases the likelihood of being enrolled in the SFIA program from 27% to 45%. This strong effect confirms

that landowners who enroll multiple parcels into a program tend to carefully weigh the financial implications of both programs.

The model also uses lake and river frontage as a measure of high amenity features associated with forest land. A parcel's adjacency to a lake or river was found to negatively affect the probability of enrolling in the SFIA program, with the influence of each on SFIA enrollment probability very similar. The likelihood forest land is enrolled in the SFIA program decreases from 31% to 20% when it is adjacent to a lake. Similarly, parcels with no river frontage have an estimated enrollment probability of 30%, compared to 19% when a parcel is adjacent to a river. Because many of these high amenity forest lands have high development potential, their taxable values are generally higher than non-waterfront forests. We suspect higher property taxes may be contributing to the negative influence lake and river adjacency has on SFIA enrollment probability. We did not include property taxes as an explanatory variable in our model, as it is highly correlated with the LOGSFIAADVANTAGE variable. As such, we were not able to examine how property taxes (which are highly correlated to taxable land values) influence a landowner's enrollment decision.

The LOGSFIAADVANTAGE variable substantiates our hypothesis that landowners become progressively more willing to forego their developmental rights as the difference in annual financial incentive increases between the SFIA and 2c programs. Interestingly, the model predicts a 17% enrollment in the SFIA program when there is no difference between the financial incentive offered by the 2c program and the SFIA program (Figure 5). Perhaps these landowners have no intention of developing their forest land and view a developmental restriction as a benefit, rather than a cost. Similar to the hundreds of conservation easements that are donated every year, these owners may be altruistically motivated and believe preserving forest land has a non-monetary value. Like a permanent a conservation easement, a developmental deed restriction may affect the overall value of the property negatively, hence reducing the tax burden on the property as an additional benefit.

5.3 Effectiveness of the SFIA and 2c Programs

Before any judgment can be made as to whether the SFIA program or the 2c program is a more suitable preferential tax program for Minnesota forest landowners, the effectiveness of each program should be considered. Effectiveness is a measure of how well a preferential tax program accomplishes its stated objectives. The objectives of the SFIA program are to promote long term sustainable forest management whereas the objectives of the 2c program are to promote sustainable forest management. During the first few years the SFIA program was available to forest landowners enrollment did not reach the levels that policy makers had hoped for (Kilgore et al. 2007). The low enrollment was attributed to the covenant requirement. The 2c program was enacted to get forest landowners to enroll in some sustainable forest management program (T. Kroll pers. comm. Feb. 22, 2010).

In 2009, 373 forest landowners enrolled 60,323 acres into the SFIA program and 827 forest landowners enrolled 80,783 acres into the 2c program (Table 4). This equals approximately 143 acres per parcel enrolled in the SFIA program and 88 acres per parcel enrolled in the 2c program. There were an estimated 175,000 NIPF landowners who owned 5.7 million acres in Minnesota in 2009 (MN DNR 2010). The 2009 enrollment of 1,200 forest landowners into the SFIA or 2c

program comprised of 0.68% of all NIPF owners within the state; however, this does not account for the owners who enrolled into the SFIA program prior to 2009. Accounting for these owners increases the percentage of enrolled NIPF owners to 1.7% of NIPF owners within the state. It is difficult to fully assess the relative effectiveness of the 2c program to the SFIA program, as 2009 was the first year the 2c program was available for enrollment. While these two programs should be monitored over time to fully assess their relative effectiveness, a few conclusions can be drawn from this study. The 2c program attracted many more landowners (70% of the parcels enrolled in 2009) than the SFIA program (30% of enrolled parcel). The larger proportion of landowners enrolling in the 2c program in 2009 might be attributed to the program's "newness," but it is more likely that the prospect of avoiding a covenant was more enticing to these landowners.

Both programs could arguably have met their objectives in 2009, as the enrolled forest landowners are committed to sustainably manage their lands that year. However, owners enrolling in the SFIA program in 2009 committed their lands to be sustainably managed until at least 2017, whereas landowners enrolled in the 2c program have only made a commitment to sustainably manage their forests for 2009. The owner who enrolled into the 2c program has the option of developing and/or subdividing the land in 2010. The average \$5.99 per acre paid to the owner enrolled in the 2c program in 2009 is a cost paid by all other non-2c program property tax payers in the local taxing district (i.e., town or township, county, school district) where the enrolled land resides; most of the ecological, recreational, and timber-harvesting utility on that owner's land could be severely diminished if the land is subsequently developed. The same can be said for the SFIA program after the enrolled owner's minimum time required to be in the program has expired. However, the SFIA program requires the landowner to wait an additional four years after requesting to be removed from the program. The waiting period, in conjunction with the severe penalties for early withdrawal, should hamper most incentive to the forest landowner to quickly turn over the property to a developer. However, if developers are willing to pay enough money, owners with land enrolled in the SFIA program may accept the early withdrawal penalties. Overall, the SFIA program is more effective at realizing the benefits of any sustainable management practices that have been conducted on the enrolled property over time.

It should also be noted that the coexistence of the 2c and SFIA programs increases the opportunity cost of forest landowners to commit to an eight year covenant requirement. Because forest landowners have the option of enrolling in a program that offers financial savings but does not require a covenant, theoretically, landowners will require the savings offered by the 2c program plus an additional payment to accept the covenant requirement. It is assumed that when offered the same level of savings to choose between two preferential tax programs, one with and the other without a covenant requirement, a forest landowner would always choose the program that is least restrictive. Therefore, the forest landowner would choose the program without a covenant requirement given the same level of savings. Without the option to enroll in a program that does not require a covenant, the opportunity cost for accepting the covenant requirement is most likely lower. The implication of this logic is that the coexistence of the 2c program with the SFIA program diminishes the effectiveness and efficiency of the SFIA program.

6. Conclusions

A strength of our study is its use of data that revealed the enrollment preferences of forest landowners, rather than relying on surveying techniques to approximate private forest owner preferences. Because the two forest property tax programs were identical in all meaningful respects sans the requirement of one that landowners give up development rights for at least eight years, we were able to attribute a landowner's decision to forego annual property tax relief to their unwillingness to relinquish the land's development rights. We are unaware of a similar study in this regard.

Our study highlights the difficulty of securing widespread participation in incentive programs that require forest landowners to give up development rights, even if only temporary doing so. We found forest landowner resistance to the eight-year minimum development restriction required by the SFIA program was widespread and substantial, the same conclusion reached in Kilgore et al. (2008). Those who forfeited additional property tax savings in order to avoid giving up this right did so at an average cost of \$422 per parcel. Yet the results suggest that policy tools requiring the development rights of landowners as a condition of participation can work, even in areas subject to high development pressure.

7. Literature Cited

- Alig, R. J., and A.J. Plantinga, Andrew J., 2004. Future forestland area: impacts from population growth and other factors that affect land values. *Journal of Forestry* 102:19-24.
- Amacher, G.S., M.C. Conway, and J. Sullivan. 2003. Econometric analysis of nonindustrial forest landowners: Is there anything left to study? *Journal of Forest Economics* 9:137-164.
- American Farmland Trust; Northampton, MA: American Farmland Trust. 2008. FIC Fact Sheet and Technical Memo. *National Fact Sheets and Technical Memos*.
- Baughman, M.J. 1988. Natural resource characteristics preferred by woodland buyers in northern Minnesota. *Northern Journal of Applied Forestry* 5:69-70.
- Baughman, M.J., and K. Updegraff. 2002. Landowner survey of Forest Stewardship plan implementation. Report to United States Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry, University of Minnesota.
- Bell, C.D., R.K. Roberts, B.C. English, and W.M. Park. 1994. A logit analysis of participation in Tennessee's Forest Stewardship Program. *Journal of Agricultural and Applied Economics* 26:463-472.
- Best, C. 2002. America's private forests: challenges for conservation. *Journal of Forestry* 100:14-17.
- Birch, T.W., 1996. Private forest-land owners of the Northern United States, 1994. USDA Forest Service Resource Bulletin NE-136.
- Bliss, J.C. 2000. Public perceptions of clearcutting. *Journal of Forestry* 98:4-9.
- Brockett, C.D., and L. Gebhard. 1999. NIPF tax incentives: do they make a difference? *Journal of Forestry* 97:16-21.
- Broussard, S.R., S.B. Jones, L.A. Nielsen, and C.A. Flanagan. 2001. Forest stewardship education: fostering positive attitudes in urban youth. *Journal of Forestry* 99:37-42.
- Brunson, M.W., D.T. Yarrow, S.D. Roberts, D.C. Guynn, Jr., and M.R. Kuhns. 1996. Nonindustrial private forest owners and ecosystem management: can they work together? *Journal of Forestry*, 94:14-21.

- Butler, B.J. 2008. Family forest owners of the United States, 2006. *GTR-NRS-27*. Newtown Square, PA: USDA Forest Service, Northern Research Station.
- Butler, B.J., J.H. Hewes, P. Catanzaro, J.L. Green, M.A. Kilgore, D.B. Kittredge, J. Langer, Z. Ma, A. Reuben, and M. Tyrrell. 2010. Effects of federal, state, and local tax policies on family forest owners: technical report. USDA Forest Service/ University of Massachusetts Amherst, Family Forest Research Center, Amherst, MA. FFRC Research Paper No. 2010-01. Available on-line at: www.familyforestresearchcenter.org/projects/taxes.html.
- Conway, M.C., G.S. Amacher, J. Sullivan, and D. Wear. 2003. Decisions nonindustrial forest landowners make: an empirical examination. *Journal of Forest Economics* 9:181-203.
- Creighton, J.H., Baumgartner, D.M., and K.A. Blatner. 2002. Ecosystem management and nonindustrial private forest landowners in Washington State, USA. *Small-scale Forest Economics, Management and Policy* 1:55-69.
- Daniels, T.L. 2001. Coordinating opposite approaches to managing urban growth and curbing sprawl: a synthesis. *American Journal of Economics and Sociology* 60:229-243.
- Daniels, S.E., M.A. Kilgore, M.G. Jacobson, J.L. Green, and T.J. Straka. 2010. Examining the compatibility between forestry incentive programs in the US and the practice of sustainable forest management. *Forests* 1:49-64.
- Ellefson, P.V., A.S. Cheng, and R.J. Moulton. 1995. Regulation of private forestry practices by state governments. *Minnesota Agricultural Experiment Station, Station Bulletin no. 605*, pp.130 -134.
- Gobster, P.H., R.G. Haight, and D. Shriner. 2000. Landscape change in the Midwest: an integrated research and development program. *Journal of Forestry* 98:9-14.
- Gustafson, E.J., and C. Loehle. 2006. Effects of parcelization and land divestiture on forest sustainability in simulated forest landscapes. *Forest Ecology and Management* 236:305-314.
- Haines, A.L., T.T. Kennedy, and D.L. McFarlane. 2011. Parcelization: forest change agent in Northern Wisconsin. *Journal of Forestry* 109:101-108.
- Harmon, A.H., S.B. Jones, and J.C. Finley. 1997. Encouraging private forest stewardship through demonstration. *Journal of Forestry* 95:21-25.
- Helms, J.A., ed. 1998. *The Dictionary of Forestry*, 181. Bethesda, MD: The Society of American Foresters.
- Hibbard, C.M., M.A. Kilgore, and P.V. Ellefson. 2001. Property tax programs focused on forest resources: a review and analysis. Staff Paper Series no. 150. St. Paul, MN: Department of Forest Resources, University of Minnesota.
- Hosmer, D.W., and S. Lemeshow. 1980. A goodness-of-fit test for the multiple logistic regression model. *Communications in Statistics*, A9:1043-1069.
- Hughes, W. T. Jr., and G.K. Turnbull. 1996. Restrictive land covenants. *Journal of Real Estate Finance and Economics* 12: 9 -21.
- Husak, A.L., S.C. Grado, and S.H. Bullard. 2004. Perceived values of benefits from Mississippi's forestry Best Management Practices. *Water, Air, and Pollution: Focus* 4:171-185.
- Kilgore, M.A., and C.R. Blinn. 2004. Policy tools to encourage the application of sustainable timber harvesting practices in the United States and Canada. *Forest Policy and Economics* 6: 111-127.
- Kilgore, M.A., J.E. Leahy, C.M. Hibbard, and J.S. Donnay. 2007. Assessing family forestland certification opportunities: a Minnesota case study. *Journal of Forestry* 105:27-33.

- Kilgore, M.A., S.A. Snyder, J. Schertz, and S.J. Taff. 2008. What does it take to get family forest owners to enroll in a forest stewardship-type program? *Forest Policy and Economics* 10:507-514.
- Kline, J.D., D.L. Azuma, and R.J. Alig. 2004. Population growth, urban expansion, and private forestry in Western Oregon. *Forest Science* 50:33-43.
- Kline, J.D., and R.J. Alig. 2005. Forestland development and private forestry with examples from Oregon (USA). *Forest Policy and Economics* 7:709-720.
- Leahy, J.E., M.A. Kilgore, C.M. Hibbard, and J.S. Donnay. 2008. Family forest land owners' interest in and perceptions of forest certification: focus group findings from northern Minnesota. *Northern Journal of Applied Forestry* 25:73-81.
- Ma, Z., B.J. Butler, D.B. Kittredge, and P. Catanzaro. 2012. Factors associated with landowner involvement in forest conservation programs in the U.S.: Implications for policy design and outreach. *Land Use Policy* 29:53-61.
- Majumdar, I., L. Teeter, and B. Butler. 2008. Characterizing family forest owners: a cluster analysis approach. *Forest Science* 54:176-184.
- Mashour, T., J. Alavalapati, R. Matta, S. Larkin, and D. Carter. 2005. A hedonic analysis of the effect of natural attributes and deed restrictions on the value of conservation easements. *Forest Policy and Economics* 7:771-781.
- Mehmood, S.R., and D. Zhang. 2001. Forest parcelization in the United States: a study of contributing factors. *Journal of Forestry* 99:30-34.
- Minnesota Department of Natural Resources. 2010. A Strategic Plan to address forest-related conditions, trends, threats and opportunities as identified in the companion Minnesota Statewide Assessment of Forest Resources. Accessed online 6/4/2011 at: <http://files.dnr.state.mn.us/forestry/subsection/mnForestResourcestrategies.pdf>
- Minnesota Department of Revenue, Minnesota Forest Resources Council. 2000. A tax system that makes sense for Minnesota: forestry tax reform. Accessed online 11/05/2010 at: <http://www.leg.state.mn.us/docs/pre2003/mandated/010159.pdf>
- Minnesota Forest Resources Council. 1999. *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers and Resource Managers*. St. Paul, MN: Minnesota Forest Resources Council.
- Minnesota Statutes, 2009a. Chapter 290C. Sustainable Forest Incentives Act. St. Paul, MN: Office of the Revisor of Statutes.
- Minnesota Statutes, 2009b. Chapter 273.13 Subdivision 23. Class 2(d). St. Paul, MN: Office of the Revisor of Statutes.
- Miskowiak, D., and L. Stoll. 2006. Planning implementation tools purchase of developmental rights (PDR). *Center for Land Use Education*. Accessed online 07/16/2011 at <http://www.uwsp.edu/cnr/landcenter/pdf/implementation/PDR.pdf>.
- Mundell, J., S.J. Taff, M.A. Kilgore, and S.A. Snyder. 2010. Using real estate records to assess forest land parcelization and development: a Minnesota case study. *Landscape and Urban Planning* 94:71-76.
- Nagubadi, V., K.T. McNamara, W.L. Hoover, and W.L. Mills, Jr. 1996. Program participation behaviors of nonindustrial forest landowners: a probit analysis. *Journal of Agricultural and Applied Economics* 28:323-336.

- National Resources Conservation Service. 2012. FY-2009 HFRP Contract Information. Accessed online 10/05/2012.
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/easements/forests/?&cid=nrcs143_008414.
- Nowak, D.J., and J.T. Walton. 2005. Projected urban growth (2000-2050) and its estimated impact on the US forest resource. *Journal of Forestry* 103:383-389.
- Pruetz, R., and N. Standridge. 2009. What makes transfer of development rights work? Success factors from research and practice. *Journal of the American Planning Association* 75:78-87.
- Rickenbach, M., and T.W. Steele. 2006. Logging firms, nonindustrial private forests, and forest parcelization: evidence of firm specialization and its impact on sustainable timber supply. *Canadian Journal of Forest Research* 36:186-194.
- Rickenbach, M.G., and P.H. Gobster. 2003. Stakeholders' perceptions of parcelization in Wisconsin's Northwoods. *Journal of Forestry* 101:18-23.
- Snyder, S.A., M.A. Kilgore, R. Hudson, and J. Donnay. 2008. Influence of purchaser perceptions and intentions on price for forest land parcels: a hedonic pricing approach. *Journal of Forest Economics* 14:47-72.
- Stevens, T.H., S. White, D.B. Kittredge, and D. Dennis. 2002. Factors affecting NIPF landowner participation in management programs: a Massachusetts case study. *Journal of Forest Economics* 8:169-184.
- Sullivan, J., G.S. Amacher, and S. Chapman. 2005. Forest banking and forest landowners forgoing management rights for guaranteed financial returns. *Forest Policy and Economics* 7: 381-392.
- Theobald, D.M., J.R. Miller, and N.T. Hobbs. 1997. Estimating the cumulative effects of development on wildlife habitat. *Landscape and Urban Planning* 39:25-36.
- U.S. Department of Agriculture, Forest Service. 2004. The Healthy Forests Initiative and Healthy Forests Restoration Act: Interim Field Guide. FS-799. Washington, DC: U.S. Department of Agriculture, Forest Service.
- Wear, D.N., R. Liu, M. Foreman, and R.M. Sheffield. 1999. The effects of population growth on timber management and inventories in Virginia. *Forest Ecology and Management* 118:107-115.
- Wear, D.N., M.G. Turner, and R.J. Naiman. 1998. Land cover along an urban-rural gradient: implications for water quality. *Ecological Applications* 8:619- 630.
- Williams, D.E., R.R. Gottfried, C.D. Brockett, and J.P. Evans. 2004. An integrated analysis of the effectiveness of Tennessee's Forest Greenbelt Program. *Landscape and Urban Planning* 69:287-297.
- Zhang, D., and W. Flick. 2001. Sticks, Carrots, and Reforestation Investment. *Land Economics* 77:443-456.