

ABSTRACT

Snider, Anthony Glenn. Nonindustrial private forestland owners: Estimating responses to economic and demographic changes. (Under the direction of Frederick W. Cabbage)

This research consisted of two distinct efforts. First, following a literature review of the characteristics, objectives, and incentive programs available to nonindustrial private forest (NIPF) landowners, the potential effects of wood chip mill harvests on forest management practices of these landowners in North Carolina were analyzed. The study estimated NIPF pulpwood harvest volumes and the impacts of changes in timber market returns to NIPF owners. Economic welfare effects of producer and consumer surpluses attributable to market adjustments were also calculated. Potential savings from reduced site preparation costs from cleaner harvests associated with chip mill markets were estimated. Additionally, the potential changes in financial returns to growing timber with wood chip markets were estimated using discounted cash flow analyses of typical forest management returns.

Given the existing market structure and price elasticities for timber, increased timber demand and better markets would consistently increase economic returns for both timber buyers and sellers. In absolute terms, forest industry (buyers) had higher benefits while NIPF owners (sellers) had higher percentage benefits. Based on 1990 trends in timber production and prices, some NIPF owners have experienced decreased returns from softwood stumpage sales. Increasing hardwood pulpwood timber production and prices yielded average statewide incremental returns of \$595,000 per year for NIPF owners. Approximately 80% of the total value accrued to owners in the coastal plain,

but the largest average annual percentage increase per year (9.9%) was received for NIPF hardwood pulpwood harvests in the mountains.

Higher timber prices and shorter rotations for growing softwood timber led to sawtimber production with a chip component having the greatest returns for NIPF owners, followed by chipping the stand entirely at a shorter rotation, and last, production of sawtimber alone. These alternatives generated internal rates of return (IRRs) of 6% to 13%. The lower timber prices and long rotations for hardwoods generally yielded lower investment returns, ranging from 3% to 7% IRRs depending on the forest type and management regime. The addition of a wood chip component did little to increase these returns. These economic analyses suggest that better markets will benefit both NIPF landowners and timber buyers, thus prompting increased harvests for chip wood.

The second component of this research involved the analysis of archival tax data on the North Carolina Use-Value Property Tax Program. Following a review of rural land preservation tools, an analysis of the effects of property values, property taxes and population density on landowner decisions to sell, subdivide, or withdraw their properties from the use-value program in North Carolina was conducted. Parcel level tax data from nine counties representing the three geophysical regions and urban levels of North Carolina for the period 1987 through 1999 were collected using a disproportionate stratified systematic sample. Data were analyzed using logistic regression.

The odds of landowners subdividing increased with tract size, population density, and acreage value of the tract. Increases in population density, acreage value, and taxes paid raised the odds of landowners selling their properties. Sales were less likely to occur in urban counties. The odds of landowners deciding to withdraw from the use-value

program increased with higher population density, but declined with increases in property taxes. Additionally, withdrawal was less likely in the piedmont and among the largest parcels. The effect of population growth outweighed the effects of other continuous variables on all three landowner decisions and was the only significant variable in regressions on parcel sales, subdivision, and withdrawal from the use-value program.

**NONINDUSTRIAL PRIVATE FORESTLAND OWNERS:
ESTIMATING RESPONSES TO ECONOMIC
AND DEMOGRAPHIC CHANGES**

by

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DEDICATION

I wish to dedicate this work to two extraordinary people who created supportive space in my life. The first of these is my father-in-law, Edwin S. Shively, who's quiet strength and accepting spirit assisted me in pursuing whatever path suited my nature, without judgement. He calmly tolerated my political tirades (often against the candidate of his choice) and taught me the value of silence through countless hours helping him in his workshop or manning the shrimp nets on his boat in the sound behind Ocean Isle. We became friends in addition to family. Unfortunately, he passed away prior to the completion of my degree.

The second person to whom this work is dedicated is my aunt Nathalene Lankford, who has always made me feel that I am unique in the world. She has been one of the most constant lights in my life and one of my most steadfast sources of spiritual guidance. Her example of joyful faith and her unwillingness to utter an unkind word against anyone has given me continued hope for my species and a belief that worldly accomplishments are secondary to the health of my soul. It is impossible to convey how much she has given to me in all phases of my life. Her belief in me has helped me believe in myself. I am incredibly thankful to have her as part of my family.

BIOGRAPHY

I was born in Stuttgart, Germany on 20 January 1960. Shortly thereafter I came to the United States with my parents to live in Canton, North Carolina, where we remained until I reached the age of five. My family then moved to Southern Pines and eventually to a property surrounded on three sides by Weymouth Woods, a state park designed to protect one of the few remaining fragments of the longleaf pine ecosystem. Spending my adolescent years in this forest, for the most part alone, had a profound impact on my development and cultivated my interest in the natural world.

Following graduation from high school, I hitchhiked along the eastern seaboard to Nova Scotia and Newfoundland. Returning to North Carolina, I completed an Associate Degree in Science with honors at Sandhills Community College and a B.A. in Geography at the University of North Carolina at Chapel Hill. During the completion of the latter degree, I was blessed to be wed to Robbin Shively, after having met in an environmental science class. Also a geographer, Robbin and I spent much of our time exploring in her 1967 Volkswagen beetle before moving to Vermont to earn an M.A. in Political Geography.

We then moved back to North Carolina where I worked as a land surveyor and pursued additional graduate studies in Population Geography and Entomology. As a survey crew chief, I was often one of the last people to see wooded tracts slated for development in their forested state. I came to know first hand the extent of urban growth in the Piedmont of North Carolina and decided to enroll at North Carolina State University in Forestry to explore why land use changes occur and what means may be developed for controlling the direction and magnitude of those changes.

While at NC State, I received four fellowships: the Dan K. Moore Fellowship to Keep North Carolina Clean and Beautiful, the Hewlett Teaching Fellowship, the Preparing the Professoriate Teaching Fellowship, and the Namkoong Graduate Fellowship. I was responsible for a chapter in the North Carolina Chip Mill Study on potential economic responses of nonindustrial private forest owners to an influx of wood chip mills. A significant portion of my research on attrition to the North Carolina Use-value Property Tax Program was funded through a grant from Environmental Defense that I wrote in conjunction with Dr. Frederick W. Cubbage. In addition to my academic pursuits, I served as Graduate Student Representative for the College of Forest Resources and as President of the Natural Resources Organization of Graduate Students. I also conducted a logo design endeavor that resulted in the adoption of a new logo for the Department of Forestry.

My time spent at NC State has proven to be happy and fruitful. Many of my assumptions were challenged and I learned a great deal not only about natural resources, but also about people and how their beliefs influence their opinions. In the future I hope to take what I have learned here into the wider world and make a difference.

ACKNOWLEDGMENTS

Without the support and encouragement of numerous individuals, the completion of my degree would not have been possible. I would like to thank some of those people, beginning with my doctoral committee, Dr. Frederick W. Cubbage, Dr. Elizabethann O'Sullivan, Dr. George Hess, and Dr. Jon Stucky. Each of these faculty members encouraged my success and challenged me to go beyond my perceived limitations.

The analysis of attrition to the North Carolina Use-value Property Tax Program was underwritten by a grant from Environmental Defense. I would like to express my gratitude both to this organization and to Dan Whittle, who served as my liaison with Environmental Defense.

For logistical support and overwhelming patience in the face of confused receipts and ever-changing funding situations, thanks are in order to both Eileen Broderick and Michael Meiners. I am also appreciative of the friendship of my fellow cadre of students in the College of Natural Resources. They have enriched all aspects of my graduate experience. Rick Hamilton provided a sounding board for some of my thoughts about solutions to land use problems and helped clarify aspects of the use-value program.

Several of my friends deserve special recognition. Stephanie Jeffries helped maintain a good attitude in the extremely close quarters that served as our shared office. Her enthusiasm always served to raise the quality of my efforts. When the temptation to change career paths came to the fore, Todd Earnhardt wisely counseled me to stay the course and see the larger picture. Without the selfless contributions in time, travel, and diligence in scanning county tax records by Emerald Estock, I might still be collecting data. His efforts were beyond the measure of ordinary friendship and I am in his debt.

My family have been steadfast supporters throughout my education. In particular I wish to thank my mother-in-law, Gaynelle Shively; my father-in-law, Edwin Shively; my brother-in-law, Bill Wilson; and sister-in-law, Stella Shively for their belief in my ability and their refusal to ask when I was going to be finished with learning. There is no way for me to express my thanks to my wife and best friend, Robbin Snider. She has allowed me to open any door of interest throughout our life together and has kept me from being another divorced graduate student statistic.

Collection of the data from each of the counties was facilitated by a host of adept and affable records stewards and use-value program administrators. In each county I was provided all the records I needed for my research, training in using the computerized data bases, and a place in which to carry out data collection. These people made each county a pleasant place in which to work and I am grateful for having met each of the people with whom I interacted.

Finally, I need to thank the rogue crew: Calico Tom Flint, “Mad” Roger Vane, “Mad” Ethel Rackham, and “Bloody” Morgan Reid. The high level of insanity present in all these buccaneers helped preserve the sanity I still possess. They are “jolly rogers” all.

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CHAPTER 1. AN OVERVIEW OF NONINDUSTRIAL PRIVATE FORESTLAND

CHARACTERISTICS AND OBJECTIVES

Introduction

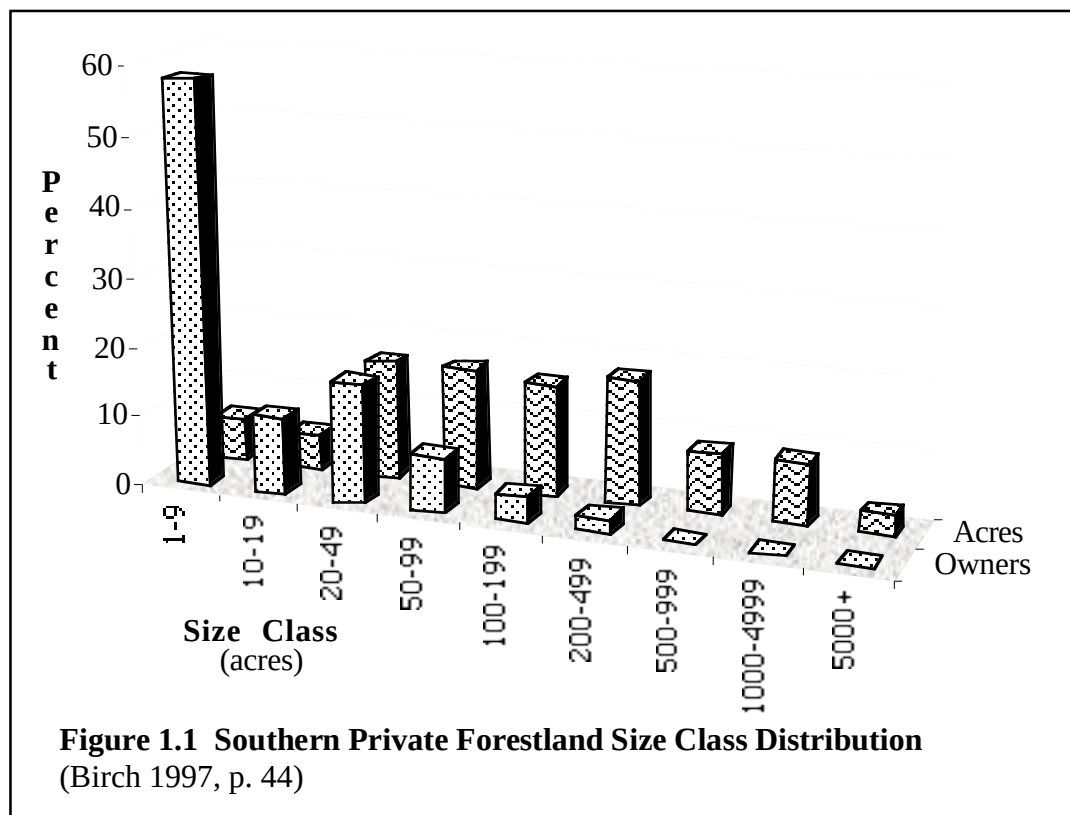
Thirty-three percent of the United States (736.7 million acres) is forested, 58% of which is privately owned. These forestlands include both forest industry properties and nonindustrial private forests (NIPFs). The latter are owned by persons or entities not involved in the wood processing industry. Two-thirds of American forests are in timberland, 73% of which is privately held (Birch 1996) (Table 1.1). Timberland is defined as forest land that is either producing or is capable of producing more than 20 cubic feet/acre/year of industrial wood and that is not withdrawn from timber utilization.

Table 1.1 National Forestland and Timberland Ownership in Millions of Acres				
	Public	Private		Total
		NIPF	Industry	Private
Forestland	312.9*			423.8*
Timberland	132	276.5†	81.5†	358*
*(Birch 1997) †(Ellefson et al. 1990)				

NIPF landowners hold nearly three-fifths of the nation's timberland (276.5 million acres) and provide nearly half of the wood harvested in the U.S. There are over seven million NIPF landowners in America, seventy percent of whom hold fewer than 10 acres. These small holdings comprise 3% of the total NIPF timberland acreage (Ellefson et al.

1990). Only eight percent of NIPF owners have holdings of 100 acres or more, but these owners control 73% of the total NIPF acreage (Weatherhead 1984).

In the South, three-fourths of private forest landowners hold tracts of fewer than 20 acres. This group controls 12% of the forestland in the South. Five percent of all private owners have tracts of more than 100 acres and these owners control 54% of the southern private forests (Moulton and Birch 1995) (Figure 1.1). Three-fourths of the



forests in the South are NIPFs (Baird et al. 1986). In North Carolina, timberland occupies 60% of the total land area and 76% of the timberland is owned by NIPFs (Johnson 1991). This group clearly dominates the overall forested landscape at the regional and state scales.

The timber output from these lands is important regionally and nationally. “Timber is the most important southeastern agricultural crop, having twice the value of soybeans or cotton and three times the value of tobacco, wheat, or corn” (Allen et al. 1996, p. 4). The South contains about 23% of the softwood growing stock in the U.S. and about 44% of the hardwood growing stock. In 1991, the South accounted 53% of the total U.S. softwood removals and 59% of the hardwood removals (Powell et al. 1993). The region produces more industrial roundwood than any other region in the world (Cubbage and Abt 1998). The dominance of NIPF owners among forest landowners and the economic importance of timber in the South make understanding the characteristics of NIPF owners important in the discussion of long-term landscape objectives. Their choices, as a class, have the potential to greatly modify the landscape.

NIPF Landowner Characteristics

Many research studies have been conducted to determine what factors influence NIPF management decisions. Only relatively recently have studies investigated the effects of markets and policies in conjunction with landowner characteristics on management behavior (Alig et al. 1990). Prior to 1979, studies of NIPF owners were primarily descriptive. These efforts tended to focus on one or more of several dichotomies: economic vs. social/psychological determinants of behavior (producer vs. consumer ideas), publicly desired behavior vs. individually rational behavior, and large vs. small ownerships. However, "The effects of markets have virtually been ignored in landowner studies: consequently landowner response under different market conditions remains unknown" (Royer 1979b, p. 25). Shortcomings of market analysis, aggregation,

and an excess of attention given to public rather than individual goals led Royer to declare that ". . . past landowner survey data are, at best, marginal" (1979b, p. 29).

Two additional problems are found in the NIPF literature. The first revolves around survey participant selection. Most NIPF studies have been based on random surveys of owners. These have usually not been stratified by size of holding, so those owners with smaller holdings have been over represented relative to the amount of timberland they control. A bias towards owners with larger holdings has occurred in samples based on geographic area (Royer 1980). The second concern is that responses expressed in the number of NIPF owners derived by either random or geographic methods are not directly comparable to those expressed in acreage.

General Objectives

"Foresters tend to characterize NIPF owners as rural-dwelling and land-connected, anti-environmentalist, timber-oriented, and intensely in favor of private property rights" (Jones et al. 1995, p.41). The validity of this statement has been called into question by findings in the literature. In addition to producing timber, NIPF owners also act as consumers of forest goods and services and their decisions reflect this perspective. When NIPF owners do sell timber, they are often acting as non-professional marketers selling to professional buyers and are therefore at an informational disadvantage.

To test the NIPF as consumer hypothesis, a study was conducted in New York to analyze the decision-making processes of NIPF owners harvesting their lands. The study found that 79% of the owners consulted only one source for price data. For about half of

these owners, the single source was the timber buyer with whom they contracted for harvest. Only 26% checked with a number of buyers, 17% relied on friends and neighbors, and 4% consulted the NY State Stumpage Price Report; a widely published listing of timber prices in the study area. The authors concluded that the selling behavior of the NIPF owners indicated that they operated under a consumer mentality rather than a producer mentality with response to forest products (Rosen et al. 1989).

When asked, NIPF owners often cite objectives other than timber production for owning forests. Nationally, “Nearly forty percent of the private forest landowners believe the primary reason for owning forestland is that it is simply 'part of the farm' or 'residence'" (Birch 1996, p. 15). As this figure includes both industrial and NIPF forests, the true percentage for NIPF owners is probably higher. While those private owners who hold their land with timber production as the main objective comprise only 3% of the total private forest landowner population, this 3% controls 29% of the private forest area in the U.S. (Birch 1996).

In the South, 38% of owners listed residence as their main reason for owning forestland. Eight percent cited farm or domestic use, 16% cited recreation or aesthetics, and investment was listed by 12% as their first consideration. Only 4% of private forest owners listed timber production as their main reason for owning forestland. On an area basis, timber production was the most important reason for ownership 35% of the time and land investment was second with 14% (Moulton and Birch 1995). “*On a total area basis, more than 60% of the southern forest land was owned by individuals who had timber production as a primary or secondary objective, and various commodity interests were important for more than 75% of the land base*” (Cubbage 1997, p. 20, emphasis

added). Thus, while many NIPF owners have non-timber reasons for owning forestland, a large percentage of southern forest acres are owned by persons with timber production objectives.

Studies conducted at the state level have yielded similar landowner objectives. For example, in a random, area based telephone survey of 731 NIPF landowners in Alabama, property was found to be owned for a variety of reasons, the most prevalent of which was to keep it in the family (Bliss and McNabb 1992). A study of NIPF landowners in Illinois found the three most important reasons for owning woodlands were: (1) providing for wildlife habitat, (2) for preservation of natural beauty, and (3) "provision of a heritage to pass on to future generations" (Young et al. 1984, p. 3). In a survey of Pennsylvania forest owners, reasons for owning property included that it was part of the farm, for farm and domestic use, aesthetic enjoyment, investment, recreation, part of residence and timber production (Birch and Pywell 1986). Work in Virginia by Amacher (1998) found that the owners of small tracts place more value on non-timber forest amenities than do owners of large forest parcels.

Specific Characteristics

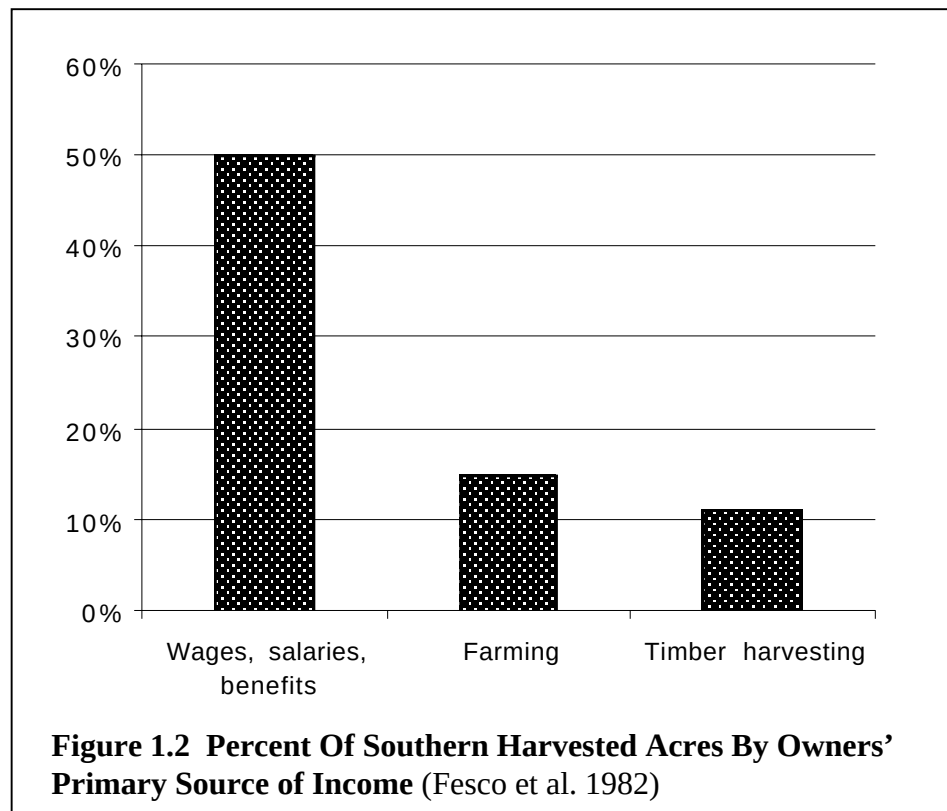
Yet most of the forestland in the South is harvested for timber.

While southern private landowners own forestland for a variety of reasons, most hold positive views on harvesting timber: 45% of owners have harvested timber from their land and 29% plan to harvest within the next 10 years. Significantly, owners of 78% of the private forestland acreage in the South have harvested timber from their lands, and owners of 60% of the land plan to harvest timber within the next 10 years. The 55% of owners who have not harvested on their lands own only 22% of the overall Southern forestland. Those who say they will never harvest their land own only 12% of the southern private forest (Moulton and Birch 1995, P. 44).

In North Carolina, as of 1994, 76% of forestland had been harvested for timber within the tenure of the current owner (Birch 1997). Reviewing the characteristics of NIPF owners who choose to harvest their forests provides insight into those owners who control the majority of forested acres.

Timber Harvesting

Of the southern NIPF land harvested in the decade prior to 1981, 89% was held as a family operation or partnership or corporation of family members. “Almost half of the harvested land was owned by persons whose major source of income was ‘wages, salaries, or retirement benefits’” (Fesco et al. 1982, p. 5) (Figure 1.2). Fifteen percent of

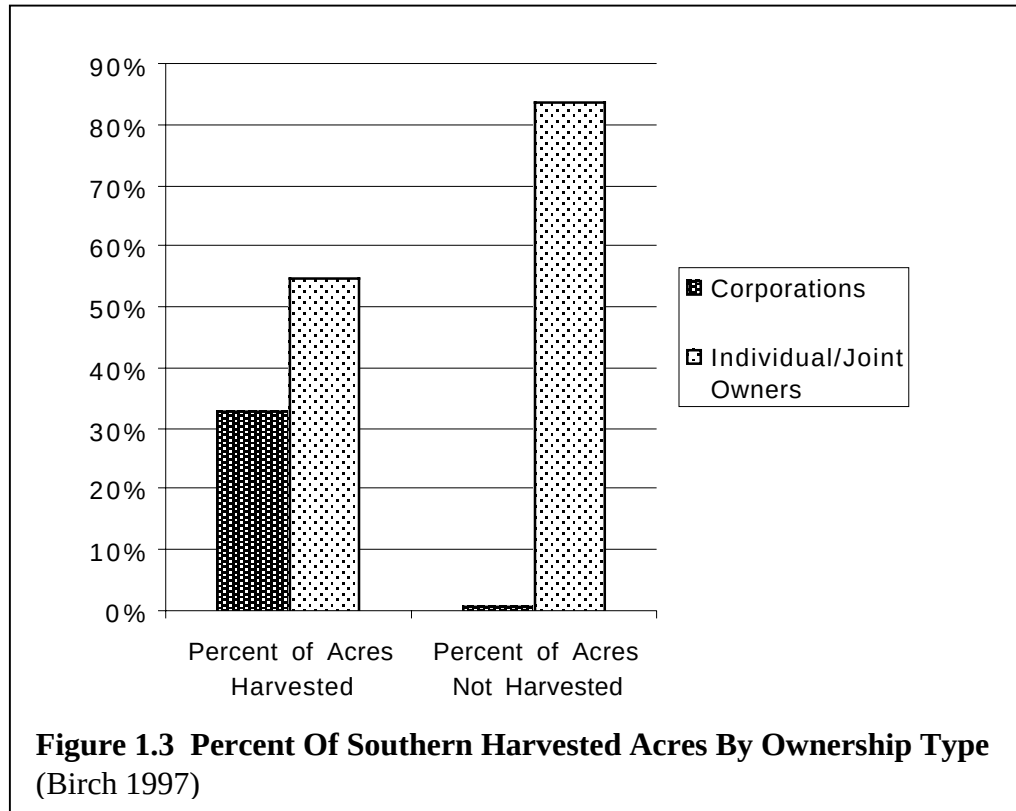


the acres harvested were owned by farmers and 11% by people for whom timber harvesting was their main source of income. Operations holding farmland owned 70% of

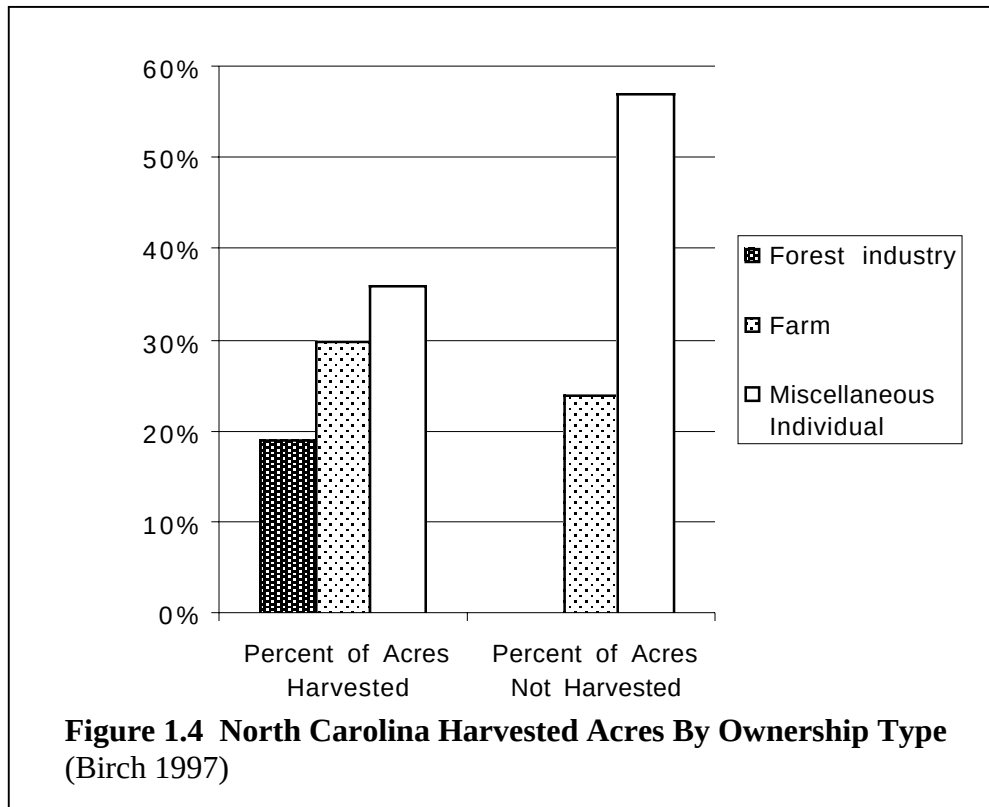
the harvested land, but only 42% was held by people actually living on a farm. The owners of about two-thirds of the harvested acres lived within 10 miles of the harvested sites (Fesco et al. 1982).

Fifty one percent of the harvested southern NIPF land was purchased while 48% was acquired through inheritance. Persons over 46 years of age owned 83% of the harvested acres and 33% were owned by persons over 65. About one-third of the harvested land was owned by persons with 1980 before tax incomes of at least \$45,000, one-sixth by persons in the \$25,000 to \$45,000 range and one-quarter by persons making less than \$15,000 per year. Eighty-four percent of the harvested acres were from tracts of 100 acres or more and 71% were from harvests in excess of 100 acres (Fesco et al. 1982).

In the South, as of 1994, 84% of acres which had not been harvested during the current owners' tenures were owned by individuals and joint ownerships (Figure 1.3). The same group also owned 55% of the harvested acres as well. Corporations owned 33% of the acres harvested in the region, but only 1% of the acres not harvested. In North Carolina, 19% of previously harvested acres were owned by forest industry. Those past harvested acres owned by miscellaneous individuals comprised 36%, while farm acres comprised 30%, as shown in Figure 1.4. The remaining acreage was owned by clubs, utilities, industrial businesses, real estate and other holders. Miscellaneous individuals also owned 57% of the acres not harvested. Of the acres that were harvested in North Carolina, 30% were owned by owners 65 years of age or older, while 36% were owned by owners listed as "All other owners," referring to corporations. Those owners 55 to 64 years old owned 15% of the harvested acres, while those 45 to 54 owned 13% (Birch 1997) (Figure 1.5) .

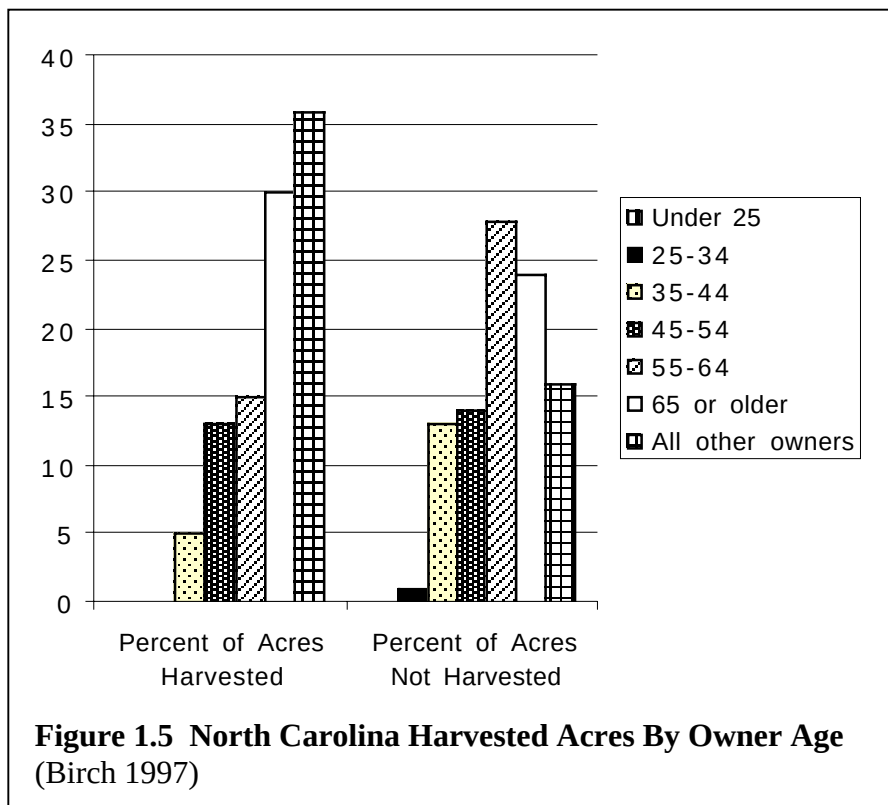


The major deterrents to harvesting include, among other things, landowner objectives and goals, the inability to make a return on the expense of harvesting due to the small size of the holding and the inability of the landowner to find loggers with whose work he or she is satisfied. As fragmentation makes management of land more difficult due to small size of tracts, access to timber is reduced and loggers are less willing to harvest small tracts. This results in lower prices being offered for timber thereby reducing the inclination on the part of landowners to harvest. Likewise, absentee owners are less likely to harvest the timber on their lands than resident owners (Amacher et al. 1998). An additional note of interest is that level of owner education appears to have a negative correlation with willingness to harvest (Alig et al. 1990).



Fesco et al. (1982) found the three most important reasons listed for harvesting timber in the South to be: (1) recognition of the maturity of the timber, (2) the offering of a suitable price, and (3) the desire to improve the growth of trees left on the site. On three-fourths of the harvested acres in this study, reasons 1 and 2 were listed as moderately or highly important by landowners. The need for income (exclusive of estate or inheritance taxes) was moderately or highly important on 42% of the harvested acres.

Increases in stumpage price (the price paid to the landowner for timber on a tract) tend to have positive effects on owners' decisions to harvest. In fact "nonindustrial harvests are more often due to a good offer than to any preconceived management plan. . . . while cost sharing which affects supply primarily through its impact on capital costs, has little or no affect [sic] on the probability of timber harvest" (Boyd 1984, p. 103).



Additionally, both large tract size and farm occupation have positive effects on decisions to harvest timber (Alig et al. 1990).

In a survey of 52 NIPF owners of large forest tracts across Mississippi by Baird et al. (1986) designed to gauge the factors influencing decisions to harvest, 42 of the landowners had harvested at some time. The 10 who had not harvested cited the immaturity of their timber or small acreage as the primary causes for not harvesting. The primary reason cited for harvesting was the maturity of timber. Other reasons cited were current stumpage price, a need for money at the time of harvest and a desire to improve the stand.

A study in the Piedmont of Virginia found that the decision to harvest was positively affected by stumpage prices, the perception of risk with regard to timber as an

investment on the part of the landowner, and the size of the tract. The authors noted that on large tracts, timber and nontimber values can possibly be pursued simultaneously without conflict due to geographic separation on the tract. Additionally, resident landowners were 26% more likely to harvest their timber when it reached maturity than were absentee owners, due to the amenity values placed on forested land by the latter (Amacher et al. 1998). The same study found that income, the level of debt held by the owner, whether the pines were of sawtimber size, the slope of the land, and the existence of a decision to bequeath the property were of no significance in the decision to harvest timber.

"Thirty-two percent of private forest landowners state that they intend to harvest in the next 10 years. These owners control 63% of the private forest. Conversely, 34% of the owners say they never intend to harvest. They hold only 12% of the private acreage. . . . Owners with indefinite harvest plans control 23% of the private forestland" (Birch 1996, p. 17). These figures are for private forests at the national scale and include both private industrial and NIPF lands. The values for NIPF intent to harvest are probably somewhat lower than those for both groups combined, given the inclusion of industry in the overall figures.

Statements regarding harvesting intentions should be treated with caution. Work by Turner et al. (1977), found that landowners did not have "firmly fixed intentions" about harvesting. By following a group of landowners in Delaware through two studies, one in 1970 and one in 1974, Turner et al. found that the proportion who said they would never harvest their land remained fairly constant (58% in 1970, 59% in 1974). Of those who said they would never harvest in 1970, 17% changed their minds by 1974 and

decided they would harvest. Eighteen percent of the owners who claimed in 1974 that they would never harvest had joined this group from those who believed they would harvest. "In the short time of 4 years, only 65 percent were consistent about willingness or unwillingness to harvest" (Turner et al. 1977, p. 499).

Reforestation

In terms of its overall effects, reforestation following harvest has nearly as much impact on the long term landscape as harvesting itself. The period before the Great Depression in the 1930s was characterized by little reforestation effort by NIPFs. Only a few thousand acres per year were planted or direct seeded to trees. The Civilian Conservation Corps planted trees on public and private lands for nine years in the mid-1930s and early 1940s, achieving a total of 2.3 million acres (Moulton 1994), but replanting rates plummeted during the period of WWII. With the advent of the Soil Bank Program in the late 1950s (discussed in the section on government incentives, below), NIPF reforestation acreage rose to over 1 million per year, but declined again with the curtailment of the Program in the 1970s (Alig et al. 1990).

Since the early 1980s, NIPF reforestation efforts have again climbed, reaching the one million acre mark in 1986 and then surpassing it (Alig et al. 1990). The U.S. Forest Service conducts periodic analyses of forest conditions and management throughout the country. Known as the Forest Inventory and Analysis (FIA), these studies provide a wealth of information on the state of the nation's forests. In North Carolina, reforestation has increased since the 1984 FIA study by 56%, with 78% of this increase occurring on NIPF lands and 18% on industry lands. The area artificially regenerated (as opposed to

prepared for natural regeneration) grew by 39%, accounting for 29% of all regeneration. The rate of NIPF planting doubled in the 1984 FIA analysis while industry planting increased by 6%. NIPF plantings totaled over 57,000 acres, including 14,000 acres that had not previously been forested. Forty-eight percent of industry lands were in planted pine as of the last FIA analysis, while 6% of NIPF lands were in planted pine (Johnson 1991).

This rise in planting effort was concomitant with the development and expansion of state and federal planting incentives such as cost-share programs, as well as reforestation tax credits and forest management assistance programs. These programs have reached about half of the lands being reforested overall. In fact, when technical assistance is also considered, only 20% to 30% of the lands reforested are done so without cost sharing, technical assistance or some other form of governmental assistance (Alig et al. 1990). Owners typically do not respond to timber prices when considering decisions to reforest. They do, however, respond to the costs of replanting, including interest rates. Higher replanting costs deter reforestation (Alig et al. 1990). In a study by Royer (1987), a 1% increase in reforestation costs led to a 2.74% reduction in reforestation activities, while a 1% increase in pulpwood prices led to about a 1% increase in reforestation. Changes in sawtimber prices had no significant effect on reforestation.

Amacher et al. (1998) found that debt load was negatively related to reforestation. Another major deterrent to reforestation on NIPF lands in the South is the prevalent belief on the part of the landowners that harvested areas will regenerate to pines naturally. There is also an apparent lack of agreement on the means by which reforestation should

take place. In a study of Alabama landowners, there was little consensus among NIPF landowners on how to perform regeneration on harvested lands. About three-fourths of the owners believed prescribed burning was appropriate. While 48% approved of the use of herbicides, only 10% were actually using the chemicals and 35% said the use of herbicides was unacceptable. Approximately 60% believed the conversion of hardwood stands to pine plantations should be limited. Those owners with more acres and those with higher incomes used more herbicides. The authors implied that increased education corresponded to greater familiarity (and acceptance) of many forest practices (Bliss and McNabb 1992). Other reasons for not reforesting include the long time until a return on the cost is realized and a belief that the eventual return will be too little. Plans to sell also reduce the probability of reforestation. Increases in age have the same effect. In a survey of southern NIPF landowners, a 10% increase in owner age above a mean of 57 years resulted in a 16% reduction in the probability of reforestation (Royer 1985).

Additionally, "Landowners who are aware of governmental cost share programs are over 50% more likely to reforest than those who are not. Those who are advised by professional foresters at harvest or through a management plan are almost 20% more likely to reforest" (Royer 1987, p. 662). When Royer separated landowners by income levels, those with lower incomes found costs, cost-sharing and technical assistance to be the most important factors affecting decisions to reforest. Among higher income individuals, cost-sharing and technical assistance remain important, but the cost of reforestation as a consideration is supplanted by stumpage prices.

Other authors found that from 1971 to 1981 cost-sharing may have been a factor in 70% of the regeneration investment (Hardie and Parks 1991). Boyd (1984) found that

awareness of cost sharing programs increased the probability of timber stand improvements (including reforestation) by 5.5%, while technical assistance boosted the probability of improvement by 7.3%. Cost-sharing and taxes were found to be the incentives listed by most southern landowners as likely to influence their reforestation decisions. Even though cost sharing funds are available to offset much of the cost of replanting, the owners of one-fourth of the acres harvested in the decade prior to 1981 claimed that there was "too much red tape" involved in attaining these funds (Fesco et al. 1982). Capital substitution has also been raised as a possible consequence of cost sharing programs, but the results from the studies performed have been inconclusive (Alig et al. 1990).

In general, . . . cost-share assistance provides the greatest motivation for NIPF owners to reforest their lands. Technical assistance was usually a significant variable in encouraging reforestation, and often was of second importance after cost-share payments in influencing reforestation and harvesting decisions. Landowner characteristics, tax effects, and market prices were usually less important in determining landowner behavior than technical assistance (Cubbage et al. 1996, p. 373).

Cost sharing programs may be differentiated from tax incentives in that while the former programs require technical oversight, tax incentives do not. Instituted in 1980, the Reforestation Tax Incentive is a mechanism by which landowners may amortize the costs of reforestation (artificial or natural, including the costs of site preparation) over a seven year period against any source of income. Prior to the passage of this legislation, reforestation costs had to be capitalized. There has been concern that reforestation efforts undertaken without technical assistance might prove to be of lesser quality than those which used technical assistance.

The Reforestation Tax Incentive contains no technical standards for tree planting. Nor does it require professional assistance from foresters or authorize funds for such assistance. Cost share programs require site visits from state foresters who must approve the reforestation project before payments can be received by the landowner. A study was conducted of reforested sites in nine southern states comparing those who had used only tax incentives for replanting with those who had used both tax incentives and cost sharing. This study found that no significant differences in reforestation quality existed between the two types of reforestation incentives (Moulton et al. 1991). In a South-wide study of harvesters who had reforested their lands, 59% had used the Reforestation Tax Incentive, while 48% had utilized cost-share programs and 36% had used both. This study also found these means of offsetting reforestation costs to be additive in nature rather than acting as substitutes for one another (Royer and Moulton 1987).

Landowner goals and objectives also play a role in reforestation. Of those southern NIPF owners who reforested their lands after cutting in the decade prior to 1981, those owning 90% of the acres listed a desire to keep their land in continuous production as moderate or highly important as a goal. About three-fourths of the harvested acres were owned by persons who reforested in anticipation of future profits or on the advice of a professional forester. Having revenues from harvesting or access to cost sharing funds for reforestation were important to the owners of 40% of the reforested acres. Forty percent of the acres that planted seedlings, broadcast seed or left seed trees used cost share funds while 69% of the clearcut areas that planted seedlings used these funds (Fesco et al. 1982). In a Virginia study, both the time spent hunting and the decision to bequeath forestland to heirs increased the likelihood of reforestation.

Absentee landowners were about twice as likely to reforest as resident landowners (even though only 20% of those who harvested undertook reforestation). The probability of reforestation also increased with tract size (Amacher et al. 1998).

Ownership Changes

Regardless of what the current owner's objectives might be, if the property changes hands, there is a possibility that the new owner will have different objectives. In a study of southern NIPF lands which had been harvested in the past decade, "Only five percent of the acres were being considered for sale to nonfamily members within the next 5 years, while 86 percent of the harvested land was held by owners with no intentions to sell" (Fesco et al. 1982, p. 4). This study found that those owners who stated plans to pass their lands to heirs as being of high or moderate importance controlled 80% of the harvested acres, but did not address the turnover rate of non-harvested forest acres.

The decision to bequeath property to one's heirs is obviously related to the decision to sell. A sample of Virginia forest landowners found that 53% of all owners intend to bequeath their land. This percentage did not depend on whether the landowner resided on the property or on tract size. The level of income, the debt load carried by the landowner (which was correlated with income), the time spent on the land in nonconsumptive activities, and the number of people in the household all had a significant positive effect on the decision to bequeath forestland. Interestingly, stumpage price had a significant negative effect on this decision (Amacher et al. 1998).

Nationally, "More than 40% of the current owners acquired forestland for the first time since 1978; these owners control 24% of the private forestland. . . . [I]n the South,

44% of the owners are new since 1978. About 48% of the private forest acreage is held by owners who first acquired forestland before 1950" (Birch 1996, p. 14). As of 1983, one-third of southern NIPF land owners had acquired their property less than 10 years ago, one-third had acquired 10 to 30 years ago and one-third had owned their properties for more than 30 years (Fedkiw 1983). The short tenure of property holdings can have an adverse impact on management. For example, Royer (1985) found that plans to sell a parcel resulted in a nearly 22% decline in the probability of reforestation.

Fragmentation

Finally, fragmentation (dissection of forestland by other land uses) and parcellation (division of a forested parcel among multiple owners) have the potential to reduce the contiguous forest cover in the landscape. "Since the early 1900s, every forest survey finds more owners. The most recent comparison shows ownerships increasing 1.6 times faster on average than general population growth: about 146,000 more ownerships created from a basically static forestland base every year - 400 more pieces every week" (DeCoster 1998, p. 25).

Since 1978, the total private forestland in the United States has increased from 333 million acres to 393 million acres. At the same time, the number of private ownerships has increased from 7.8 million to 9.9 million. These trends have resulted in a reduction in the average size of private landholdings from 42.7 acres to 39.7 acres nationally (Birch 1996). Although a small portion of this increase may be attributable to an increase in overall forested land in the South, a large proportion of the new ownerships are the result of fragmentation of larger landholdings into small parcels.

Nationally, the number of ownerships with fewer than 10 acres has increased since 1978. The 10 to 49 and 50 to 99 acre ownership classes have also increased, as have their percentages of the total. The percentage of ownerships in the 100 to 499 acre class has declined. "More than 90% of the private ownerships have fewer than 100 acres of forestland each, and they control 30% of the private forestland" (Birch 1996, p. 14). Of the 13 southern states, North Carolina has 705,000 private owners, more than any other southern state and 14% of the South's total owners (Moulton and Birch 1995).

Management Considerations

In the U.S. prior to the 1940s, there was much concern over the environmentally destructive harvesting methods used in timbering and the rate of harvest. In the 1940s the annual growth of forests exceeded the annual cut for the first time in over 100 years and the public's attention shifted from harvesting practices towards engaging NIPF owners in investment and management (Royer 1979a). Nationally, as of 1994, only 5% of private forest landowners had a written management plan for their properties, accounting for 39% of the total private forest acres. Of the acres under management, industry owned 43% and NIPF owners held 57% (Birch 1996). In the South, as of 1994, again, only 5% of the private forest landowners had a written management plan, accounting for 40% of the private forestland. Industry controlled 48% of this forestland and NIPFs with a management plan (numbering 250,000 Southwide) controlled 52% (Birch 1997).

A survey of over 1100 North Carolina non-industrial landowners (farm and forest) by Megalos (1999) found that 16% of private landowners with 10 acres or more had a written management plan, accounting for 41% of NIPF forestland in North

Carolina. The North Carolina Division of Forest Resources (DFR) estimates that the NIPF owners with tracts of 1 to 999 acres who have active written management plans (written or examined within the past 10 years) comprise 9% of the private timberland owners with this size tract. These management plans cover 24% of the North Carolina private timberland acres in tracts under 1000 acres (Brown 2000).

Megalos explained the difference between his statistics and those of Birch as “likely an artifact of a larger response from active landowners, since the survey cover letter indicated that results would likely impact future forestry incentive program policy, funding and delivery” (Megalos 1999, p. 54). He further speculated that the high percentage of respondents who were enrolled in North Carolina’s use valuation tax program (30%) might have increased his statistic. It should also be noted that while the Birch estimate was for landowners with tracts of 1 acre or more (a majority of whom had small tracts), Megalos’ work was with landowners owning 10 or more acres. In terms of harvesting under management, only 20% of the acres harvested in the South between 1971 and 1981 had a written management plan (Fesco et al. 1982), and few NIPF acres undergo intermediate treatments such as thinning (Alig et al. 1990).

Two basic theories, utility and profit maximization, have been used in analytical studies to test hypotheses about NIPF investment behavior. Utility is defined as including both monetary and non-monetary benefits associated with landholdings. NIPF landowners select among these benefits to achieve maximum utility for themselves. The profit maximizing approach defines the landowner as a commercial entity using forests as its means of production (Alig et al. 1990). The latter approach appears more correct for timber industry, while the former is more applicable to smaller NIPF owners.

By separating NIPF owners according to their economic situations, goals and knowledge of opportunities, a 1980 study in Georgia, found that those NIPF owners who invest in their woodlands tend to be better educated, be in business or professions, have incomes over \$25,000 per year and own more than 100 acres of forestland. Business and professional people made up only 21% of all Georgian NIPF landowners, but comprised 51% of the investors. Sixty-seven percent had education beyond high school and 78% owned more than 100 acres even though only 47% of all NIPF landowners held tracts of this size. Keeping the land productive was the most often stated goal. Two-thirds of the investors had made similar investments prior to the study period and 23% were in occupations related to forestry (Mullaney and Robinson 1980).

The degree and type of management undertaken obviously depends on the objective and goals stated above, but one study found environmental attitudes also had a bearing on the types of management undertaken. Differentiating between the attitudes of households on the basis of NIPF ownership, Bliss et al. (1997) found a great deal of similarity of NIPF owners with the non-forest owning public in the expression of an environmental ethic. The researchers expected forest owners to have higher approval ratings on three common forestry practices: clearcutting, prescribed fire and herbicide use. Instead, little difference was observed between forest owners and non-owners with regard to these issues. Education had an impact, however. "Respondents with more years of formal education were significantly more likely than less educated respondents to approve of clearcutting on land owned by individuals, prescribed burning, and herbicide application" (Bliss et al. 1997, p. 39).

In a study of NIPF owners in Alabama, 43% of those surveyed believed that forestry should be regulated on private lands to protect the environment (40% disagreed), and 58% as compared to 24% believed harvesting should be strictly controlled in wetlands. Sixty-four percent believed the government should regulate harvesting to protect endangered species (Bliss and McNabb 1992). Surprisingly this study was area based and therefore biased toward large landowners who are more inclined toward timber management. The study also found that the less educated landowners tend to favor regulation more than those with more education. In a survey of NIPF owners in the Pacific Northwest, Johnson et al. (1997) found that tract size also had an effect on attitudes towards regulation, with small holders being more inclined to support regulation than large holders.

Many studies have emphasized that management is more likely to occur on larger tracts. In fact, ". . . if there has been one factor most often associated with differences in landowner responses on surveys, it has been the size of landholdings" (Royer 1980, p. 127). Others have argued against an exclusive focus on ownership area in determining investments.

It is the excess of income over expenditures from year to year, with the resulting accumulation of liquid capital assets, which makes a person a likely participant in programs of forest management intensification, not the size of the holdings (Mullaney and Robinson 1980, p. 5).

Another factor often considered in determining landowner proclivity to manage is the effect of prices. However, evidence that landowners are responsive to price is inconclusive. Stumpage prices and income were found to be less important in determining North Carolina landowner decisions to perform intermediate treatments than

were owner characteristics and economic considerations. Of these, the availability of cost-sharing funds and technical assistance were most important, followed by size of holding and education (Boyd 1984).

The availability of technical assistance and its sources have also been studied as factors in landowner decisions of whether or not to invest in management. On 75% of those southern lands where pine improvements were made, the owners indicated that the advice of a professional forester was a key element in their decision to manage (Royer and Kaiser 1985). In a survey of West Virginia tree farmers and consulting foresters (Egan et al. 1997), differences in attitudes toward specific harvest techniques and environmental effects were discovered between these two groups, despite general agreement on general harvesting philosophies and objectives. Both tree farmers and consulting foresters agreed on the premise of utilization of forests for timber products. This result was expected as both groups are involved in management of timber resources for utilization.

The two groups disagreed significantly on whether or not clearcutting should be banned with a majority of tree farmers affirming it should and the majority of consultants believing it should not. Although of lesser magnitude, there was also a statistically significant difference in the beliefs of the two groups regarding the impact harvesting has on the environment. The tree farmers were more likely to agree that negative impacts would occur than were consultants, although those tree farmers who believed negative impacts would occur were in the minority of all tree farmers.

Owners who own less than 100 acres usually use public technical assistance, if any assistance is employed. Those owners with tracts over 400 acres use private

technical assistance more often. Intermediate acreages use both types of technical assistance. The use of public foresters was found to not have an impact on forestry investment decisions. The distance an owner lives from their property was also found to be insignificant with respect to investment. The use of consulting foresters and industry assistance were found to have a significant impact on investment decisions. The level of owner education also impacted investment decisions by affecting the level of investment more than the probability of investing (Hodges and Cubbage 1988).

Whether or not a landowner has a written management plan was found to be the single most influential factor in determining whether the owner would use professional assistance in conducting both harvests and reforestation (Zhang and Mehmood 1999). Those owners with higher incomes were more likely to utilize consulting foresters than industry foresters while income level had no bearing on use of public foresters. This study found that small landowners are not well served by any of the three types of foresters (public, consulting, or industry) in assistance with reforestation. The study also found that those tracts with a larger percentage of area in pine were more likely to be served by industry foresters.

In a 1981 study of several southern states, only 37% of the land clearcut, partially cut, or commercially thinned was under consultation by a forester. Tree selection was performed by the owners themselves on 26% of the acreage harvested and by the loggers on 35% (Royer and Kaiser 1985). Baird et al. (1986) have differentiated between active and passive managers of timberland. The former have timber production as their major objective and harvest in accordance with an overall management plan. Passive managers have other objectives than timber production as their main reasons for holding property

and harvest in a more ad-hoc fashion. The study attempted to discern differences in landowner characteristics between these two groups and found no difference between the two groups in term of age (except that all passive owners were over 40 years old) or the method of acquisition of landholding (inheritance or purchase). Those who were more educated and in professional positions were more likely to actively manage their properties. Additionally, owners with longer tenures and larger holdings also tended to actively manage and use assistance programs. Only three of the 22 active managers were not involved in assistance programs or in some sort of management agreement with forest industry. By contrast, 17 of the passive managers had never participated in any type of outside assistance (Baird et al. 1986).

Deterrents

One reason for the meager management rates among NIPFs is the disparity between the objectives of NIPF owners and their perceptions of the purpose of forest management. Approximately 75% of landowners surveyed in Alabama agreed with the statement, “Producing timber is the most important objective of forest management” (Bliss and McNabb 1992). Given the predominance of non-timber objectives of many landowners as described above, a belief that the primary purpose of management is timber production provides little reason for NIPFs to invest in forest management. Attempts have been made to recognize the existence of non-timber values in owner objectives and to incorporate these in management plans.

Lack of investment in timber by NIPF landowners may also be caused by (1) preference for non-timber outputs, (2) low potential return on timber and (3) lack of

information (Holley and Green 1980). Additionally, the small size of many holdings creates diseconomies of scale unless the properties have very good site indices. It is also uneconomical for small forest owners to perform information gathering on price and technology. Nor are they financially able to perform their own silvicultural research (Row et al. 1979). The short tenure and the advanced age of many NIPF owners mentioned above also act as deterrents to management investment. As a result of these factors, owners are unlikely to see a return on their investments.

Many landowners also lack knowledge on management, markets and the value of their timber, and fear being taken advantage of when selling stumpage (Cubbage 1979). One other consideration in determining management decisions is the ability of the landowner to obtain acceptable logging services. In a study of Illinois NIPF owners, the greatest barrier to participation in management for wood products listed was the quality of the loggers' work. Fifty-one percent stated that the quality was discouraging, while only 12% said it was encouraging (Young et al. 1984).

Incentives

When listing incentives to manage, landowners often cite the obverse of perceived deterrents. For example, almost 75% of Alabama NIPF owners stated that strong markets for their products influenced their management decisions (although the study is not specific as to how decisions were influenced). The desire to reduce the tax burden associated with owning forestland provides an additional incentive to participate in management. More than two-thirds listed tax treatments and one-third cited government subsidies as influences in their management decisions (Bliss and McNabb 1992). When

attempting to account for management decisions on southern NIPF acres harvested between 1971 and 1981, Fesco et al. (1982, p. 14) discovered that, "According to landowners surveyed, reduced inheritance and estate taxes would affect decisions on three-fourths of the acres harvested." A survey of NIPF owners in Washington and Oregon found that "A majority of landowners were willing to modify their harvest in some way for an annual federal income tax break over the next 10 years" (Johnson et al. 1997, p. 27). More small holders were willing to do this than large holders.

The period from 1944 to 1969 has been touted as the "golden age" of forestry in the South, due to changes in the capital gains tax provisions of 1944, which were modified in 1969. Capital gains treatment has been gradually increased with recent income tax changes, again restoring benefits to timber income compared to other investments. The previous favorable tax situation has been given credit for helping to rebuild southern forests (Murphy 1980). In addition to capital gains taxes, estate taxes have been cited as a major deterrent to investment in forest management (Nelson 1980). It is worth noting that these comments were from a conference attended by forest owners each holding over 700 acres and 99% of whom had received forestry advice in the past year as compared to 17% within the past 10 years for all NIPF forest owners (Lee 1980). By contrast, Megalos (1999) found that tax issues in general were not a significant issue in decisions of North Carolina forest owners regarding forest management for tracts of 10 acres or more. Only 4.1% stated that tax related issues served as an obstacle to active management.

Government Incentive Programs

Government programs exist at both the federal and state levels to provide incentives to landowners for the management of forested acreages. Many of the programs used by forest owners were designed to reduce surplus crop production, remove marginal lands from agricultural production, and deter erosion. They have also had a large impact on reforestation, as discussed earlier. Table 1.2 lists the major government incentives and assistance programs related to forestry.

Table 1.2 Major Government Incentives And Assistance Programs Related To Forestry		
Date	Program Title	Program Objectives
Federal Programs		
1924	Clarke-McNary Act	Federal-state cooperation in technical assistance
1933	Agricultural Conservation Program	Cost-sharing for agricultural conservation
1937	Cooperative Farm Forestry Act (CFFA)	Technical assistance to farmers with woodlots
1950	Cooperative Forest Management Act (CFMA)	Superseded CFFA and provided technical assistance to non-farmer forest owners
1956	Soil Bank	Cost-sharing for agricultural conservation
1973	Forestry Incentives Program (FIP)	Cost-sharing for planting trees
1978	Cooperative Forestry Assistance Act	Superseded CFMA and introduced multiple output management
1985	Conservation Reserve Program (CRP)	Reintroduction of Soil Bank Program for agricultural conservation
1985	Swampbuster	Wetland retention
1985	Sodbuster	Retention of native range and forest

Table 1.2 (continued)		
1985	Environmental Conservation Acreage Reserve Program	Added CRP to Wetlands Reserve Program and others designed to establish permanent easements
1990	Forest Stewardship Program	Technical assistance for multiple use objectives
1990	Stewardship Incentive Program	Superceded FIP and provided cost-sharing for multiple use objectives
North Carolina State Programs		
1977	Forestry Development Program	Cost-sharing for multiple use objectives

Federal Incentives

The Agricultural Adjustment Act of 1933 (which evolved into the Agricultural Conservation Program (ACP)) focused on agricultural conservation practices but promoted tree planting as a means of reaching its target of reducing surplus crop production. Likewise, the Soil Bank was established in 1956 for approximately the same purposes and promoted establishment of woodlots on excess farm acres. The Soil Bank program was responsible for the planting of a total of 2.2 million acres (Moulton 1994). This program was reborn in the 1985 Farm Bill (as the Conservation Reserve Program (CRP)) for the purpose of retiring highly erodible cropland to vegetative cover, including trees (Megalos 1998). These acts effectively shifted acreage out of cropland and into pasture or forestland (Alig et al. 1998). The CRP program led to the largest tree planting effort in history for private land (between 1987 and 1992), with about 2.6 million acres of former cropland converted to forest. The incentive for conversion centered around a 50% federal cost-share payment to offset the costs of planting combined with annual rent

payments to the farmer for 10 years. Interestingly, during the 1987 to 1992 period, urbanization converted over 3 million acres of forestland to developed uses (USDA NRCS 1996, cited in Alig et al. 1998).

While planting efforts of the CRP surpassed both those under the Soil Bank and the CCC, the goals outlined in the CRP have not been met. Originally, one-eighth of all land placed in the CRP was to have been planted to trees. As of 1992, only 6.8% of CRP land was in forest, but the percentage for the three signup periods following 1990 had increased to 12.3% on average due to increased administrative emphasis on afforestation (Moulton 1994). While enrollment in the CRP is low in the South, the majority of tree planting has occurred in this region. “In the long run, timber harvesting from former CRP land will likely generate a higher level of economic activity than existed while the land was in agricultural production” (Moulton 1994, p. 27). Benefits in water quality also accrue from shifting land out of agriculture and into forests.

The Conservation Title of the 1985 Farm Bill contains provisions to retard the conversion of wetlands, and native range and forests to cropland (Swampbuster and Sodbuster programs respectively). While Swampbuster, like the CRP, required farmers to apply erosion control measures to acres planted in crops in order to avoid loss of USDA farm benefits, Swampbuster was not linked to erosion control measures, but was geared more directly to preventing conversion. These programs were continued in the 1990 Farm Bill and new programs of interest to forestry were added as well. The CRP, along with a new program, the Wetlands Reserve Program (WRP), became subsumed under the Environmental Conservation Acreage Reserve Program (ECARP). Two new programs, the Environmental Easement Program (EEP) and the Water Quality

Improvement Program (WQIP) joined ECARP under the broad banner of the Agricultural Resources Conservation Program (ARC).

To encourage farmers to consider planting hardwood species, the CRP offered the option of selecting 10-15 year contracts if hardwood trees were planted as opposed to the 10 year contracts for softwoods. The three new programs (WRP, EEP, and WQIP) shared an increased environmental focus. The WRP was designed to place farmed wetlands and farmed former, restorable wetlands under permanent easement. The EEP was designed to place environmentally critical areas in perpetual easements. Forestry practices would be allowed in these easements. The WQIP was designed for lands which continue to be farmed. Its goal was to institute water quality plans on a number of these acres (Moulton et al. 1991).

In 1973 the first cost-share program to target tree planting as its major objective was developed; known as the Forestry Incentives Program (FIP). This program will pay up to 75% of all plant and improvement costs on NIPF lands (Boyd 1984). By 1993, FIP had been involved in the planting of 3.32 million acres in trees. An additional 1.45 million acres received timber stand improvements and 270,000 acres were prepared for natural regeneration under the program. Seventy-three percent of all the acres involved in the program and 90% of the acres planted to trees were in the South (Megalos 1998). This program was designated to terminate in 1995, but survives on emergency funding from year to year.

The combined efforts of the ACP, the Soil Bank program, and the FIP led to the planting of 12.4 million acres by 1992 (Kurtz et al. 1994). These three programs require a 10 year commitment on the part of the landowner to maintain the planted trees. A study

performed in 1992 found that 80% of the acres planted in forest under the Soil Bank program remained in forest. Of the trees planted under the ACP, 88% remained in trees while 97% of the acres planted under the FIP were still forested (Kurtz et al. 1994). Despite their failure to meet such goals as reduction of agricultural surpluses, these programs have clearly been effective at keeping former cropland in a forested state. The greatest losses of forestland to urban uses following the contractual period of these programs has occurred in the vicinity of all-weather roads. Overall losses “were associated with smaller total land ownership, smaller plantations size and sites of poorer quality” (Kurtz et al. 1994, p. vi).

Federal and state cooperation in providing technical assistance for forestry began in 1924 with the passage of the Clarke-McNary Act, which helped develop a number of federal and state technical programs. The year 1937 marked the beginning of official on-the-ground federal forestry technical assistance to landowners in the field with the Cooperative Farm Forestry Act. This act provided funding at the federal level for assistance provided by state foresters for farmers with woodlots. In 1950, assistance was extended to forest owners who were not farmers with the enactment of the Cooperative Forest Management Act, which superseded the Cooperative Farm Forestry Act. The 1950 legislation was “the first comprehensive program to provide substantial technical assistance to nonindustrial private landowners” and required states to match their allocated federal funds (Cubbage et al. 1996, p. 367). The above legislation was consolidated under and superseded by the 1978 Cooperative Forestry Assistance Act which follows the objectives of multiple output management by providing federal funds for state forester assistance.

The multiple use objectives of the 1978 legislation were codified into a comprehensive program for NIPFs under the Forest Stewardship Program (FSP) in the Forestry Title of the 1990 Farm Bill. Funding to implement the landowner objectives set forth under FSP stewardship management plans is provided by the Stewardship Incentive Program (SIP). Funds may be awarded for any of nine broad landowner objective groups including protection of habitat, wetlands and water quality, agroforestry establishment, and forest recreation enhancement, but tree planting accounted for 40% of all SIP expenditures. Interestingly, the 1999 appropriations bill contained no funding for SIP, but continued emergency funding for FIP (Megalos 1998).

State Programs

At the state level, North Carolina began its forestry cost-sharing program, the Forestry Development Program (FDP), in 1977. FDP quickly surpassed FIP in the number of acres planted in North Carolina, reaching a nearly sevenfold advantage by the 1997-98 planting season (Megalos 1998). Whereas FIP offers funding for 29 specific forestry practices, FDP only offers funding for 27 (precommercial thinning and pruning are absent from FDP) (Megalos 1999). FDP payments to landowners currently amount to approximately \$3 million in total at the statewide level (Hocutt 2002). It is interesting to note that state incentive programs are supported by three forestry sectors: NIPF landowners, industry, and state forestry divisions. NIPF owners stand to gain by being the recipients of the incentive dollars, industry gains access to cheap and plentiful raw materials, and state foresters gain in power through larger budgets and more employees. A national analysis of the political and economic factors associated with state cost-share

programs found that the influence of industry far outweighed that of either NIPF owners or state foresters. This was due to the ability of industry to lobby more effectively given the relatively small number of firms in comparison to the number of NIPF owners (Mehmood and Zhang 1999).

As fragmentation of forested tracts increases, management across ownerships may become more important in achieving both timber and nontimber objectives. Baughman (1996) lists several examples of attempts to organize landowners into regional or landscape scale units designed to better control the effects of harvesting on the environment and to better take advantage of information and programs available to them. Multiple use provisions contained in the 1990 farm bill may allow for the funding of programs to meet these goals on the premise that the general public is better served by this expanded emphasis than by a narrow focus on timber production. Evaluating the societal worth of nontimber activities is harder with existing economic methods.

A final consideration pertaining to management incentives relates to the previously discussed landowner objectives.

Because NIPF landowners often receive substantial nonmarket benefits (e.g., aesthetic satisfaction, camping, wildlife) from their forest lands, they place dissimilar values on timber assets than do industrial owners. Narrowly focused forestry assistance programs that operate under the premise that timber is the primary motive of NIPF landowners will have limited success in increasing production from these lands” (Allen et al. 1996, p. 9).

This statement is echoed by Johnson et al. (1997, p. 27), who noted that “Responses to public intervention are shaped by the owners’ objectives, and intended versus actual outcomes of public programs may not match if owners’ motivations are not sufficiently factored into intervention planning.” Clearly, if we attempt to reach NIPF landowners

through incentives, we must incorporate their objectives and provide incentives that meet both the goals of larger society and those of the individual owners as well.

Conclusion

NIPF owners have a clear ability to impact the landscape. Understanding their objectives, characteristics, and the incentive/regulatory framework in which they make their decisions is crucial to understanding the decisions themselves. Policies that attempt to affect large tract holders but which alienate small holders will be met with political resistance due to the greater number of NIPF owners with few acres. Likewise, the dichotomous nature of NIPF holdings requires that efforts that attempt to affect large changes in the landscape be targeted to the relatively few holders of large parcels. Interestingly, the situation is not static, as larger parcels continue to be divided into smaller tracts.

Most NIPF owners harvest timber, but few do so under the guidelines of a written management plan and few are willing to invest in management of their forests. These characteristics are not universal, but are different depending on the size of the holding and the education of the owner, among other things. Reforestation is increasing among NIPFs, and most of what is occurring is influenced by cost-sharing programs or technical assistance. While the majority of NIPF owners espouse non-timber objectives for owning forestland, the owners of most acres have timber production as an important objective.

In short, NIPF owners are a varied lot, with differing opinions and goals, but reflect the general society in many, important ways. The following chapters of this

dissertation seek to better understand some of the market incentives which influence NIPF owner decisions. Additionally, the following work seeks to delineate some of the forces which affect changes in NIPF land use and tenure.

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CHAPTER 2. AN ECONOMIC ANALYSES OF POTENTIAL MARKET CHANGES ASSOCIATED WITH WOOD CHIP MILLS

Introduction

Wood chip mills have been credited with both instigating increased harvesting and shifting NIPF forest management towards production of smaller diameter timber. These changes are attributed to the increased demand for pulpwood sized timber associated with increased chipping capacity and landowner response to that demand. Economists assert that people behave in a rational manner. This assumption provides the underpinning of market models. By rational, economists mean that people “accurately solve their optimization problems so as to maximize their well-being within the limits allowed by the constraints (that is, scarcities) with which they must contend” (Landsburg 1995, p. 686). For this assumption to be correct, people do not have to think rationally, just act in a rational manner. Additionally, not all of the people in any group need to exhibit rational behavior for the group as a whole to satisfy the condition of rationality for the group.

If one accepts the assumption that most NIPF owners behave in an economically rational manner, determining the changes in economic benefits which accrue to these owners might provide insights into their behavior when and if they are presented with new wood chip mill markets. Increases in chipping capacity resulting from an influx of chip mills would cause a shift in the demand curve and provide additional consumer and producer surpluses (benefits) in the market for pulpwood sized timber. Welfare analysis determines the value of benefits to producers and consumers associated with changes in

market conditions. I used this approach to determine the potential changes in benefits associated with an increased demand for chip wood, consistent with the siting of additional chip mills in an area.

NIPF landowners incur costs with timber production. These costs may include site preparation and fertilization or may be as simple as the annual property tax assessed to forestland. In order to determine the benefits returned to NIPF landowners from various silvicultural options, I performed discounted cash flows for both softwood and hardwood forest types. The results from this analysis allow for comparisons between different management and harvesting options by assessing the returns from investments to each. The assumption of rationality implies that NIPF landowners will choose the option that nets them the greatest return from their timber.

Timber harvests that include a chip mill component are purported to leave the harvest site relatively free of woody debris. These cleaner sites should result in lower costs of reforestation than on sites with more woody debris. As NIPF reforestation is affected to a larger degree by the cost of replanting rather than the income obtained from timber sales (Royer 1987), a reduction in site preparation costs should have a positive effect on the willingness of NIPF owners to reforest their lands.

Methods

I will discuss the methods involved in each of the three study components separately, beginning with welfare analysis, then discounted cash flows, and finally, site preparation.

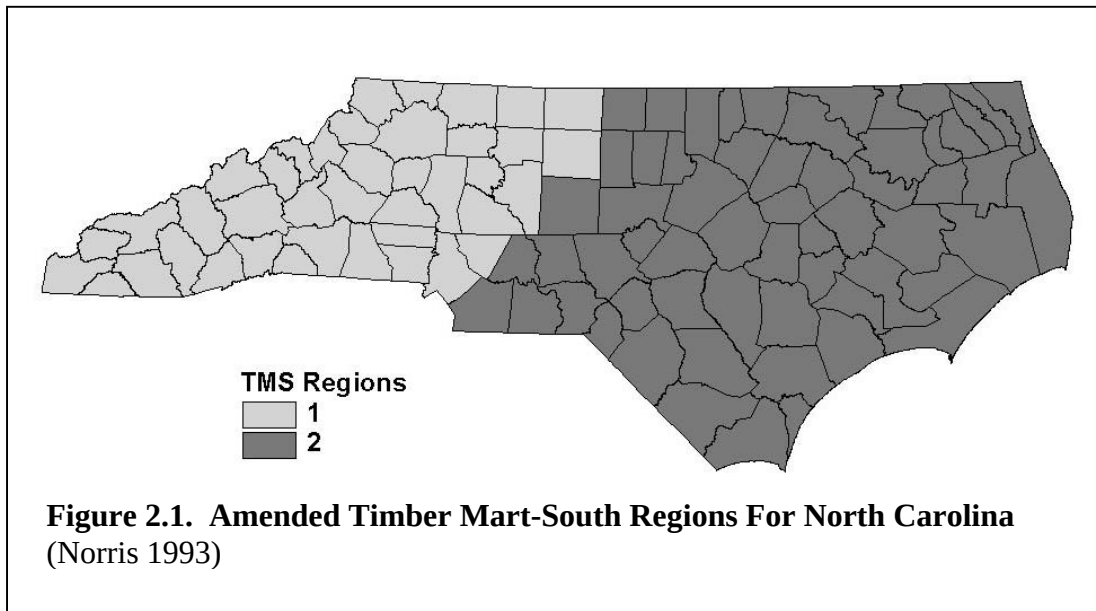
Welfare Analysis

Area Conversion

Beginning in 1993, prices reported by Timber Mart-South (TMS) for North Carolina were segregated into two geographical regions. Prior to this year, TMS reporting for North Carolina had been divided into three geographical regions in the state. In order to allow for comparisons between years back to 1990 (the baseline year of this study) TMS regions for 1990 and 1991 were recombined to correspond to the current areas used by TMS, using formulas and weights provided by Prestemon and Pye (1999).

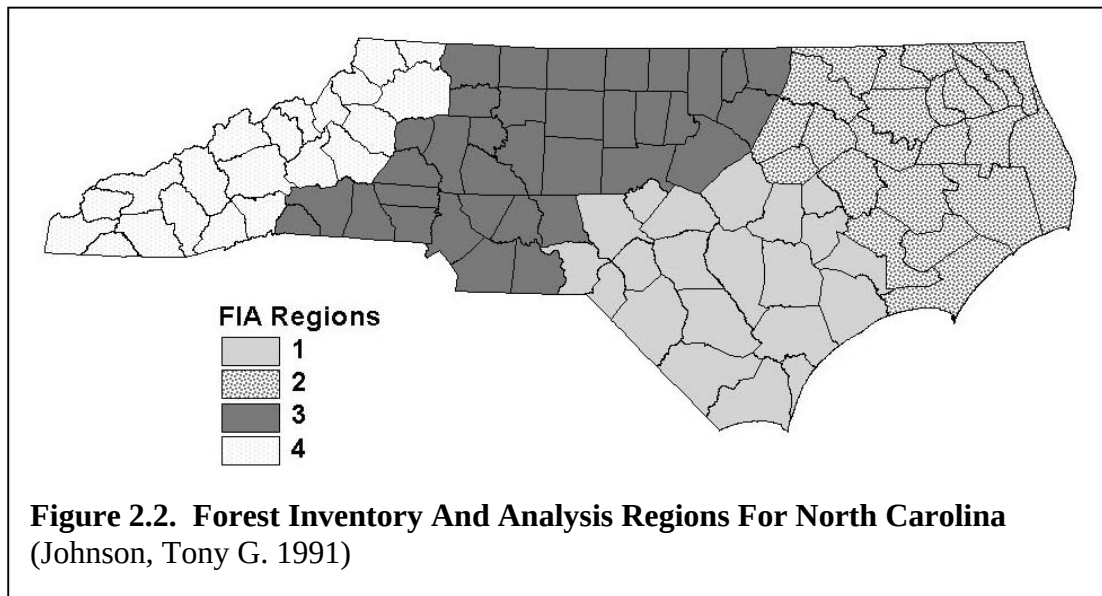
TMS Prices

TMS prices for softwood and hardwood pulp in North Carolina were obtained (Norris 1990-1997). These prices were subsequently adjusted for inflation to 1990 values using gross domestic product indices (Office of the President 1998). TMS divides North Carolina into two price regions with a transition zone between them where prices shift gradually. To simplify calculations, I obtained from TMS a listing of which zone contained the majority of area of each of the transition counties. These counties were then assigned to that zone, thereby completely dividing the state into two regions (Fig. 2.1). Thus, two prices were used for hardwoods and two prices for softwoods, reflecting the two regions of the state. While not a completely accurate representation of the price situation in North Carolina, the number of transition counties was small in comparison to the total number of counties in each division, making this method seem reasonable.



Determination of NIPF Contribution

Using 1990 US Forest Service Forest and Inventory Analysis (FIA) data for each of the four FIA regions of North Carolina (Johnson 1990; Thompson 1990; Brown 1991; Johnson 1991b) (Fig. 2.2), NIPF sawtimber removals were subtracted from total NIPF growing stock removals to estimate the percentage of NIPF pulpwood production in each county of North Carolina. These percentages were then applied to the pulpwood production figures obtained from the Southern Pulpwood Production reports from 1990 through 1997 (Schaberg 2000) to determine the estimated pulpwood volume attributable to NIPFs in each North Carolina county. The county values were then aggregated into their respective TMS price areas.



These pulpwood volumes were derived from data that reported softwood cordage, while TMS prices are for pine pulpwood specifically. Using 1990 FIA data, the percentage of softwood pulpwood harvest attributed to pine was determined for all four regions of North Carolina. Pine accounts for 80% of softwood pulpwood volume in area four. In all other areas, pine accounts for at least 95% of softwood pulpwood volume. Consequently, use of pine pulpwood prices from TMS in conjunction with softwood pulpwood volumes seems justified.

Generation of Producer and Consumer Surpluses

Determination of producer and consumer surpluses was based on work by Wagner et al. (1994) and involved several steps. The formulas set forth by Wagner et al. for determining quantity demanded/supplied with an increase in demand were:

$$P_D = (1+z)b_0 + b_1Q_D \quad \text{and} \quad P_S = (1+s)a_0 + a_1Q_S$$

where z = percent change in demand, s = percent change in supply, b_0 = intercept of the demand curve, a_0 = intercept of the supply curve, b_1 = slope of the demand curve, a_1 = slope of the supply curve, Q = quantity demanded, and P = price. Since $P_D = P_S$, allowing only shifts in the demand curve and solving for both equations simultaneously, the above formulas can be rearranged as:

$$a_0 + a_1Q = (1+z)b_0 + b_1Q$$

which can be solved for Q :

$$Q = (1+z)b_0 - a_0 / a_1 - b_1$$

Slopes were derived using the formula:

$$((1/e)*P_0) / Q_0$$

where e = elasticity of the curve, P_0 = initial price, and Q_0 = initial quantity. Having determined Q , price P was determined using the formula:

$$P = b_0 + b_1Q.$$

Elasticities reflect the percent change in quantity supplied and quantity demanded for a 1% change in price. Relationships where the change in quantity supplied/demanded is greater than one are said to be elastic. Those less than one are inelastic. The sign of the elasticity indicates the direction of change in the quantity supplied/demanded when price increases.

Selection of the appropriate elasticities involved a review of several works (Newman 1987; Newman and Wear 1993; Adams and Haynes 1996; Zhang et al. 1996; Nagubadi and Munn 1998; Siry et al. 1998). The present study used softwood elasticities from Newman (1987) for both supply (0.23) and demand (-0.43). This was also the

model Wagner et al. utilized in formulating their surplus equations. Additional work by Newman and Wear comparing elasticities of NIPFs and industry found that “The respective elasticities are not significantly different between the two ownerships” (1993, p. 680), so the use of elasticities which are not derived specifically for NIPFs seemed justified.

None of the models surveyed provided both supply and demand elasticities for hardwoods that were useful in the application of the formulas employed for this study. Nagubadi and Munn (1998) provided a negative supply elasticity that has the opposite sign of that postulated for supply functions. This elasticity was found to not be significantly different from zero by these authors. The hardwood supply elasticity provided by Siry et al. (1998) and used in this study (0.144) was both positive and significantly different from zero. Of the studies surveyed, only Nagubadi and Munn provided a demand function for hardwood pulpwood. This paper utilized their elasticity of demand value for hardwoods (-0.028). Changes in price and quantity demanded as a result of shifts in the demand curve were used to determine changes in consumer and producer surpluses by calculating the changes in the respective areas under the appropriate curves. This was accomplished using elementary geometry.

Discounted Cash Flows

Discounted cash flow (DCF) returns to NIPF investment in timber production with and without chip components were computed using the CASH program (Belli et al. 1985). Harvest volumes were derived for softwoods and hardwoods using growth and yield models developed at the NC State University School of Forest Resources (Gardner

et al. 1982; Hafley 1991). The parameters used to estimate for growth and yield in each of the models are discussed below.

The site index for softwoods was set at 65 feet for 25 years and a Piedmont/upland growth curve was utilized. Initial planting density was set at 700 trees per acre and 85% survival was assumed with a 0% hardwood component. These parameters are typical of an ideal pine plantation. Three harvest scenarios were analyzed for softwoods. In the first scenario, all volume in the stand was converted to pulpwood at 20 years. The second scenario consisted of the stand being harvested to 80 ft² of basal area at 18 years and only sawtimber harvested at 30 years. In the third scenario, the stand was harvested to 80 ft² of basal area at 18 years and both sawtimber and pulpwood were harvested at 30 years. Site preparation costs of \$50 were assumed for those prescriptions containing a chip component and \$150 for those without a wood chip component.

For hardwoods, two forest types were analyzed: upland slope/ridge and wet flat. The former type is of limited productivity while the latter type is the most productive hardwood forest type in the Southeast. Average harvest volumes were generated for each hardwood forest type. A rotation age of 80 years was assumed for hardwood analysis, with no thinning during the life of the stand.

Three harvest scenarios were examined for each hardwood forest type: one in which all volume in the stand was converted to pulpwood at maturity, one in which only sawtimber was harvested from the stand, and one in which both pulpwood and sawtimber were harvested at the end of the rotation. The harvest scenario of chipping all timber at 80 years reflects a concern was raised by citizen groups that the increased demand for pulpwood would encourage landowners to chip all of their stand at maturity. Using DCF

analysis allowed for an economic assessment of this harvesting approach. No site preparation costs were included in the hardwood analysis, reflecting the extensive type of hardwood management practiced by many NIPF owners in the state.

For both softwood and hardwood analyses, a 6% real interest rate was assumed, with an annual property tax rate of \$1.69 per acre. The tax figure is an average of the value of forest properties in North Carolina multiplied by the average use value tax rate in the state (Connelly 2000). All product prices were obtained from Timber Mart South (Norris 1997). Hardwood sawtimber prices were increased by 25% in those prescriptions with a chip component to reflect the production of better timber on cleaner harvest sites.

Site Preparation Cost Savings Analysis

Potential savings in site preparation prior to planting associated with cleaner harvests on NIPFs were calculated on the assumption that more intensive wood chip harvests would eliminate site preparation costs. The number of acres artificially regenerated were taken from FIA data (Johnson 1991a, table 22). These data are annual averages for the period from 1984 to 1990. Both the percent of acres harvested for pulpwood (40%) and the percent of acres harvested which serve as furnish for chip mills in each FIA region were obtained from Southern Schaberg (2000). An average figure of \$122.14 per acre was used for all site preparation costs in the South (Dubois et al. 1999). These figures were then simply multiplied to determine the average maximum potential annual savings that could result from cleaner harvests associated with chip mills.

Results and Discussion

Welfare Analysis

Historical Trends

Based on historical data for the period 1990-1997, NIPF owners experienced decreased returns from softwood stumpage sales in the Mountains and Piedmont of North Carolina (TMS Area 1). These changes have been the result of declines in both prices and harvest rates (Table 2.1). The average annual incremental return (in 1990 dollars) to NIPF softwood pulpwood statewide was \$34,527, for an average annual increase of 0.2% (Table 2.2). Increasing hardwood pulpwood timber production and prices yielded incremental returns of \$594,567 (in 1990 dollars) per year on average for NIPF owners, for an average annual increase of 4.9%.

Table 2.1. Percent Changes In Pulpwood Prices And NIPF Harvest Volumes, 1990-1997			
Timber Type	TMS Area	Price 90-97	Volume Harvested
Softwood	1	-5%	-29%
	2	-9%	23%
Hardwood	1	29%	52%
	2	10%	26%
State Total		6%	20%

Approximately 80% of the total value accrued to owners in the Coastal Plain (TMS Area 2), but the largest percentage increase per year (9.9%) was received for NIPF hardwood pulpwood harvests in the Mountains (Area 1). The average annual total NIPF pulpwood returns for the entire state amounted to \$32,371,101 and showed an average annual incremental increase of 1.9%.

Table 2.2. Average Annual NIPF Pulpwood Returns, 1990-1997 (1990 Dollars)				
Timber Type	Area	Mean GDP Adjusted Returns	Mean Yearly Change	Change as % of Mean Return
Softwood	1	3,843,481	-197,101	-5.1%
	2	16,278,138	231,628	1.4%
Total for Both Areas		20,121,619	34,527	0.2%
Hardwood	1	2,123,769	209,240	9.9%
	2	10,125,713	385,327	3.8%
Total for Both Areas		12,249,482	594,567	4.9%
State Total	(All)	32,371,101	629,094	1.9%

Producer and Consumer Surpluses (Benefits)

The impacts of shifts in demand in North Carolina timber markets were examined using economic welfare analysis to estimate benefits accrued to NIPF owners and forest industry. The price elasticities used for hardwood were 0.144 for supply and -0.028 for demand. For softwoods, the elasticities were 0.23 for supply and -0.43 for demand. Increased demand for timber consistently increased economic returns for both timber buyers and sellers. In absolute terms, forest industry (buyers) had higher benefits while NIPF owners (sellers) had higher percentage benefits.

For softwoods, total welfare benefits to both buyers and sellers increased about 1.7% for each 1% rise in demand. The increase in total welfare benefits to both buyers and sellers for hardwoods was about 2% per each 1% increase in demand. For example, for a 1% increase in demand for both softwood and hardwood pulpwood, total welfare benefits would increase by \$6.4 million annually. These would amount to \$5.0 million annually for consumers (forest industry; 78%) and \$1.4 million for producers (NIPFs;

22%). Welfare benefits from hardwoods would generate the greatest increase, accounting for 89% of the total increase from a 1% aggregate demand shift.

If the assumption of rationality on the part of market participants holds true, the realization of benefits on the parts of both producers and consumers will provide incentives to participate in the market for forest goods if demand increases. Chip mills could provide just such an increase in localized demand. In short, the fact that NIPF owners often rely on increased price as a trigger in deciding to harvest their timber (Fesco et al. 1982; Boyd 1984) indicates that the expanded benefits inherent in an increase in demand will cause more NIPF owners to participate in the forest product market.

Present Value Analysis

Returns were greater in the Coastal Plain than in the Mountains/Piedmont Timber Mart-South region due to higher prices. Softwood timber management regimes were analyzed based on traditional sawtimber rotations of 30 years with and without a pulpwood and chipping harvest component, and a simple 20 year pulpwood/chipping rotation. Higher timber prices and shorter rotations for softwood timber led to sawtimber production with a chip component having the greatest returns, followed by chipping the stand entirely at a shorter rotation, and last, production of sawtimber alone. These alternatives generated internal rates of return (IRRs) of about 6% to 13%, with the latter figure corresponding to a harvest of sawtimber with a pulp component in the Coastal Plain (Table 2.3).

Table 2.3 Softwood DCF Results						
	Harvest Regime					
	Area 1			Area 2		
	Pulp only	Thin, ST	Thin, ST/Pulp	Pulp only	Thin, ST	Thin, ST/Pulp
NPV	103.34	0.65	183.92	134.48	97.81	295.94
IRR	11.37%	6.01%	11.91%	12.36%	7.96%	13.44%
ST = sawtimber, NPV = net present value, IRR = internal rate of return						

The lower timber prices and long rotations for hardwoods generally yielded lower investment returns than softwoods, ranging from about 3% to 6% IRRs on upland ridge sites and 4% to 7% on wet flat sites (Tables 2.4 and 2.5). In both hardwood forest types

Table 2.4 Hardwood Wet Flat DCF Results						
	Harvest Regime					
	Area 1			Area 2		
	Pulp only	ST only	ST/Pulp	Pulp only	ST only	ST/Pulp
NPV	-19.21	23.08	28.67	-22.51	31.17	34.98
IRR	4.21%	6.94%	7.10%	3.53%	7.17%	7.27%
ST = sawtimber, NPV = net present value, IRR = internal rate of return						

and price regions, production of pulpwood alone had the lowest rates of return. For wet flat sites, all sawtimber options had IRRs greater than 6%. Addition of a wood chip component to a sawtimber harvest did little to increase hardwood returns, raising IRR by less than 1%. The scenarios provided in this analysis serve as a reference point against which other management options may be compared. They also serve to demonstrate the relationship between the returns to timber and each of the harvesting scenarios.

Table 2.5 Hardwood Upland Slope and Ridge DCF Results						
	Harvest Regime					
	Area 1			Area 2		
	Pulp only	ST only	ST/Pulp	Pulp only	ST only	ST/Pulp
NPV	-22.61	-9.99	-5.06	-24.83	-6.98	-3.61
IRR	3.50%	5.31%	5.68%	2.79%	5.55%	5.78%
ST = sawtimber, NPV = net present value, IRR = internal rate of return						

Site Preparation Cost Savings Analysis

The number of acres artificially regenerated each year was multiplied by the percent of area harvested for pulpwood going to chip mills to estimate the maximum potential savings that might be attributed to wood chipping. More than 6,500 acres would be regenerated each year according to this assumption, at an average savings of \$122 per acre (Table 2.6).

Table 2.6 Potential Site Preparation Savings				
FIA Survey Unit	Artificially Regenerated Acres	% of Acres Furnishing Chip Mills	Acres Furnishing Chip Mills	Savings
S. Coastal Plain	17,556	16%	1,124	\$137,285
N. Coastal Plain	18,554	15%	1,113	\$135,942
Piedmont	18,393	49%	3,605	\$440,315
Mountain	2,597	75%	779	\$95,147
State Total			6621	\$808,689

The Mountain forest survey unit received the least potential benefit while both of the Coastal Plain survey units garnered more than \$135,000 each in savings. The

Piedmont region received the highest benefit, with a savings of about \$440,000. At the state level, the maximum potential annual savings in site preparation associated with cleaner harvests amounted to \$808,689. By comparison, the North Carolina Forest Service estimates that the Forest Development Program pays a statewide total of about \$3 million to landowners (Hocutt 2002). If fewer (or more) acres were chipped than the 1999 wood chip data indicated, then the potential savings associated with chip mill harvests would be proportionately less (or greater).

Conclusion

The majority of NIPF forestland in the South is held by persons with interests in timber production (Cubbage 1997). The results of economic welfare analysis indicate that an increase in demand by timber buyers would encourage an increase in production on those acres held by persons with commodity interests. A 1% shift outward in the demand curve would yield more than \$6 million in welfare benefits. Forest industry (wood consumers) would receive about 75% of this benefit, and about 89% of the increase in welfare benefits would be generated by hardwood demand shifts. NIPF owners would receive about \$1.4 million dollars in additional benefits from the same 1% outward shift in demand.

In neither the softwood nor the hardwood market did production of pulpwood alone provide the highest return per acre, but production of pulpwood provided significantly greater returns than production of sawtimber alone in softwood markets and added to the value of the harvest in both markets (Table 2.3 – 2.5). However, the total incremental value that a pulpwood (wood chip) component added to net present values

(NPVs) or internal rates of return (IRR) to hardwoods was trivial – less than \$10 per acre in NPV at a 6% discount rate, or 0.2 percentage points added to the IRR. The increase in softwoods was more substantial, amounting to over \$150 and adding more than 5% to the IRR.

Prices are one of the major incentives among NIPF owners to harvest timber. Based on my analysis, adding a chip component to the market would provide more incentive for owners to sell their timber. The actual incremental returns realized from increased pulpwood harvest volumes in the state from 1990 to 1997 were moderate, averaging about \$629,094 per year, with 95% of that value increase in hardwood pulpwood. Potential savings in decreased site preparation costs were slightly more than \$800,000 per year. Thus the aggregate direct returns actually realized by NIPF landowners and the potential site preparation savings were modest, at \$1.4 million in total per year or less than 5% of the total state timber sale value. However, these returns would be important for individual landowners who received them.

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CHAPTER 3. A LOGISTIC ANALYSIS OF ATTRITION TO THE NORTH CAROLINA USE-VALUE PROPERTY TAX PROGRAM

Introduction

Humanity has a history of utilizing forest resources. “Overall it is now estimated that no more than ten per cent of the original forests that once stretched from Morocco to Afghanistan even as late as 2000 BC still exist” (Ponting 1991, p. 76). In modern times, developing countries have experienced high rates of deforestation. In the 1980s, Costa Rica had one of the highest deforestation rates in the world (de Camino et al. 2000), much of which was associated with increases in population (Rosero-Bixby and Palloni 1998). In the United States, and in North Carolina in particular, intensive agriculture in the early 1900s significantly reduced forest cover and degraded soils (Trimble 1974).

While the land-use change that occurred in the early 1900s was somewhat reversible, as evidenced by the reforestation of former agricultural areas, one of the current threats to forest land, urbanization, has more lasting effects. Granskog et al. (2002) found that in the period from 1992 to 1997, 2.63 million acres of forestland were converted to urban uses in the South. In North Carolina, which had the fourth largest area of land developed of the southern states, 48% of the acreage converted came from forestland (Granskog et al. 2002).

In addition to urban conversion, forestland is experiencing other changes. Private lands comprise 90% of all southern forestlands. In the South, private forestland tracts in the 100 to 1,000 acre class have declined by 15% since 1978. During the same period, tracts of fewer than 10 acres have increased by 51%, 10-49 acre tracts have increased by

83% and 50 to 99 acre tracts have increased by 18% (Moulton and Birch 1995) (Figure 3.1). In short, larger forest tracts are being broken into smaller

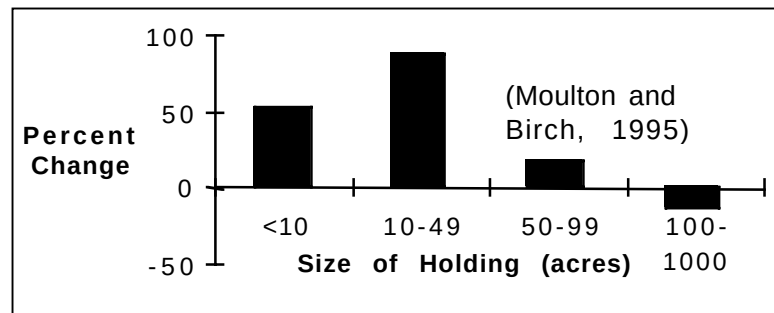


Figure 3.1.
Percent Change In Size Class, 1978-1994

parcels. As a consequence, the number of owners in the South has increased since 1978 by more than a million (28%). In landowner surveys conducted in 1994, the South had the highest number of owners in the country; 50% of the total number (Moulton and Birch 1995). As the number of owners increases, so does the probability that some parcels will be shifted out of forestry.

Smaller tracts are less economically viable for forestry, even the extensive type of forestry practiced by many southeastern landowners. Many of these smaller tracts have been removed from the forested land base and placed in other land uses. In the period between 1945 and 1992, there was an increase of approximately 2% in U.S. cropland area, an 11% decrease in pastureland, a 7% reduction in forestland area, and a more than 285% increase in area devoted to urban and developed uses (USDA ERS 1995, cited in Alig 1998).

In this study I sought to understand the characteristics of attrition to the use-value property tax program in North Carolina. Attrition serves as a proxy for land use change in the state. Additionally, I was interested in the underlying causes of this attrition. Of particular interest was the relative impact of tax burden and economic opportunity as

represented by the market value of ownerships on attrition. In order to prevent any bias in landowner response to questions about their decisions or possible lapses in memory on the part of survey respondents, I chose an archival approach, using county level property tax records and census data. By doing so I was able to add a perspective not normally found in the NIPF literature based on landowner surveys. Additionally, this approach uses archival data to examine the popular concept that property taxes provide an impetus to land use change.

Preserving Rural Land

In an attempt to slow the land use changes described above, and to provide property tax relief for non-urban land uses, all states have adopted programs aimed at preserving agricultural and forested land. Nelson (1990) listed four approaches used to preserve rural land: (1) tax incentives and disincentives, (2) right-to-farm legislation, (3) acquisition of development rights, and (4) agricultural zoning (Figure 3.2). Comparing these tools provides a framework for better understanding the property tax tools used in North Carolina.

- (I) Right-to-farm legislation
- (II) Acquisition of development rights
 - A) Transfer of development rights
 - B) Purchase of development rights
- (III) Tax incentives and disincentives
 - A) Property tax programs
 - 1) Restrictive agreement with cancellation penalty
 - 2) Differential tax assessment programs
 - a) Preferential assessment
 - i) Pure preferential assessment
 - ii) Preferential assessment with conveyance or use change penalty
 - iii) Deferred taxation with rollback penalty
 - b) Income tax credits against property taxes (circuit breakers)
 - B) Capital gains tax treatments
- (IV) Agricultural zoning
 - A) Non-exclusive zoning
 - B) Voluntary agricultural districts
 - C) Exclusive zoning

Figure 3.2. Rural Land Preservation Techniques (Nelson 1990, p. 124)

I. Right-to-Farm Legislation (and III (B). Capital Gains Tax Treatments)

Nelson asserted that right-to-farm legislation does little to deter either development or land speculation, but is instead designed to reduce nuisance lawsuits aimed at farming practices. Likewise, capital gains penalties, applied to profits made on sale or exchange of land within a specified time from purchase, have not served to deter speculation and land-use change. Instead, the pace of change has only been delayed until the legally specified time has passed and the tax implications have been avoided (Nelson 1990).

II. Acquisition of Development Rights

Two types of development rights acquisition are practiced: transfer of development rights between private entities (TDRs) and purchase of rights by public entities (PDRs). Conservation easements are examples of PDRs in which the rights may also be held by private organizations. TDRs work by rezoning at least two areas, one as a “sending” area in which development is restricted and one as a “receiving” area, in which development is accelerated through the purchase of rights from the sending area.

Research on TDRs in Maryland (Nelson 1990) found that only the owners of land least likely to develop in the future were willing to sell their rights. Those close to urban areas waited until zoning changed the land-use to permit urbanization. Developers sought to purchase rights as cheaply as possible, and looked to areas distant from cities where the rights sold for less, reducing the effectiveness of this tool in halting urban spread in the long run. Additionally, receiving areas may be reluctant to absorb the additional development necessary to make the scheme successful. Since PDRs, like TDRs, are voluntary, they suffer from the same problems. Both types of development rights acquisition served best as open space preservation efforts, preventing development on those parcels of land whose owners were willing to sell development rights, but neither systematically halted urban expansion (Nelson 1990). These approaches may lead to leap-frog type sprawl as developers bypass those parcels without development rights to reach developable properties (Morris 1998; Granskog et al. 2002).

In North Carolina, legislation has been enacted which will allow properties in the use-value program to be placed under conservation easements and continue to retain use-value tax benefits. Prior to this change, lands under conservation easements could be

deemed as not meeting the “sound management” requirement of the use-value program and ejected from the program. Sale of the property will not affect use-value status as long as the easement remains intact (North Carolina General Assembly 2002, §105-277.7). The relevant bill, S1611, was signed by the governor on 31 October 2002 and is now session law 2002-184.

III (A). Property Tax Programs

The property tax is a direct tax that resides with the states under Article 1 of the U.S. Constitution (Wunderlich 1997). It is an *ad valorem* tax; levied according to the value of the property. Property taxes are “in rem”; that is, they are assessed on physical objects (property) rather than on a taxpayer’s ability to pay. Historically this tax was seen as the only practical way to tax the value of personal estates.

Administered by local governments, the property tax is used to pay for local services such as education, fire and police protection, and sanitation. It is used far less often to redistribute wealth than state and federal income taxes. The value of the property is held to be the current fair market value as determined by the local tax assessor. Once the local operating budget of the locality is determined, the revenue needed to meet the budget is divided by the value of the property within the local jurisdiction to arrive at the rate by which property will be taxed. The bulk of the revenue generated by the property tax is used to fund local education, which has little direct relation to the market value of property. In general, property taxes are progressive at the very bottom and top of the income scales, but mildly regressive over the majority of the range (Musgrave and Musgrave 1984, p. 258).

“Early in the last century, landowners worried about the property tax. Substantial amounts of forest land were abandoned because the property tax eliminated the economically beneficial use of the property” (Flick 2000, p. 1). “Concern that the environmental benefits of forested ‘green space’ would be lost to competing urban uses have led to legislation taxing timber land at a lower rate based on its ‘present’ rather than its highest use” (Boyd 1985, p. 2). Taxes are a salient piece of economic information for most landholders. Royer (1983, cited in Dennis 1992) claims that while landowners may be ill informed regarding the forest management options available to them, they are very aware of the tax burden associated with forestland ownership.

A major factor explaining the unpopularity of the property tax is that, among all major taxes, it is the only one which is subject to direct annual or semiannual payments. The property tax comes due in large chunks and is highly visible to the taxpayer. It thus differs sharply from the other major taxes, including the income tax, which is largely invisible and paid in small installments (Musgrave and Musgrave 1984, p. 475).

Several methods are used to reduce the property tax burdens on rural landowners in the United States.

Restrictive Agreements

Property tax programs rely on either differential tax assessment or restrictive agreements with cancellation penalties. California and New Hampshire utilize restrictive agreements. Both states require landowners to enter into contracts with the county in which the landowner agrees not to develop the property in exchange for reduced property taxes. Embodied in California as the “Williamson Act,” restrictive agreements have an initial 10 year period and are automatically renewed on an annual basis thereafter. A penalty of 12.5% of the market value of the property is assessed to the owner in the event

of development. As such programs are voluntary, landowners near urban areas are less likely to participate, and those that do are bypassed by developers, creating leapfrog type sprawl. For this reason, Nelson (1990) concluded that these types of programs do not deter development.

Differential Tax Assessment Programs

Preferential assessment

Differential tax assessment programs are divided between preferential assessment programs and income tax credits to offset property taxes (circuit breakers). Most states employ some form of preferential assessment; either pure preferential assessment, preferential assessment with penalties, or deferred taxation with rollback penalties (Table 3.1). Pure preferential assessment assesses property taxes only on the productive value of farmland, with no direct penalty for land-use change. This type of program does not retard development and increases speculation (Nelson 1990). Preferred assessment with penalties assesses a fine to the landowner when preferential status is revoked. This stipulation encourages landowners to withdraw from the program in anticipation of development, in order to minimize any penalty.

The majority of states, including North Carolina, use deferred taxation. Under this type of program, property is assessed at both the market rate and at the value for its current use. Taxes are assigned according to the latter value, but both values are recorded. In the event of land-use change, the tax savings for a number of years prior to the change are billed to the landowner (known as a “rollback”), often with interest. Since only a portion of the tax savings over the life of program participation are assessed when

land-use changes, the program provides an incentive for speculation and may aggravate urban sprawl (Keene et al. 1976a; Nelson 1990).

Table 3.1. State Rural Land Protection Programs											
	Pure preferential assessment	Preferential assessment with use or change penalty	Deferred taxation with rollback penalty	Restrictive agreements with cancellation penalty	Circuit breaker	Capital gains penalty	Right to farm	Non-exclusive zoning	Exclusive zoning	Transfer of development rights	Purchase of development rights
Alabama			X				X				
Alaska			X				X				
Arizona	X						X				
Arkansas	X						X				
California		X		X			X	X			
Colorado	X						X	X			
Connecticut		X	X			X	X				X
Delaware	X		X				X	X			
Florida	X						X	X		X	
Georgia			X				X				
Hawaii			X				X	X	X		
Idaho	X						X	X			
Illinois			X				X	X			
Indiana	X						X	X			
Iowa	X						X	X			
Kansas			X				X	X			
Kentucky			X				X				
Louisiana	X						X				
Maine		X	X				X	X			
Maryland		X	X				X	X		X	X
Massachusetts		X	X				X				X
Michigan					X		X	X			
Minnesota			X				X	X			
Mississippi	X						X				
Missouri	X						X				
Montana			X				X				
Nebraska			X				X	X			
Nevada			X								
New Hampshire		X	X	X			X	X			X

Table 3.1. (continued)											
	Pure preferential assessment	Preferential assessment with use or change penalty	Deferred taxation with rollback penalty	Restrictive agreements with cancellation penalty	Circuit breaker	Capital gains penalty	Right to farm	Non-exclusive zoning	Exclusive zoning	Transfer of development rights	Purchase of development rights
New Jersey			X				X	X		X	X
New Mexico	X						X				
New York			X				X	X			X
North Carolina			X				X	X			X
North Dakota	X						X				
Ohio			X				X	X			
Oklahoma	X						X				
Oregon			X				X		X		
Pennsylvania			X				X	X			X
Rhode Island			X				X				X
South Carolina			X				X				
South Dakota	X										
Tennessee			X				X				
Texas			X				X				
Utah			X				X				
Vermont		X	X			X	X			X	X
Virginia			X				X	X		X	
Washington							X			X	X
West Virginia	X						X				X
Wisconsin					X		X				
Wyoming	X										
(Nelson 1990, p. 125)											

“In addition to current usage, most states and provinces specify that farm, forest, and open space lands meet certain minimum requirements to be eligible for use-value assessment” (Gloudmans 1974, p. 22). These requirements usually take one or more of the following forms: a minimum number of acres for inclusion, a minimum gross income

or percentage income derived from the property in the program, and a minimum time period of ownership.

The literature indicates that use-value taxation cannot fully curtail the development of rural land. Gloudmans (1974) noted that rollback penalties are often overshadowed by the economic opportunities of development. He stated that “any hope for the prevention of a land use change depends . . . upon the participating farmer being so penalized in the form of a lower sales price that he is discouraged from selling. Only in this regard, can the rollback tax be considered an encouragement, and then not a guarantee” (Gloudmans 1974, p. 42). Additionally, use-value has been decried for offering no control or regulation on the temporal and spatial patterns of development, making this tool fairly ineffective in planning. In general, use-value taxation alone is incapable of stemming development of rural land (Keene et al. 1976a; Wunderlich 1997; Newman et al. 2000; Granskog et al. 2002).

Morris (1998) examined the effects of preferential taxation on the retention of land in farming using data from 3000 counties in 47 states (including all 100 counties in North Carolina). Data on land in farming were drawn from the U.S. Census of Agriculture for the period from 1959 to 1987, resulting in a total of 21,000 observations of county-year data. The analysis compared farmland retention over time between those counties with use-value taxation and those lacking use-value. Results showed that about 10% more farmland was retained in those counties with preferential taxation than those without. Additionally, Morris found that states with deferred taxation (like North Carolina) experienced significantly greater loss of farmland than states relying on pure preferential assessment, but noted that this finding is inconclusive.

Morris also found that inclusion of county-level fixed effects explained much of the variance in the model, raising R^2 from 0.0475 to 0.975. These effects included population density, market value of farmland and buildings, total property tax per capita, and value of farm production. All of the county-level variables were statistically significant. Unfortunately the regression coefficients were not standardized, so comparison of the individual effects was not possible.

Despite her findings on the impact of preferential taxation on farmland retention, Morris reached the following conclusions, in accordance with the literature:

Clearly, if the difference between returns from farming and development is high enough, even zero taxation cannot preserve farmland indefinitely. The impact of a tax reduction can then only be to delay conversion of lands for which the disparity between farm and development returns is comparable with the tax reduction (Morris 1998, p. 147).

Finally, areas of urban sprawl cannot rely on preferential assessment, taking decades to accrue its potential impact on land use, to preserve open space when tax burdens are minor compared with potential returns to development (Morris 1998, p. 157).

Thus it appears that differential taxation is a necessary, but not sufficient condition to prevent the urbanization of rural land.

This distinction is important since use-value programs were not only designed to retard land-use conversion, but also to provide tax relief for participants in certain desired land-use practices. The failure of these programs to halt the tide of urbanization should not be taken as an indication of their inability to provide pecuniary relief for landowners engaged in farming or agriculture. In fact, they have been very successful in accomplishing this objective; so much so that property taxes have decreased in importance in motivating landowners to change land-use on their properties. As a case in

point, in a 1975 survey of Pennsylvania farmers asking the reasons for selling land, high property taxes were cited much less frequently than retirement, death, the presence or absence of heirs, and the price offered for the land (Keene et al. 1976b). Pennsylvania instituted its use-value program in 1966, many years before the study was conducted.

Income Tax Credits Against Property Taxes (Circuit Breakers)

“Under a circuit breaker system, property tax payments which exceed certain percentages of income would either be deducted from state income taxes or directly rebated to the taxpayer” (Gloudmans 1974, p. 24). In Michigan, farmers receive an income tax rebate when the local property tax exceeds 7% of the their income.

Participation requires a minimum 10-year contract with the state to keep their property in an approved land use. Failure to fulfill this contract requires the landowner to reimburse the state for all taxes rebated, plus interest. Failure to renew the contract at its end requires landowners to remit rebates from the previous seven years, without interest. Less than 5% of Michigan’s land base is enrolled in this program. Nelson (1990) stated that these sorts of programs have generally not been successful in preserving rural land.

IV. Agricultural Zoning

The final preservation technique discussed by Nelson, agricultural zoning, has three formats: (1) non-exclusive zoning, (2) voluntary agricultural districts, and (3) exclusive zoning. Non-exclusive zoning determines the degree to which parcels may be subdivided in an agricultural area. As land-use conversion is permitted in non-exclusive zoning, this format encourages the creation of large residential estates at the minimum acreage allowed in the zone, effectively increasing the extent of subdivisions. Voluntary

agricultural districts are usually created in response to petitions by farmers in an area and include differential property tax assessment, as well as protection from encroaching urban zoning and its concomitant regulations. This format suffers from the same problems as other differential tax schemes as outlined above.

Exclusive zoning (or growth management) seeks to prevent land-use changes in targeted areas. This format may or may not have minimum parcel sizes as part of its design. States that institute growth management plans outline criteria with which local efforts must comply, under state review. Communities failing to meet these criteria can have state funds withheld or can have building moratoria imposed. Oregon provides the best known example, requiring local governments with prime agricultural land to institute exclusive agricultural zones. Urban growth boundaries also confine development to previously developed areas. By statute, agricultural land is assessed at its farm value, but as development is prohibited, speculation is eliminated and rural land is protected (Nelson 1990). Growth management through regulation requires both a determination on the part of government officials to deliberately plan the pattern of land use in their jurisdictions and to enforce any enacted regulation in the face of citizen opposition.

Development Fees

Development fees were not listed in Nelson's topology of rural land preservation techniques (Figure 3.2). Designed primarily for the funding of municipal improvements in either new or existing developments, development fees also have the potential to serve as a tool for regulating land-use change. These fees take two forms: exactions and special assessments.

Exactions

Exactions are government requirements, either in-kind or financial, that a developer must meet in order to receive a building permit. In-kind exactions require developers to donate land, facilities, or public services to the community. Financial exactions are monetary payments, commonly known as “impact” or “development” fees. Exactions are based on the premise that the infrastructure and service needs generated by new development should be “internalized” in the cost of development.

Exactions are authorized under the concept of police power, reserved to the states under the U.S. Constitution and conferred by the states on local governments to regulate land use. Police power provides the authority to protect health, safety, welfare, and morals, but not to impose taxes. Exactions may only be assessed if they create a specific service needed by development or ameliorate a particular harm caused by development.

Development fees differ from taxes in that taxes need not be tied directly to the consequences of a development project, while exactions must be used specifically to offset development consequences. “The courts consider a public expenditure attributable to new development when it is for the use of project occupants . . . or to mitigate adverse project impacts on the wider community” (Altshuler and Gómez-Ibáñez 1993, p. 4). The latter interpretation has the potential for use in offsetting loss of non-market forest values due to development. Since the 1970s, most states have adopted a “rational nexus” test to determine if the funds from exactions are directly related to the impacts of the development being assessed (Stegman 1986; Altshuler and Gómez-Ibáñez 1993).

The courts have upheld exactions for streets, sidewalks, sewers, and other infrastructure elements connected directly to the new development, but have been less

supportive of exactions for off-site improvements such as schools and parks.

Additionally, higher standards are not supposed to be instituted for newer developments than for existing areas, so older areas must be brought up to the new standards if improved conditions are desired, and exaction funds cannot be used to make improvements in the established areas. Consequently, taxes are often raised to bring infrastructure in older areas up to the standards in new developments (Stegman 1986). Exactions for purposes other than land dedication for streets and utilities are a relatively recent phenomenon, experiencing rapid diffusion after 1970 (Altshuler and Gómez-Ibáñez 1993).

Most exactions are derived from negotiation between towns and developers, rather than through a fixed formula, and judicial intervention in the process is rare (Altshuler and Gómez-Ibáñez 1993). Local developers tend to support development fees for defensive reasons; they fear the perception that new developments are not paying their way will incite local populations to institute development moratoriums. Developers will usually not challenge exactions as long as the cost of the exaction does not exceed the cost of litigation and the construction delays inherent in compliance (Stegman 1986).

Both economic theory and the limited empirical evidence available indicate that landowners do not pay the cost of exactions. Buyers and renters of new development projects bear the cost of the fee, provided the exactions are applied over a sufficiently long period and are evenly applied in a jurisdiction. In the short run, those entities which hold land in anticipation of development will have to absorb the cost of the exactions or write them off as losses. If exactions are not applied in a jurisdiction evenly, those areas

imposing higher exactions will experience decreased development (Altshuler and Gómez-Ibáñez 1993).

Special Assessments

Special assessments are different from exactions. Traditionally, special assessments are seldom imposed at the time of development but are instituted to fund improvements in existing infrastructure (such as street improvements), often at the behest of residents. They are typically ongoing levies rather than single payments. Additionally, special assessments are assigned to all residents within a certain area, not just new residents and they seek to benefit those assessed rather than the larger community (Altshuler and Gómez-Ibáñez 1993).

Yinger (1998b) noted that special assessments may be applied to new developments in an attempt to finance new infrastructure, as is practiced in Minnesota. He implied that this form of fee has characteristics that make it a superior tool for development control. Development fees are paid by developers, who attempt to pass these costs on to the homebuyer. Since developers are mobile entities, no jurisdiction can decrease profits to developers relative to another jurisdiction and retain the developer's interest. Consequently, if a development fee is imposed in one jurisdiction, either the value of housing must increase or the cost paid for land must decrease to equalize profits between jurisdictions. Yinger (1998b) claimed that lower land prices pass the incidence of the fee backwards to the landowner.

The price of housing will capitalize the cost of development fees and the benefits of the improvements in infrastructure created by the development fees. Assuming that

the cost and benefit of the new infrastructure are equal, the cost should offset the benefit equally in housing prices, resulting in no net change. But the value of additional infrastructure is not completely capitalized in the value of a house since “any increase in house value due to infrastructure improvement is subject to property taxes. The household does not get to ‘keep’ the full value of the benefit because some of it is taxed away” (Yinger 1998b, p. 220).

In this situation the developer will pay less for land to maintain profits. “Even with mobile households, competitive housing markets and infrastructure investments that meet a benefit-cost test, however, one-quarter or more of the burden of these fees could fall on the owners of undeveloped land” (Yinger 1998a, p. 11). The author argued that since special assessments are paid by the homebuyer directly, the depression in house bids associated with a one-time special assessment payment is completely offset by the increased house value derived from infrastructure improvements, so there is no change in the price of housing and no shift in incidence of the assessment to the landowner. Additionally, the benefits of the infrastructure improvements are funded by those who receive them (Yinger 1998b).

Yinger’s hypothesis of no net change in housing prices is predicated on a failure of the taxing jurisdiction to incorporate the value of the infrastructure improvements in the assessed value of the house. Such a scenario would place all the incidence of the special assessment on the homebuyer. Incorporation of the infrastructure improvements in the assessed value of the house would raise property taxes, resulting in decreased profits on the part of the developer (since the additional taxes would be capitalized into the price paid for the house) and a backward shifting of incidence to the landowner.

Finally, regarding development fees in general, it is worth noting that these policies can have a regressive impact on the housing market. By raising the cost of housing they increase the percentage of household income spent on housing, having a greater impact on low-income households than on wealthier households. Additionally, since exactions cause a contraction in the development industry relative to the demand for housing, the overall cost of housing rises, creating further hardship for the poor (Altshuler and Gómez-Ibáñez 1993).

Selected State Examples

The following states were selected to represent different land-use programs.

Virginia

Virginia, like North Carolina, uses deferred taxation with a rollback penalty to control land-use changes, but imposes more stringent fines for disenrollment. Enacted in 1971, Virginia's use-value program allows enrollment of forest, agriculture, and open lands. Land value under the program is determined by capitalization of rents or representative incomes and assessments are revised every 4 years. Minimum program acreage for agriculture, horticulture, and open space is five acres. Twenty acres is the minimum for forestry. Development penalties include a rollback of tax savings for the past 6 years plus 6% interest (Gayer et al. 1987).

Alternatively, landowners may form a voluntary agricultural district by jointly agreeing to restrict development on their lands for 4 to 8 years. Such districts require a minimum of 500 participating acres and limit enrollment of more than 3,500 acres by a

single owner. Agricultural districts are protected from state and local regulation of forest and agricultural activities in excess of those needed to protect health and safety.

Additionally, agricultural districts are somewhat protected from eminent domain acquisitions and from increased taxes on nonagricultural improvements. Failure to abide by contract provisions triggers the rollback provisions outlined above (Gayer et al. 1987).

Gayer et al. (1987) found that participation in the use-value program was at 55% for forestlands and 40% of non-forestlands in 1982. The study also found that all jurisdictions surveyed needed to increase tax rates to maintain revenue stability in the wake of use-value implementation. Statewide, 5.49% of taxes were shifted from use-value participants to non-participants (Gayer et al. 1987). Unfortunately, the study did not include urbanization or population density variables in the analysis, making comparison of rural and urban jurisdictions impossible.

Georgia

Georgia employs two differential taxation schemes for agricultural land. The first of these, Conservation Use Valuation (CUV), is essentially a restrictive agreement program used extensively in northern Georgia where property values are high and strong residential and commercial development is occurring (Georgia Department of Revenue 2001). Instituted in 1992, CUV has several stipulations. Enrolled land must be in a desired use and non-family corporations are not eligible to participate in the program. Each landowner is limited to 2,000 acres enrolled in the program statewide. Under CUV, landowners can have their *ad valorem* taxes lowered by 90% or more. Newman et. al.

stated that “the objective of the program is basically to keep non-corporate agricultural or woodland in a non-developed state” (2000, p. 266).

Individual covenants under CUV are limited to 10 years, although they may be renewed. For properties enrolled in the program, assessment is done by the state and applied at the county level. Penalties for breaking any part of the covenant include a fine of twice the taxes saved for the period the covenant has been in effect, plus interest on the entire parcel covered by the covenant. Interest is “1% per month from the date the tax is due until the date the tax is paid” (Georgia General Assembly 2001).

The second program, the Agricultural Preference Tax (APT), has requirements and limitations similar to CUV but reduces property taxes by 25% rather than revaluing enrolled tracts. Under the APT program, “agricultural property can be assessed at 75% of the assessment of other property. This means that this type of property is assessed at 30% of fair market value rather than 40%” (Georgia Department of Revenue 2002, p. 15). Landowners are free to enroll in either program and choose the one which provides the greatest tax savings. APT is used primarily in southern Georgia.

The Georgia legislature has mandated that an annual report of the fiscal implications of the Conservation Use Valuation (CUV) program be generated. “Unfortunately, other than providing the number of covenants existing in a county, little information is available regarding the impacts that the program may actually be having on land use” (Newman et al. 2000, p. 257).

Oregon and Florida vs. Georgia

Research by Nelson (1999) comparing Oregon, Florida, and Georgia found striking differences in the ability of these states to control development and its impacts. Oregon and Florida have mandated growth-management while Georgia has not, preferring to rely on differential taxation, as discussed above. In the period between 1980 and 1990, Oregon and Florida experienced urban population growth of ~25% and ~33% respectively, while population density in urban areas fell by only 0.53% and 5.14%. By contrast, Georgia's urban population grew by ~33%, but experienced a 15.58% reduction in urban population density, indicating sprawl. The study also noted that while the nation lost 1.79 acres of farmland for each new resident in the 1980s, Oregon and Florida lost 0.33 and 0.66 acres respectively. Georgia lost 2.1 acres during the same period. "Literature demonstrates reasonably well that in the absence of growth-management mandates, local governments are usually ineffective [at] . . . containing urban sprawl" (Nelson 1999, p. 122).

Massachusetts

It is worth noting that while many states utilize a single use-value system for forest and agricultural lands, some states employ separate assessment programs for these different land uses. Massachusetts is one such state. Massachusetts' modified assessment legislation for forestry (known as Chapter 61) was passed in 1914 and amended in 1955. This program requires participating landowners to practice forest management, pay a yield tax on harvested timber, and pay a reduced annual property tax. Landowners failing to meet program requirements must repay tax savings plus an 8%

interest penalty per year, up to a total of \$200 per acre. The program is limited to parcels of 10 acres or more (Kronrad and Harou 1978; Kronrad and Harou 1982). The state's preferential agricultural assessment program was initiated in 1973 and applies to agricultural land only (Keene et al. 1976b).

North Carolina

In North Carolina, the deferred tax program (known as use-value taxation or the use-value program) is restricted in forestry to tracts of 20 or more acres (although agricultural and horticultural operations with fewer acres are permissible) not owned by corporations. In addition to the parcel size requirement, forestry participants in the use-value program must have a "sound management program," defined as "A program of production designed to obtain the greatest net return from the land consistent with its conservation and long-term improvement" (North Carolina General Assembly 1997, §§105-277.2-105-277.7). Upon admission into use-value assessment, a lien is placed on the subject property. As a deterrent to leaving the program, should the owner chose to use the land in some manner other than that specified under the use-value program, market value rate taxes become due for the year of change as well as the difference between market rate and use-value taxes for the three previous years, with interest.

The interest assessed is determined by the month the property comes out of use-value. Interest is assessed at the rate of 2% for January of the first year of the rollback, and 0.75% for each month thereafter of the three year rollback period (North Carolina General Assembly 1997, §105-360). For example, the interest on a property leaving use-value in February would be 2 .75% for the first year (2% for January and 0.75% for

February), 11.75% for the second year (2.75% plus 12 times 0.75% for all 12 months of the second year), and 20.75% for the third year (12 times 0.75% for all 12 months of the third year). A property leaving the program in December would incur the maximum interest penalty of 10.25% for the first year, 19.25% for the second year, and 28.25% for the third year (Smith 2002). On fulfilling these tax requirements, the lien on the land is lifted.

The savings to forest owners in North Carolina from use value taxation are substantial. While the average market value for an acre of forestland in the state is \$550, the average use-value assessment for a forested acre is \$225 (Connelly 2000). The North Carolina Department of Revenue (NCDOR) estimates that 97% of the acres in North Carolina that are eligible for use-value taxation are enrolled in the program. According to Connelly (2000), the counties are not consistent in how the standard of “sound management” is interpreted. Additionally, in the past there has been a reluctance on the part of the counties to interpret this standard as requiring a written management plan on the part of the forest landowner as the counties did not have the manpower to assess compliance with written plans. However, the number of counties requiring written management plans is increasing.

Methodology

I hypothesized that property tax burdens, property values, and population density have an effect on changes in land use and that these variables affect subdivision (dividing properties into smaller ownerships), sale of properties, and landowner withdrawal from the use-value program differently, depending on the characteristics of the individual

tracts considered. These hypotheses were tested using an historical, objective analysis of these relationships based on a sample of tax records of properties in the use-value program and census data for nine counties in North Carolina. Data were analyzed using logistic regression.

Independent Variables

Parcel-level data collected on each tract included: size of tract in acres, method of acquisition (acquired from family or purchased out of family), market value of tract, amount of market value deferred, taxable amount after use-value deferment, actual tax paid. For all variables, the current year as well as lagged variables for the previous two years were analyzed (Table 3.2). This approach was taken to determine if landowners were responding to changes in the independent variables from previous years in making their decisions regarding the use-value program. Additionally, variables were expressed as both raw values, increases, and as percentage increases in order to ascertain which type of information influenced landowners' decisions.

Table 3.2. Independent Variables, Descriptions And Expected Effects	
Variable	Units and Expected Effect
Size Class (categorical control)	1 = 20-49 acres, 2 = 50-99 acres, 3 = 100+ acres) Expected effect: Increased fragmentation with larger tracts, Increased sales with smaller tracts, No effect on withdrawal
Region of State (categorical control)	1 = mountains, 2 = piedmont, 3= coastal plain Expected effect: No effect expected
Urban Status (categorical control)	1 = rural, 2 = interface, 3 = urban Expected effect: Increased attrition with higher urban status
Mode of Acquisition (categorical control)	1 = from family, 2 = outside of family, 3 = unknown Expected effect: Increased attrition among purchased parcels

Table 3.2. (continued)	
Acreage Value in Current Year	One dollar increments Expected effect: Increased attrition with increased value
Acreage Value in Previous Year	
Acreage Value Two Years Ago	
Increase in Acreage Value Growth Rate in Current Year	One dollar increments Expected effect: Increased attrition with increased rates
Increase in Acreage Value Growth Rate in Previous Year	
Increase in Acreage Value Growth Rate Two Years Prior	
Percent Increase in Acreage Value in Current Year	One percent increments Expected effect: Increased attrition with increased value
Percent Increase in Acreage Value in Previous Year	
Percent Increase in Acreage Value Two Years Prior	
Tax Paid Per Acre in Current Year	One dollar increments Expected effect: Increased attrition with increased tax
Tax Paid Per Acre in Previous Year	
Tax Paid Per Acre Two Years Prior	
Increase in Tax Growth Rate Per Acre in Current Year	One dollar increments Expected effect: Increased attrition with increased rates
Increase in Tax Growth Rate Per Acre in Previous Year	
Increase in Tax Growth Rate Per Acre Two Years Prior	

Table 3.2. (continued)	
Percent Increase in Tax Paid Per Acre in Current Year	One percent increments Expected effect: Increased attrition with increased tax
Percent Increase in Tax Paid Per Acre in Previous Year	
Percent Increase in Tax Paid Per Acre Two Years Prior	
County Population Density in Current Year	One person per square mile increments Expected effect: Increased attrition with increased population
County Population Density in Previous Year	
County Population Density Two Years Prior	
Increase in Population Density Growth Rate in Current Year	One person per square mile increments Expected effect: Increased attrition with increased rates
Increase in Population Density Growth Rate in Previous Year	
Increase in Population Density Growth Rate Two Years Prior	
Percent Increase in Population Density in Current Year	One percent increments Expected effect: Increased attrition with increased population
Percent Increase in Population Density in Previous Year	
Percent Increase in Population Density Two Years Prior	

Table 3.2. (continued)		
Average County Acreage Value in Current Year	One dollar increments Expected effect: Increased attrition with increased value	
Average County Acreage Value in Previous Year		
Average County Acreage Value Two Years Prior		
Increase in County Acreage Value Growth Rate in Current Year	One dollar increments Expected effect: Increased attrition with increased rates	
Increase in County Acreage Value Growth Rate in Previous Year		
Increase in County Acreage Value Growth Rate Two Years Prior		
Percent Increase in County Acreage Value in Current Year	One percent increments Expected effect: Increased attrition with increased value	
Percent Increase in County Acreage Value in Previous Year		
Percent Increase in County Acreage Value Two Years Prior		
Difference Between Parcel Acreage Value and Average County Acre Value in Current Year	One dollar increments Expected effect: Higher attrition in parcels with greater acreage value than average county acreage value	
Difference Between Parcel Acreage Value and Average County Acre Value in Previous Year		
Difference Between Parcel Acreage Value and Average County Acre Value Two Years Prior		

In addition to the parcel-level tax information, census data were collected for each county for each year of interest (U.S. Census Bureau 2000). As the vast majority of parcels were located outside of towns, only county level data were utilized. County-level values of real property were also obtained for each county and year (North Carolina Department of Revenue various years-b). These were divided by annual sales ratios (North Carolina Department of Revenue various years-a) to derive estimates of total market values for all real property in each county for each year. Sales ratio figures are generated by the NCDOR through an annual sample of all land transactions in each county. The sales price for the sampled parcels is compared to the assessed market value to determine the average county level ratio of sales figure to assessed market figure (North Carolina Department of Revenue 1988).

I divided the sales ratio adjusted values of all real property in each county by the total acreage in the county (U.S. Census Bureau 2002) to gain an estimate of the average adjusted value of an acre in each county for each year. The difference between the acreage value of the individual parcels in my sample and that of the average, sales-ratio adjusted value of an acre in each county was calculated. This value, and the lagged versions of the value for the previous two years, were included in the analysis to see if landowners were responding to a change in the value of their properties relative to the average county-level changes in property value.

Dependent Variables

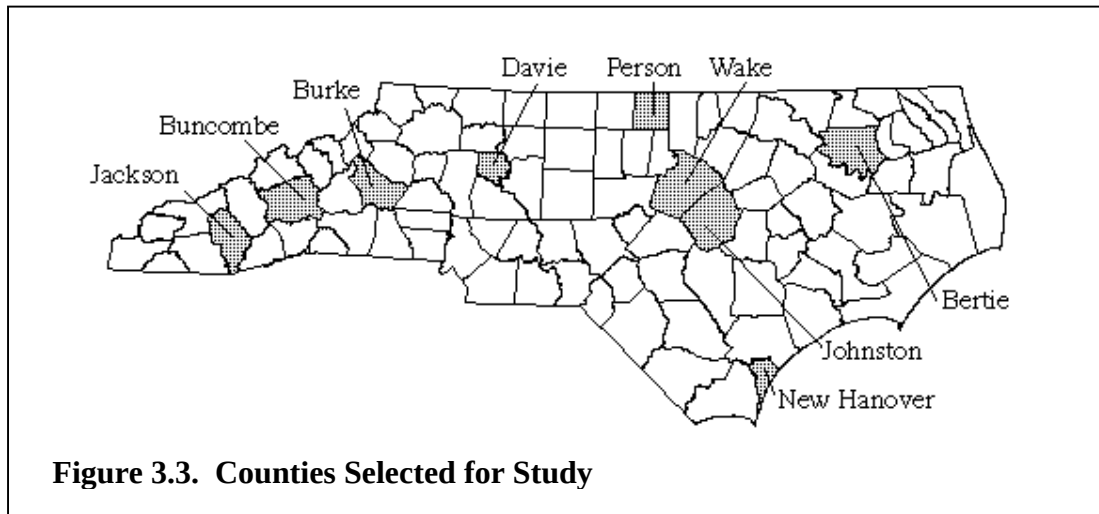
Three dependent variables were utilized, corresponding to the three means by which use-value properties became ineligible under the program during the time studied. The first of these was sale of the property. During the study period, properties sold to non-family members were removed from the use-value program and the rollback provision of the law was triggered. This condition no longer applies due to changes in the relevant legislation, as will be discussed below. Secondly, an individual landowner could decide to withdraw from the program on their own. Given the high participation rate of eligible properties in the use-value program, withdrawal from the program with no change in acreage or ownership indicates a likely change in land use.

The last dependent variable of interest was whether or not a property has been subdivided. For the purposes of this research, the unit of interest was a use-value ownership, defined by three components: (1) enrollment in the use-value program, (2) having a specific owner, and (3) having a specific number of acres. Changing any of the three components eliminated the property from inclusion as a valid parcel for continued inclusion in analysis. While the variables corresponding to sale and withdrawal are clear-cut as outlined above, defining subdivision requires a metric by which to decide when a property has been sufficiently divided to warrant its removal from the sample. For the purposes of this research, a property has been subdivided if 5 or more acres or 10% of the original tract acreage have been subdivided. This limit was chosen in order to overlook passage of small residence lots to family members.

Sampling

Megalos (1999) studied landowner responsiveness to forestry incentives using survey data gathered from nine North Carolina counties. He selected three counties in each geographic region of the state (mountain, piedmont, and coastal plain). In each of these regions, the counties selected represented three levels of urban status (rural, urban, and rural/urban interface). I tried to utilize the same counties selected in Megalos' study, thereby adding to his established data base, and was able to do so in both the mountain and coastal regions of the state. In none of the piedmont counties selected by Megalos were the county tax records complete enough to allow them to be used in this study. Consequently, substitute counties were selected utilizing criteria summarized in Megalos (1999) (Table 3.3) (Figure 3.3).

Table 3.3. Counties Selected For Study		
County	Region	Urban Status
Buncombe	Mountain	Urban
Burke	Mountain	Urban/Rural Interface
Jackson	Mountain	Rural
Wake	Piedmont	Urban
Davie	Piedmont	Urban/Rural Interface
Person	Piedmont	Rural
New Hanover	Coastal Plain	Urban
Johnston	Coastal Plain	Urban/Rural Interface
Bertie	Coastal Plain	Rural



Tracts selected for study were grouped into three size classes: 20-49 acres, 50-99 acres, and 100+ acres. Given the relatively small number of parcels containing large acreage in North Carolina, the larger two size classes were oversampled. The lower limit of 20 acres corresponds to the lower threshold allowed for participation in the forestry component of the use-value program. Utilizing a preliminary sample of the 1990 tax records in the selected counties, the proportion of parcels in each size class in use-value provided the basis for a disproportional stratified systematic sample of the 1990 use-value records in those counties. Disproportionate stratified sampling “is useful when the sizes of important subgroups in the population differ greatly” (O’Sullivan and Rassel 1999, p. 140). It prevents underrepresentation of important groups with fewer members.

The following formula, based on Czaja and Blair (1996, p. 148), was used to determine the number of parcels which must be viewed to gather an appropriate overall sample:

$$D/(x*y)$$

where D = the desired number of parcels of the least numerous size class, x = the proportion of the properties in the least frequent size class in the preliminary sample, and y = the proportion of properties in use-value in the preliminary sample (required for those counties which did not maintain separate lists of use-value properties). The total number of records in the sample population was divided by the result of this equation to determine the number of records that must be viewed to derive the sample, resulting in the skip pattern for the systematic sample. The sample start was then selected randomly.

Although systematic samples do "not produce independent selections . . . because once the initial object has been chosen all other selections follow" (Taylor 1977, p. 75), they generally provide as good a representation of the population as simple random samples and are therefore suitable for use in statistical formulas based on simple random sampling (Agresti and Finlay 1997). The above protocol gathered the correct number of parcels in the largest size class, but generally selected an overabundance of parcels in the two smaller size classes. Parcels in these classes in excess of the number desired for analysis were systematically eliminated (based on a random start) to arrive at the desired numbers in each size class. Data were collected from 1987 (where available, to construct lagged variables) through 1999, enabling a nine year analysis (1990-1998) of landowner decisions.

"There has been surprisingly little work on sample size for logistic regression. The available methods to address sample size have been implemented in just a few specialty software packages" (Hosmer and Lemeshow 2000, p. 339). This problem is particularly onerous in areas of new research where no estimates of probabilities are

available from which to derive sample size targets. Bloomfield (2001) suggested a beginning sample size of 30 parcels from each county. This suggested target was trebled in order to be conservative, setting a target of ~90 parcels from each county, equally divided between the three size classes. Hosmer and Lemeshow (2000) suggested as a rule of thumb having no more parameters in the final model than 1/10 the successes or failures (whichever is fewer in number) in the dependent variable. Hosmer and Lemeshow's sample size rule was met in all three regressions in this analysis.

Each county maintains its tax records independently, often using very different systems and recording different components of the tax picture. These differences created problems in gathering and comparing the data from different counties. A brief description of the records and the difficulties encountered follows.

Buncombe

The 1990 Buncombe County tax data consisted of property record cards on microfiche, arranged by ward and lot number (geographically). Using the formula by Czaja and Blair above and the data from a preliminary sample, the skip pattern for the full sample was determined. The preliminary sample targeted an area of the county rich in use-value properties. This protocol resulted in an underestimation of the number of records which must be viewed to achieve the desired sample size. Consequently, the skip interval was decreased and sampling was restarted to obtain more records. Even with this adjustment, the final sample yielded fewer parcels than predicted, but still an acceptable number for analysis.

Using microfiche (for years prior to 1990), an on-line system for tracing tax bills (for 1991-1998), and CDs (for 1999), each selected property was tracked until 1999, until it left the use-value program (either through sale or removal by the current owner), or until it was subdivided. Buncombe County recorded the market value of the property, the amount deferred, and the actual taxable amount (deferred value of the land plus buildings and improvements).

The deed for each selected parcel was reviewed to determine if the parcel had been acquired through purchase outside of family, or through either inheritance or family purchase. Both a computer database and deed books were used to research these documents. Parcels passing between persons with the same last name, maiden name matching that of the previous owner, or maiden initial matching the last name of the previous owner were deemed to have passed through family. Mode of acquisition was determined similarly for each tract in each county. Data collection in Buncombe county took twice as long as anticipated in the original timeline for the project, because this was the first county I sampled and several types of data were used.

Burke

Burke county maintained its 1990 use-value data in a single volume alphabetical use-value tax scroll (a book listing the tax information for use-value properties). The tax scroll recorded parcel information such as owner, parcel identification number, deed book and page, and acreage, as well as the value of the property under use-value and the amount of the deferment. Information on the value of land separate from buildings and

improvements was unavailable. Market values were derived by adding the use-value amount and the deferment.

Tax scrolls for those properties not in use-value were not available and information for years prior to 1990 was obtained from individual property record cards for the parcels selected by the sample. The proportion of parcels in each size class was determined by a preliminary sample and this proportion was used to guide the full sample of the scroll. Parcel history was followed after 1990 using the use-value scrolls for each of the subsequent years.

As the scrolls were arranged alphabetically, when a particular parcel was sold to a person with a different last name, it was not possible to follow the tract using the scroll. Likewise, a landowner decision to withdraw from the use-value program resulted in the name being dropped from the use-value scroll. As it was impossible to differentiate between these two types of events from the scroll alone, individual use-value records were consulted to differentiate the two types of events. Interestingly, despite the inability to use computer records in Burke county (all research was done with paper records), the sample and follow-up of parcels went faster here than in any other county.

Jackson

Jackson County's 1990 records were contained in a 2 volume tax scroll which included both use-value and non-use-value properties. Following a preliminary sample, the 1990 scroll was sampled using Czaja and Blair's formula, above. Parcels were listed alphabetically. Records prior to 1990 were retained on microfilm and were arranged by parcel number, necessitating reorganization of the sample to check earlier years. Market

values and the amount of deferred tax were recorded for each use-value property. Use-value assessments were derived by subtracting the deferred values from the market figures. Parcel history was traced using computerized tax bills.

Wake

The 1990 tax data for Wake county consisted of property record cards retained on microfiche and housed in the Olivia Rayney Historical Library. Records prior to 1990 were also on microfiche in the library. Market and use-value assessments were recorded. Deferred values were determined by subtracting use-value from market figures. Parcel history was tracked using computerized tax bills.

Davie

Davie county's 1990 use-value data were in a separate, alphabetical use-value scroll. Data for the years prior to 1990 and following were computerized allowing for parcel history to be completely tracked on computer. In the period from 1987 to 1990, use-value assessments and deferred values were recorded, necessitating the addition of these figures to determine market values. Following 1990, market values (labeled "U," as had been the earlier use-value figures) and deferred values were recorded, necessitating subtraction. This change in records caused some initial confusion.

Person

Person was unusual in that there were more parcels in the largest size class (100+ acres) than in either of the other size classes. The smallest size class contained the fewest number of parcels. The records in this county also consisted of use-value scrolls,

arranged alphabetically. Scrolls were retained for each of the years of interest except 1987. Losses to the program due to sales were differentiated from those due to landowner withdrawal using computer records.

New Hanover

The 1990 New Hanover tax data consisted of property record cards on microfiche. Records prior to 1989 were unavailable in any form. The small number of 100+ acre tracts in New Hanover County required a complete census of the approximately 65,000 parcels in the 1990 tax records to obtain the requisite number of tracts in each size class. This effort required twice the time allotted to the county in the research plan. Parcel histories were followed using computer records. New Hanover provided an interesting example in that approximately 25% of the use-value property in the county was owned by four families (Bolick 2001). This was also the only county in which none of the use-value parcels selected for analysis were sold during the study period.

Johnston

The Johnston county 1990 use-value records were retained in a 23 volume alphabetical combined tax scroll which included personal taxes. The volumes amounted to 11,519 green-line computer pages. Following a preliminary sample, Czaja and Blair's formula was applied to determine the skip pattern for the full sample. Acquiring the sample took approximately four times as long as predicted. For years prior to 1990, similar tax scrolls were utilized to obtain information on selected parcels. Parcel histories following 1990 were tracked using computer records.

In addition to the size of its tax scrolls, Johnston county was unique in that many of its deed references were not listed in either the tax scrolls or in the computer files. To obtain the deed references for the parcels omitted from these sources, a paper grantor-grantee index was consulted for each of the years from 1945 to 1990 for each of the omitted parcels. This exercise found most of the omitted references, but added greatly to the time spent in this county.

Bertie

In Bertie county, the 1990 use-value data were on microfiche, in the form of recorded property record cards. As with other such records, a systematic preliminary sample was conducted using a random start to determine the skip pattern needed for the complete sample. This county was so rich in use-value properties, that the preliminary sample provided more than enough parcels to serve as the full sample. Parcel histories from 1987 to 1991 were tracked using microfiche. Records from the latter date forward were computerized. As in Davie county, the figure marked “U” changed meaning during the period analyzed for this study. Prior to 1991, U referred to the use-value assessed value of a parcel. After this time U reflected the amount deferred.

Analysis

Analysis was conducted with a parcel-year comprising a record. In other words, a parcel that remained in the use-value program for six years would provide six records for analysis. The rationale behind this decision was that landowners choose every year, based on the information they receive, whether or not to remain in the use value program. Additionally, the unit of interest was defined as an ownership (a parcel of defined size

and ownership in 1990) rather than the parcel itself since subdividing the parcel or changing its ownership removed the unit, as originally defined, from use-value.

This study addressed the following hypotheses (stated in null form):

H₁: Tract size is not related to the odds of subdivision, sale, or withdrawal.

H₂: Region of the state (mountain, piedmont, coastal plain) is not related to the odds of subdivision, sale, or withdrawal.

H₃: Urban status (rural, urban, rural/urban interface) is not related to the odds of subdivision, sale, or withdrawal.

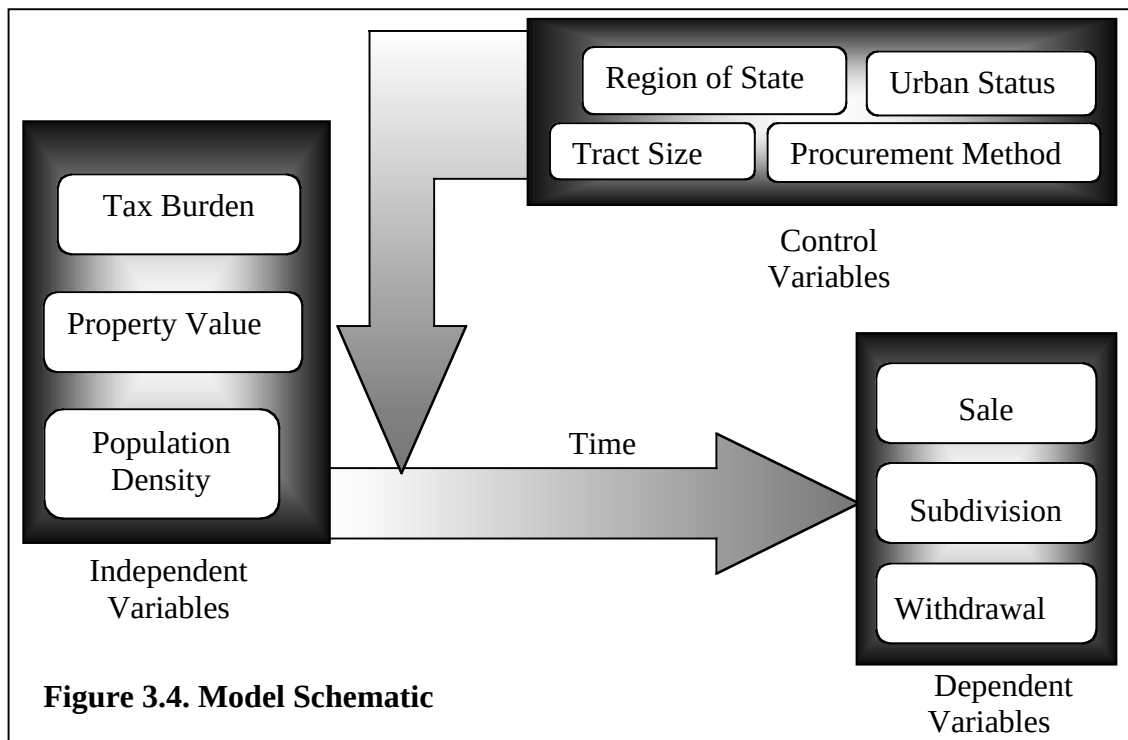
H₄: Method of acquisition is not related to the odds of subdivision, sale, or withdrawal.

H₅: Property values (individual and county level) are not related to the odds of subdivision, sale, or withdrawal.

H₆: Property tax burden is not related to the odds of subdivision, sale, or withdrawal.

H₇: County population density is not related to the odds of subdivision, sale, or withdrawal.

Figure 3.4 provides a generalized schematic of the models used in this study. Analysis was conducted using the SPSS logistic regression procedure (SPSS 1999). Before considering the results of the analysis, a brief introduction to logistic regression is warranted.



Logistic regression

Logistic regression estimates the probability of an event occurring (the dependant variable) given a set of conditions (the independent variables) and is appropriate when using binary dependent variables (Agresti and Finlay 1997). Attempts to analyze binary response variables using linear regression with dummy variables face two problems: one conceptual, one statistical. The conceptual problem lies in the probabilities of a dichotomous variable having 0 and 1 as bounds. Linear regression equations can extend to positive and negative infinity, so their predictions make no sense with regard to a dichotomous variable. Even if the relationship is S shaped and approaches limits at its maximum and minimum values, linear regression will overestimate probabilities at the top and bottom of the range and underestimate values in the middle (Pampel 2000).

Statistically, use of a dummy variable in linear regression for a dichotomous dependent variable violates the assumptions of normality and homoscedasticity (the concept that the conditional distribution of Y has constant standard deviation throughout the range of independent variables) (Agresti and Finlay 1997). The normality assumption states that the error terms are normally distributed around the predicted Y value for each value of X. With only two Y possibilities, normal distribution of errors is not possible. Put simply, ordinary least squares regression is not appropriate for dichotomous dependent variables because the error terms are not normally distributed and the variances change with the value of the independent variables (Pampel 2000).

Logistic regression eliminates the “floor” and “ceiling” associated with a dichotomous dependent variable. “First, take the ratio of P_i to $1-P_i$, or the odds of experiencing the event. Second, take the natural logarithm of the odds. The logit thus equals $L_i = \ln[P_i/(1-P_i)]$, or, in short, the logged odds” (Pampel 2000, p. 10). While the probability of occurrence can be either 0 or 1 for a dichotomous variable, the ratio of the probability of occurrence to the probability of non-occurrence (the odds of occurrence) has no upper limit (although a lower limit still exists for odds). The lower limit is eliminated by taking the natural or Napierian log of the odds. The outcomes of the logit transformations are symmetrical around a probability of 0.5 (which equals odds of 1 and a logit value of 0) and are linear in form.

Another difference between linear and logistic regression is that while linear regression assumes additivity in the independent variables (the idea that the effect of an independent variable on the dependent variable stays the same regardless of the levels of

other independent variables) this is not the case with a dichotomous independent variable. In logistic regression, if the level of one of the independent variables is sufficient to cause a change in the dependent variable, the other independent variables are rendered irrelevant. Additionally, “Each X variable has a different effect on the probability depending on its level and the level of the other independent variables” (Pampel 2000, p. 19). In logistic regression a unit change in the probability corresponds to larger changes in the logit as the probability approaches either 0 or 1. This has the effect of “stretching” the probabilities at extreme values relative to the midpoint and effectively “linearizes” the relationship between the independent and dependent variables.

Results

Summary Statistics

Rates of subdivision, sale and withdrawal

Geometric means of annual statewide rates of subdivision, sale and landowner withdrawal, after weighting to adjust for disproportionate sampling and county representation (O'Sullivan and Rassel 1999), are presented in Table 3.4.

Table 3.4. Weighted Statewide Geometric Means (Annual Rates)		
% Subdivided	% Sold	% Withdrawn
1.94 %	0.74%	0.84%

Geometric means were derived using the formula: $\sqrt[n]{y_1 y_2 y_3 \dots y_n}$ where n is the number of years of data and $y_1 \dots y_n$ are the data for the individual years (Microsoft

Corporation 1998). Weights were based on the proportion of parcels in each size class in each county and the number of counties in each urban class present in each of the three regions of North Carolina. As mentioned above, parcels which underwent subdivision were likely to have been subsequently sold. Likewise, a portion of those tracts that were sold may have left the program at a later date. Data limitations prevented quantification of these events. The percentages of parcels in the sample that underwent subdivision, sale, or withdrawal, by each control variable, are listed in Table 3.5. These data reflect the sum changes over the entire study period.

Table 3.5. Percent Change In Use-value, 1990-1998					
Region	Urban Status	Size Class in acres	% Subdivided	% Sold	% Withdrawn
Mountain	Rural	20-49	3.0%	1.3%	2.1%
		50-99	2.8%	0.0%	1.2%
		100+	2.8%	0.9%	2.3%
	Interface	20-49	1.2%	0.8%	1.9%
		50-99	1.5%	0.4%	1.5%
		100+	1.8%	2.7%	1.8%
	Urban	20-49	1.9%	0.0%	2.8%
		50-99	1.5%	1.0%	2.0%
		100+	4.1%	0.0%	1.0%
Piedmont	Rural	20-49	1.1%	0.7%	0.4%
		50-99	1.7%	1.0%	0%
		100+	2.9%	0.7%	0.4%
	Interface	20-49	1.9%	0.8%	0.8%
		50-99	3.1%	1.5%	0.4%
		100+	3.4%	0.4%	0.4%
	Urban	20-49	3.8%	1.9%	1.5%
		50-99	5.4%	1.3%	2.2%
		100+	5.7%	0.8%	1.2%

Table 3.5. (continued)					
Coastal	Rural	20-49	0.0%	1.1%	1.4%
		50-99	0.4%	2.2%	1.5%
		100+	1.1%	0.4%	0.4%
	Interface	20-49	1.3%	0.0%	2.1%
		50-99	3.5%	0.4%	3.1%
		100+	5.1%	0.9%	0.5%
	Urban	20-49	2.5%	0.0%	2.9%
		50-99	4.7%	0.0%	6.3%
		100+	2.8%	0.0%	2.8%

Table 3.4 shows that on a state-wide level, parcel subdivision was the greatest threat to participation in the use-value program during the time period studied and sale of parcels was the smallest threat. Recent changes in the use-value legislation (North Carolina General Assembly 2001) allow sold parcels that abide by program stipulations to remain in the program under the new owner without reapplication. This change makes the results of the sale regression less relevant as parcels are no longer automatically removed from the program at sale, and sale is now less of a threat to continued rural land use than the study indicated.

Regression

Three separate logistic regressions were performed, each focusing on one of the three indicators of attrition to the use-value program (subdivision, sale, and withdrawal from the program). For each of these analyses, several models were constructed utilizing a fusion of the backwards elimination procedures in SPSS and a step-by-step screening method outlined by Hosmer and Lemeshow (2000). Interaction terms were also constructed and tested in the preliminary models. None of these was found to be

significant. The various models within each analysis were compared using their individual -2 logged likelihoods ($-2LL$, discussed below).

Diagnostic procedures were conducted following the model selection phase of this research. One of the key assumptions of logistic regression is that the relationships between the independent and dependent variables are linear in the logit (this was the purpose of calculating the odds and their log). Linearity in the logit was tested using a Box-Tidwell regression (Menard 1995) for the acreage value two year prior to decision (Table 3.2) in the subdivision regression. This approach adds an interaction term, composed of the variable of interest times its natural log, to the model equation. Significance of this interaction term indicates a lack of linearity in the logit. As all other significant continuous independent variables contained values equal to or less than zero, use of Box-Tidwell regression to test linearity was infeasible due to the impossibility of computing natural logs for these values. Consequently, linearity was checked by plotting the values of the logit generated by the models against the values of the independent variables. Linearity in the logit was confirmed in all cases. Colinearity was tested using the tolerance algorithm in SPSS as outlined by Menard (1995). Tolerance “is calculated as 1 minus R squared for an independent variable when it is predicted by the other independent variables already included in the analysis” (SPSS 1999, help topics). The independent variables were not significantly correlated with one another.

-2 Logged Likelihood

Maximum likelihood estimation in logistic regression attempts to find estimates of model parameters from the data that will produce the observed pattern of dependent

variable successes and failures. This is accomplished by iteratively adjusting the parameter coefficients until a model is selected which has the greatest likelihood of producing the observed pattern seen in the dependent variable. Likelihood functions indicating “how likely it is to obtain the observed values of Y , given the values of the independent variables and parameters, $\alpha, \beta_1, \dots, \beta_k$ ” (Menard 1995, p. 13) are generated for each case in the data and multiplied together. The product of this calculation is then logged to avoid dealing with very small numbers (Pampel 2000). When multiplied by -2 , the log-likelihood function has approximately a χ^2 distribution. Larger values indicate worse prediction of the dependent variable (Menard 1995). The final models provided significant improvement in $-2LL$ over other models considered in this study, thereby indicating better prediction of the dependent variable. The final models and modified SPSS results from the three regressions are presented in Tables 3.6 through 3.8.

$$X^2$$

The statistic “Model Chi-square” in SPSS (row one, column one in Tables 3.6 through 3.8) is analogous to the multivariate F test in linear regression and is used to test the null hypothesis that all independent variable coefficients are equal and zero. If the model chi-square statistic is significant, we conclude that a model containing the independent variables provides better prediction than a model without the independent variables (Menard 1995). All X^2 values proved significant at $p = 0.10$.

Table 3.6. Results From Logistic Regression On Subdivision							
X ² significance = 0.000				Hosmer-Lemeshow Goodness-of-fit = 0.972			
<i>Variable</i>	B	S.E.	Sig.	Exp(B)	% effect	StdE(B)	std. effect
20-49 Acres (reference group)			.003				
50-99 Acres	.444	.223	.046	1.559	55.9%	1.065	6.5%
100+ Acres	.723	.212	.001	2.060	106.0%	1.108	10.8%
One Dollar Increase in Acreage Value Two Years Prior	.008	.004	.041	1.008	0.8%	1.031	3.1%
One Percent Increase in Population Density in Current Year	.210	.046	.000	1.234	23.4%	1.065	6.5%
Constant	-4.669	.217	.000	.009			

Table 3.7. Results From Logistic Regression On Sales							
X ² significance = 0.036				Hosmer-Lemeshow Goodness-of-fit = 0.413			
<i>Variable</i>	B	S.E.	Sig.	Exp(B)	% effect	StdE(B)	std. effect
Rural (reference class)			.044				
Urban	-1.828	.751	.015	.161	-83.9%	0.964	-3.6%
One Person Increase in Population Density Growth Rate Two Years Prior	.086	.030	.005	1.090	9.0%	1.017	1.7%
One Percent Increase in Tax Paid Per Acre in Previous Year	.001	.001	.060	1.001	0.1%	1.002	0.2%
One Dollar Increase in Acreage Value Growth Rate Two Years Prior	.022	.013	.078	1.023	2.3%	1.007	0.7%
Constant	-4.814	.232	.000	.008			

Table 3.8. Results From Logistic Regression On Withdrawal							
X ² significance = 0.000				Hosmer-Lemeshow Goodness-of-fit = 0.471			
<i>Variable</i>	B	S.E.	Sig.	Exp(B)	% effect	StdE(B)	std. effect
20-49 Acres (reference group)			.030				
100+ Acres	-.647	.309	.036	.524	-47.6%	0.953	-4.7%
Mountains (reference region)			.003				
Piedmont	-1.110	.340	.001	.330	-67.0%	0.922	-7.8%
One Person Increase in Population Density Growth Rate Two Years Prior	.046	.014	.001	1.047	4.7%	1.033	3.3%
One Dollar Increase in Tax Growth Rate Per Acre in Previous Year	-.040	.019	.031	.960	-4.0%	0.990	-1.0%
Constant	-4.063	.230	.000	.017			

$$R^2$$

In ordinary least squares regression, R^2 measures the proportion of the variance seen in the data that is explained by the regression model. This measure does not work for logistic regression due to the dichotomous nature of the dependent variable. The further the ratio of successes to failures deviates from 50/50, the lower the variance becomes, making the statistic meaningless when attempting to compare models and data with different ratios of success (Garson 2002).

“Researchers should use [R^2] measures as only rough guides without attributing great importance to a precise figure. In fact, many published articles using logistic regression do not present a measure of [R^2].” (Pampel 2000, p. 50). “Unfortunately low R^2 values in logistic regression are the norm and this presents a problem when reporting their values to an audience accustomed to seeing linear regression values. . . . Thus we

do not recommend routine publishing of R^2 values with results from fitted logistic regression models” (Hosmer and Lemeshow 2000, p. 167).

Despite this warning, Table 3.9 lists the Nagelkerke R^2 values for the three logistic regressions performed in this analysis. Several versions of R^2 statistics have been proposed for logistic regression. Unlike some other measures, that offered by Nagelkerke (1991) has the advantage of ranging from zero to one, making interpretation of the statistic easier for those accustomed to linear regression. Menard (1995) lists the lower end of acceptable R^2 values for logistic regression as 0.005. Each of the R^2 values below easily exceeds this threshold.

Table 3.9. Nagelkerke R^2 Values	
Regression	Nagelkerke R^2
Subdivision	0.030
Sale	0.022
Withdrawal	0.034

Goodness-of-Fit

Goodness-of-fit measures indicate how well the model fits the data. They attempt to circumvent a statistical problem inherent in logistic model evaluation using X^2 . If J = the number of distinct observed values of an independent variable, x , models with continuous independent variables may produce situations where $J \approx$ sample size (n). This situation may make the p values obtained using X^2 statistics potentially misleading since as the number of categories of x increases with the sample size, the count in each “cell” remains small, thereby not fulfilling the assumptions of X^2 . This error may be

avoided by grouping the data in such a way that the numbers in each category increase with increased sample size, rather than the number of categories.

This analysis used the Hosmer-Lemeshow goodness-of-fit statistic (row one, column 2 in Tables 3.6 through 3.8) which is based on the squared differences between the observed and predicted probabilities. SPSS groups the data in deciles of probability and compares the observed versus expected successes in the dependent variable based on the following formula

$$\chi^2 = \sum_{k=1}^g \frac{(o_k - n'_k \bar{\pi}_k)^2}{n'_k \bar{\pi}_k (1 - n'_k \bar{\pi}_k)}$$

where n'_k = the total number of subjects in the k^{th} group, o_k = the number of observed independent variable successes in the k^{th} group, and $\bar{\pi}_k$ = the average estimated probability (Hosmer and Lemeshow 2000).

In essence, the average estimated probability for each decile is multiplied by the number of cases with probabilities that lie within this decile to obtain the estimated number of successes and this result is subtracted from the number of observed independent variable successes for the group. This difference is then divided by the estimated number of success times 1 minus the estimated number of successes. These calculations are performed for each of the 10 deciles and summed to compute the goodness-of-fit statistic. The resultant statistic “is well approximated by the chi-squared distribution with $g - 2$ degrees of freedom” (where g is the 10 deciles used to group the probabilities) and gives a single indicator of goodness-of-fit (Hosmer and Lemeshow 2000, p. 149). A small observed significance level for the goodness-of-fit statistic

indicates that the model does not fit well. All three models in this analysis produced acceptable goodness-of-fit statistics.

Logistic Regression Coefficient Evaluation

Interpreting logistic regression coefficients is complicated. There are essentially three approaches: (1) analysis of coefficient changes on the probability of dependent variable success, (2) analysis of coefficient changes on the odds or logged odds of dependent variable success, and (3) analysis of the standardized coefficients.

Probabilities

“Since the relationships between the independent variables and probabilities are nonlinear and nonadditive, they cannot be represented by a single coefficient. The effect on the probabilities has to be identified at a particular value or set of values” (Pampel 2000, p. 23). In other words, the effect of the independent variables on probability of success in the dependent variable depends on where the individual case under question lies along the logistic regression curve. Unlike linear regression where the effects of the coefficients remain constant in the model over the range of independent variables, logistic regression coefficients have different effects on the model depending on the levels of the independent variables.

While the logit transformation used in logistic regression linearizes the dependent variable, the probabilities generated by the model are not linear, but asymptotic at the maximum and minimum. “The closer P comes to the ceiling or floor, . . . the smaller the effect of a unit change in X has on the probability” (Pampel 2000, p. 25). These inherent problems with interpretation of logistic regression coefficients in terms of probability

lead researchers to focus on the changes in odds rather than the changes in probability in analysis.

The odds of an event happening are equal to the probability of occurrence over one minus the probability of occurrence (the probability of non-occurrence). This relationship is known as the odds ratio, or simply the odds. Changes in odds are less confusing than probabilities and more widely understood through games of chance, lotteries and gambling. I focused on the odds interpretation of the results, described below.

Odds and Logged Odds

Logistic regression coefficients (column 2, labeled “B” in Tables 3.6 through 3.8) show the change in the logit (logged odds) of a success in the dependent variable for a unit change in the independent variable. To ascertain the effect of a change in the independent variable on the odds (as opposed to the logged odds) take the antilog of the logistic regression coefficient (also known as the exponentiated coefficient).

Exponentiated logistic coefficients (column 5, labeled “Exp(B)” in Tables 3.6 through 3.8) are generally interpreted as the increase in likelihood that a unit change in the independent variable will bring about success in the dependent variable. Subtracting 1 from the exponentiated coefficient and multiplying the result by 100 (Tables 3.6 through 3.8, column 6, labeled “% effect”) gives the percentage change in the odds (*not* the probability) of dependent variable success attributable to a unit change in the independent variable (Pampel 2000). The exponentiated coefficients contain the same

information about the relationship between the independent and dependent variables as both the logistic regression coefficient and the probability, only the presentation differs.

Although it is tempting to do so, the strength of the effects of the independent variables on the dependent variables cannot be compared using exponentiated coefficients. Each independent variable is measured differently so a unit change has a different meaning for each variable. Comparison of relative impact necessitates standardizing the coefficients.

Standardized Coefficients

Since the variables in the final models are measured along different scales (making a unit increase on a small scale appear to have more impact than a unit increase on a large scale), comparing the effects of the independent variables to each other requires that the coefficients of the variables be standardized. In linear regression, calculation of standard coefficients utilizes the standard deviations of both the independent and the dependent variables.

In logistic regression analysis, the calculation of standardized coefficients is complicated by the fact that it is not the value of Y , but the probability that Y has one or the other of its possible values, that is predicted by the logistic regression equation. The actual dependent variable in logistic regression is not Y , but $\text{logit}(Y)$, whose observed values of $\text{logit}(0) = -\infty$ and $\text{logit}(+\infty) = +\infty$ do not permit the calculation of means or standard deviations (Menard 1995, p. 46).

The standard deviation of the dependent variable can be calculated indirectly by using R^2 and the predicted values of $\text{logit}(Y)$. The former value may be obtained by regressing the probabilities predicted by the models against the dependent variables in a standard linear regression. The values of $\text{logit}(Y)$ may be obtained by generating a new

variable using the formula $\text{logit}(Y) = \ln\left(\frac{\pi}{1-\pi}\right)$, where π = the probability predicted by the model. The standard deviation of the dependent variable is then derived using the formula $b_{YX}^* = (b_{YX})(s_X)(R) / s_{\text{logit}(Y)}$, “where b_{YX}^* is the standardized logistic regression coefficient, b_{YX} is the unstandardized logistic regression coefficient, s_X is the standard deviation of the independent variable X , $s_{\text{logit}(Y)}$ is the standard deviation of $\text{logit}(Y)$,” and R is the square root of R^2 derived from the linear regression above (Menard 1995, p. 46). Column seven in Tables 3.6 through 3.8 (labeled “StdE(B)”) lists the standardized logistic regression coefficients for the independent variables, indicating the number of standard deviations of change that will occur in the dependent variable ($\text{logit}(Y)$, or logged odds) for a one standard deviation change in the independent variable. The percent change in the dependent variable attributable the standardized variable is listed in column eight of Tables 3.6 through 3.8 (labeled “std. effect”).

As there is no universally accepted method of standardizing logistic regression coefficients, and different techniques may yield different values for those coefficients (Pampel 2000), the coefficients themselves should be interpreted cautiously. However, different approaches will produce the same rank ordering among the variables.

Discussion

Table 3.10 is a collation of the data contained in Tables 3.6 through 3.8 and demonstrates the effects of the independent variables on the three dependent variables. All of the independent variables listed in the table were significant at $p = 0.10$ or better. Among the significant categorical independent variables (parcel size class, urban status of

county, and region of state), only the information for those categories which demonstrated a significant difference from a size class of 20-49 acres, being located in a rural county, and being located in the mountains (the reference categories for the regressions) are listed in the table.

Table 3.10. Collated Logistic Regression Results								
	Dependent Variables							
	Subdivision		Sale		Withdrawal			
Independent Variables	% effect	standard effect	% effect	standard effect	% effect	standard effect		
50-99 Acres	55.9%	6.5%						
100+ Acres	106.0%	10.8%						
Urban County					-83.9%	-3.6%	-47.6%	-4.7%
Piedmont Region							-67.0%	-7.8%
One Person Increase in Population Density Growth Rate Two Years Prior			9.0%	1.7%	4.7%	3.3%		
One Percent Increase in Population Density in Current Year	23.4%	6.5%						
One Dollar Increase in Acreage Value Two Years Prior	0.8%	3.1%						
One Dollar Increase in Acreage Value Growth Rate Two Years Prior			2.3%	0.7%				
One Dollar Increase in Tax Growth Rate Per Acre in Previous Year					-4.0%	-1.0%		
One Percent Increase in Tax Paid Per Acre in Previous Year			0.1%	0.2%				

The column “% effect” gives the percentage change in the odds of dependent variable occurrence attributable to a unit change in the independent variable. For the

dummy variables, this column represents the percent change in odds associated with parcel membership in the represented class as opposed to the reference class (the smallest size class, the mountain region, and rural counties). The “standard effect” column lists the standardized coefficients and allows for comparison of the impact each of the independent variables has on the dependent variables. These values should be compared with each other within each of the individual regressions.

The odds of an owner subdividing a parcel were greatest for those properties containing 100 or more acres. Being in this size class increased the odds of subdivision by 106.0% over the odds found for the smallest size class. Membership in the 50-99 acre class increased the odds of subdivision by 55.9%. In other words, for every 100 parcels that split in the 20-49 acre class, the model predicted that 156 would split in the 50-99 acre class and 206 would split in the 100+ acre class.

Of the non-categorical control variables, only a percent increase in population density in the year of analysis and the per-acre value of the property had any significant effect on the odds of subdivision. Of these, the population variable had over twice the relative impact demonstrated by the value variable (6.5% vs. 3.1% in standard effect). A 1% increase in population density increased the odds of subdivision by 23.4% while a one-dollar increase in the per-acre value of a parcel two years prior to the year of decision increased the odds by 0.8%. This lag may indicate caution on the part of landowners in making property decisions or may be simply a reflection of the time needed to sell a property once the decision to do so has been made.

While there was no significant difference between being located in a rural county or an interface county in the odds of a parcel being sold, being located in an urban county

decreased the odds of sale by 83.9% compared to being in a rural county. Urban counties experience greater differential between market value assessment and use-value assessment than rural counties, so the owners of these properties reap the greatest per-acre tax savings from the use-value program.

The decreased likelihood of sale in urban settings may also be attributable to the relatively small number of use-value parcels in urban counties. If owning use-value eligible property is an objective for a particular landowner, there are more tracts from which to choose in rural settings, should one decide to sell one's holdings. Replacing eligible property is more difficult in urban settings, so use-value properties potentially have higher value than those captured by the market due to the scarcity of the (non-market) amenities they provide for the owner.

Of the non-categorical variables, a one-person rise in the rate of population density increase two years ago increased the likelihood of sale by 9.0%. A one-dollar rise in the rate of property values increase one year ago raised the likelihood of sale by 2.3%. A 1% increase in the tax paid one year ago only increased the odds of sale by 0.1%. Again, the effect of the population variable is more than double that of the next closest non-categorical variable.

Finally, the odds of a landowner withdrawing their property from the use-value program but not selling it were greatly decreased by membership in the largest size class and among those properties located in the piedmont. The former relationship may be attributable to the difficulty in developing large properties. With the high participation in use-value by eligible properties, withdrawal from the program can serve as a proxy for land use change. Since agriculture and horticulture are allowable uses under the use-

value program, it is safe to assume that withdrawn properties will be developed.

Successfully navigating the bureaucratic and engineering requirements inherent in 100+ acre subdivisions requires a level of specialization and experience in development possessed by few landowners.

The pattern of fewer large properties leaving the program may also be a function of economies of scale. Whereas the owner of 25 acres might easily absorb the penalties associated with use-value rollback and the subsequent assessments at market value, those who hold very large tracts will suffer greater penalties if they choose to withdraw from the program and retain their land in an undeveloped state. In other words, the rollback provisions may provide the greatest disincentive to withdrawing from the program in the largest size class. The relationship between the odds of leaving the program and location in the piedmont may also be attributed to the rollback provision. While taxes paid per acre do not vary across the state, both deferment and market values vary significantly by region (Table 3.11). Analysis of 95% confidence intervals indicates that both deferments and market values are higher in the piedmont. Consequently, the penalty for withdrawal is higher in the piedmont than elsewhere.

As in the other regressions, the non-categorical variable having the greatest effect on landowner withdrawal from the use-value program was population. A one-unit increase in the rise in population density two years ago increased the odds of withdrawing from the program by 4.7%. Interestingly, a rise in the increase in per-acre tax paid decreased the odds of leaving the program. This indicates that with greater rates of tax increase, landowners who are contemplating leaving the use-value program and retaining their land are less likely to do so. While those landowners who subdivide their land

(presumably to sell a portion of the property) or sell the entire parcel may be able to pass the taxes incurred under the rollback penalty on to the buyer (Hamilton 2002), landowners not selling their properties will incur the entire cost of the rollback when they withdraw from use-value. The decreased likelihood of withdrawal in the face of larger tax increases may indicate that the rollback provides an incentive to stay in the program.

Table 3.11. Regional Category and Tax Data ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Tax paid per acre * Region	Between Groups (Combined)	13	2	6	.1	.894
	Within Groups	378885	6570	58		
	Total	378898	6572			
Deferment per acre * Region	Between Groups (Combined)	754690659	2	377345329	56	.000
	Within Groups	44652582484	6570	6796436		
	Total	45407273143	6572			
Acreage value * Region	Between Groups (Combined)	129876	2	64938	78	.000
	Within Groups	5473076	6570	833		
	Total	5602951	6572			

In summary, the three logistic regressions performed for this study represent three decisions faced each year by participants in the North Carolina use-value tax program: whether to subdivide one's property, whether to sell one's property, and whether to withdraw from the program while retaining ownership of one's property. Larger parcels were more likely to be subdivided than smaller parcels, but the largest parcels were the least likely to withdraw from the program and remain with the same owner. Tracts in urban areas were less likely to be sold than those in rural or interface counties. Parcels in

the piedmont were less likely to withdraw from the program than those in other regions of the state.

As indicated by the standardized coefficients (standard effect) in Table 3.6, population variables had the greatest impact of the continuous variables on all three decisions. Percent increases in density in the year of analysis increased the likelihood of subdivision while rises in the rate of increase two years ago made both sale and withdrawal from the program more likely.

The decisions to subdivide and sell were both affected by the market value of the property. The likelihood of subdivision increased with a rise in the per-acre value of the parcel two years ago while the decision to sell became more likely with a rise in the rate of per-acre property value increase two years ago. In other words, higher acreage values two years ago led to increased subdivision while increased rates of growth in acreage values two years ago led to more property sales.

Tax burden had an effect on the odds of both sale and withdrawing from the use-value program. In both these regressions, taxes had the least effect of any of the variables in the models, as indicated by their standard effects. Percent increases in taxes paid in the previous year slightly increased the likelihood of property subdivision. A rise in the rate of increase in taxes paid in the previous year decreased the likelihood of landowners withdrawing from the use-value program.

Thus the decision to subdivide is affected by tract size, population density, and acreage value of the tract. Increases in these variables raise the odds of subdivision. The decision to sell is increased by rises in population density, acreage value, and taxes paid, but is less likely to occur in urban counties. Landowner withdrawal from the use-value

program is increased by rises in population density, but decreased by higher increases in taxes paid. Additionally, withdrawal is less likely in the piedmont and among the largest parcels. The effect of population growth outweighed the effects of other continuous variables in all three decisions and was the only variable with significant impact in all three regressions. It is important to note, however, that it was not population density itself which was significant in the regressions, but changes in population density.

One possible explanation for the importance of population in landowner decisions may have to do with landowner reasons for owning forestland. When surveyed, many landowners cite residence as one of their primary reasons for owning forestland (Birch 1996, p. 15). Increases in density may undermine the characteristics these owners desire in a residence and persuade them to either subdivide the property, sell it, or develop it themselves, because what they originally found desirable in owning use-value property may be diminished by increased population density. Verification of this hypotheses could be attempted through interviews of the owners of the individual parcels included in the sample for this research. Such an effort could provide clues as to how density affects landowner decisions. For example, did the landowner eventually leave the subject parcel after subdivision? If the owner sold the entire property, did they then move to a more rural setting? These questions provide opportunity for future research.

Policy Considerations

The relationship between population growth and changes in land-use has been well documented in the literature. “Growth, urbanization, and decentralization of the population accelerate the conversion of rural land for urban uses” (Nelson 1990, p. 121).

Much of this change occurs at the urban fringe, where real property taxes can exceed net farm income. Since WWII, American population has become more urbanized.

Additionally, urban areas have sprawled across the landscape with diffuse development.

The relative growth of suburban, and the decline of central city and rural populations in recent years is a well known and often cited fact. Ultimately, it is this pattern of population growth that is responsible for the rapid rise in farmland values on the 'urban fringe' and related demands for use-value farmland assessment regulation (Gloudmans 1974, p. 2).

Dennis and Sendak (1992) performed an analysis of the Vermont use-value program to determine the effect of fragmentation on enrollment. The study utilized data from the periodic USDA Forest Service survey of the state, information from the state forestry division on use-value program enrollment, and state census data regarding town population densities, town growth rates, and town tax rates. The authors gathered demographic information using a 12 page questionnaire sent to the owner of each of the Forest Service's 338 sample parcels in the study area.

"The negative correlations between the probability that a parcel will be enrolled in the [use-value] program and a town's population density and growth rate indicate that the program is least effective in drawing acreage into the program in areas where it is needed most from the perspective of maintaining open space" (Dennis and Sendak 1992, p. 1213). A study using data from Ohio counties found similar results. "In the urban counties, higher taxes and higher increases in population density are associated with greater losses of farmland" (Keene et al. 1976a, p. 60).

Much of the urbanization occurring in the South is driven by population growth and migration. It is possible that the South could lose 8 to 12 million acres of forestland in the period between 1992 and 2020 (Granskog et al. 2002). The urban area of North

Carolina between Raleigh-Durham and Charlotte is predicted to be one of four major southern areas experiencing forest loss in the future. But population increases also affect rural areas.

While studies of growth and development tend to focus on urban areas, changes in population and forests are also occurring in the South's rural areas. As a result, the area in what has been called the "wildland-urban interface" is growing rapidly. Problems with interactions between people and forested systems therefore can also be expected to grow (Wear 2001, p. 15).

Both the Sierra Club and the Society of American Foresters (SAF) have recognized the impact that population growth can have on forested ecosystems.

The "population explosion" has severely disturbed the ecological relationships between human beings and the environment. It has caused an increasing scarcity of wilderness and wildlife and has impaired the beauty of whole regions, as well as reducing the standards and the quality of living. In recognition of the growing magnitude of this conservation issue, the Sierra Club supports a greatly increased program of education on the need for population control (Sierra Club 2002).

If human populations expand substantially in the future, considerable increases in the demands on forestland resources will occur. While recognizing that the much debated political aspects of population policy are peripheral to the expertise of professional forestland managers, we also recognize that the long-term effectiveness of forest management and conservation efforts depends on the resolution of this major domestic and global challenge. Therefore, the Society encourages efforts to place before the public scientific information on the dangers of unlimited population expansion and the land-management options that will have to be faced (South 1995, appendix of SAF positions).

While the Sierra Club position remains viable, the policy espoused by SAF expired in 1984 and may not reflect the current view of the organization. No current statement on population is listed on the SAF policies web site and the SAF working groups do not list population issues as one of their foci.

Rather than address the issue of population expansion and its underlying causes, natural resource policy has instead looked for means by which to offset the effects of growth. In response to a widespread perception that private timber resources were being poorly managed and would result in a timber shortage as demand increased, several studies from the late 1910s through the early 1940s by both the federal government and professional societies (including SAF) “supported federal ownership and recommended stronger planning and regulatory controls” (Cubbage et al. 1996, p. 244).

An interest in protecting the headwaters of navigable streams led to the passage of the Weeks Law in 1911, which authorized the purchase of private forestlands in the East by the federal government. In 1924, Congress passed the Clarke-McNary act to amend the Weeks Law by allowing purchase of eastern forestland for timber production. Clarke-McNary also instituted the framework for federal-state cooperation on a number of forestry issues and thereby lessened pressure for federal control of private forestlands (Cubbage et al. 1993).

At the state level, the preferred tool for attempting to influence land-use has been tax incentives, with or without penalties, as discussed above. The shortcomings of this approach are also outlined above, noting that use of differential assessment seems to be a necessary, but not sufficient means by which to control development. As discussed by Nelson:

Any program that does not ultimately assess a penalty equivalent to 100% of the present value of the stream of tax savings will induce farmers into selling to speculators, or becoming speculators themselves. In practice, however, the penalty is usually so small as to have a minimal effect on withdrawal. . . . By encouraging rather than discouraging speculation in farmland, those programs have the tendency to induce urban sprawl (1990, p. 129).

Use-value programs also raise the question of equity in that the tax burden of the governing jurisdiction shifts to non-forested properties (Hickman 1982). At issue is how much rural landowners should help bear the burden of providing services which are concentrated in urban areas. Additionally, the property tax is traditionally seen as regressive in that it imposes a larger relative burden on poorer households than on those that are more wealthy (Ladd 1998). Despite its shortcomings, one of the advantages of differential assessment over other forms of land use protection is that it is politically attractive (Keene et al. 1976b), but success in retaining rural land requires additional measures.

It may be possible to argue for the use of exaction or special assessments to offset the loss of environmental services caused by development. In order to pass the rational nexus test, use of exactions for remedial environmental services would require not only a concrete plan for the purchase of environmental services offsets, but would also have to focus on offsets that specifically addressed losses incurred through a particular development. To be politically palatable, the regressive impact on the housing market would have to be considered.

Adoption of either exactions or growth restrictions at the state level creates political difficulties. Fast-growing municipalities, and especially their fringes, typically grow faster than the state as a whole. At the state level, representatives must listen to constituents from both rapidly growing areas as well as those that are growing more slowly. The latter are likely to resist any broad approaches to slow the pace of development, making the institution of state-wide exactions difficult (Altshuler and Gómez-Ibáñez 1993). A more politically palatable solution might be to give

municipalities more statutory authority to impose exactions and growth restrictions.

However, if these measures are not implemented in a wide enough area, their incidence could be passed to the landowner in the form of lower prices paid for land as described by Yinger in the earlier discussion of development fees.

On a more mundane level, consolidation and standardization of county tax records needs to be considered. As there is no standard system for record maintenance and only guidelines regarding record retention in the state, each county's records are unique; often using very disparate systems for tracking information (even recording different tax components altogether), and presenting a challenge for cross-county comparisons. Counties retain data on microfilm, microfiche, computer databases, CD-roms, use-value scrolls (which had no data on parcels not in the use-value program), and co-mingled scrolls which contained all tax information, including that on personal taxes. Additionally, records are organized by either last name of the owner in the year recorded or by some form of geographical system, and different years were available in different counties. Standardization of county records and possible aggregation into a single database would greatly facilitate state monitoring of tax issues and implementation of programs.

Conclusion

The overall focus of this dissertation has been to examine landowner responses to the world in which they find themselves. NIPF owners have the capacity to change the landscape through their decisions by changing the composition and structure of the forest. Estimating their potential responses to market conditions (as was done in Chapter 2 of

this work) and determining the variables that have influenced their decisions in the past (as was done in Chapter 3) can help us better understand what may motivate this important group of citizens. This knowledge can help us develop incentives and other tools to help create the landscape we desire through landowner participation.

The last chapter of this project was unique in that I utilized property tax records as opposed to landowner surveys to analyze attrition to the use-value property tax program in North Carolina. My archival approach avoids potential lapses of memory or biases held by landowners regarding their land use decisions with regard to market conditions. The relationship between the independent variables and the different forms of attrition to the use-value program is not found elsewhere in the literature. Additionally, by following the protocol for county selection outlined by Megalos (1999), this effort builds on his findings regarding landowner participation in existing incentive programs.

Both the literature and the regressions performed in this study emphasize the primacy of population growth as a driving force in landscape change. Attempts to increase urban density can only be carried so far. As noted by Nelson (1990, p. 139), “The demand for acreage tracts cannot be ignored.” Consequently, rural land will face increasing development pressure as long as human population continues to swell. In addition to attempting to treat the symptoms of this condition, natural resource policy research should work to better understand the incentives and motivations behind population growth and develop approaches designed to help reduce population pressure on rural land.

If forested properties in areas with increasing density are to remain in forestry, changes in policy will be required. Attrition to the use-value program occurred despite

the existence of rollback penalties as deterrents in North Carolina. As demonstrated by Morris (1998), differential assessment does slow the pace of land-use change, but the bulk of the literature indicates that this tool alone cannot halt the loss of forestland to urbanization. If we decide that we want to effectively prevent this change, other tools will have to be used in conjunction with differential assessment, each with its own benefits and limitations.

Exactions and special assessments slow the pace of development, but these policies can increase the cost of housing and may be regressive in their effects. These tools also have the potential to have their costs passed to landowners. Use of exactions and special assessments necessitates a clear discussion of who should bear the economic burden of slowing land use change. To the degree that we believe NIPF owners should bear part of that burden, these tools are appropriate.

Exclusive zoning has been shown to be one of the most effective methods of preventing urban sprawl, but can be difficult to implement; requiring careful planning on the part of government and a willingness to withstand criticism on the part of government representatives as development pressure builds. This approach has been very successful in Oregon, where the political will exists to continue its use. Purchasing or transferring development rights (including conservation easements) can preserve open lands, but in the absence of a comprehensive plan, can lead to leapfrog sprawl and may compromise landscape-scale objectives. Acquiring development rights can be extremely useful if the properties to be included in this approach are part of a larger landscape perspective and are targeted for participation to reflect that perspective.

Deciding which of these tools to use in addition to use-value taxation presumes careful landscape-scale planning on the part of government and society. In the absence of planning, preservation efforts may not target those properties which provide the characteristics and services we desire. With careful planning and a clear understanding of where the burdens associated with our decisions will lie, we can achieve the landscape that best meets our societal objectives, equitably and efficiently.

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Appendix A. Summary Statistics for Property Value Variables, in Dollars

Region	Urban Status	Size Class in Acres	Statistic	ACRVAL	INAVAL	PINMKT
Mountain	Rural	20-49	Mean	34	1	8.1
			Std. Dev.	20.1	7.4	34.5
			Range	99	95	368.9
		50-99	Mean	26	2	12.3
			Std. Dev	12.8	5.2	44.9
			Range	61	36	486.4
		100+	Mean	25	2	11.6
			Std. Dev	21.1	4.9	36.3
			Range	101	42	231.9
	Interface	20-49	Mean	15	1	6.6
			Std. Dev	10.9	2.7	25.7
			Range	47	28	290.0
		50-99	Mean	12	1	7.0
			Std. Dev	7.4	2.5	24.9
			Range	44	31	246.6
		100+	Mean	7	0	8.9
			Std. Dev	3.0	1.2	33.6
			Range	19	11	359.8
	Urban	20-49	Mean	32	3	16.3
			Std. Dev	16.0	6.9	40.8
			Range	85	51	372.4
		50-99	Mean	25	2	18.6
			Std. Dev	11.9	5.7	53.8
			Range	94	57	554.9
		100+	Mean	24	2	18.7
			Std. Dev	20.0	8.4	57.8
			Range	93	139	525.1
Piedmont	Rural	20-49	Mean	23	1	6.7
			Std. Dev	16.2	3.5	19.1
			Range	76	32	172.9
		50-99	Mean	15	1	7.6
			Std. Dev	9.7	7.3	38.1
			Range	93	166	682.8
		100+	Mean	11	1	5.0
			Std. Dev	4.6	1.4	12.3
			Range	20	10	76.4
	Interface	20-49	Mean	26	1	9.0
			Std. Dev	15.6	4.7	30.4
			Range	75	33	242.1

Appendix A. (continued)				ACRVAL	INAVAL	PINMKT
Piedmont	Interface	50-99	Mean	21	1	8.8
			Std. Dev	9.4	3.7	27.4
			Range	37	26	188.5
		100+	Mean	16	1	9.4
			Std. Dev	8.8	4.0	36.5
			Range	54	62	455.5
	Urban	20-49	Mean	68	8	22.9
			Std. Dev	105.9	59.1	88.8
			Range	990	999	1135.0
		50-99	Mean	39	4	19.7
			Std. Dev	25.4	13.1	58.9
			Range	137	120	401.2
		100+	Mean	38	3	17.7
			Std. Dev	25.4	10.0	60.2
			Range	152	101	595.6
Coastal	Rural	20-49	Mean	10	0	10.8
			Std. Dev	7.4	6.6	54.8
			Range	87	152	889.0
		50-99	Mean	12	1	6.6
			Std. Dev	11.2	2.9	21.1
			Range	62	50	256.7
		100+	Mean	9	0	7.3
			Std. Dev	5.3	1.8	29.8
			Range	30	29	469.4
	Interface	20-49	Mean	16	0	7.5
			Std. Dev	19.5	1.6	35.0
			Range	142	13	396.5
		50-99	Mean	10	0	4.1
			Std. Dev	5.4	1.4	15.3
			Range	23	19	158.8
		100+	Mean	8	0	6.0
			Std. Dev	3.9	1.0	24.7
			Range	19	11	278.1
	Urban	20-49	Mean	49	4	20.1
			Std. Dev	30.4	16.2	79.3
			Range	190	174	711.7
		50-99	Mean	28	2	19.0
			Std. Dev	19.0	8.4	59.5
			Range	65	60	438.1
		100+	Mean	20	1	19.4
			Std. Dev	12.1	4.3	124.6
			Range	60	43	1894.4

Appendix B. Summary Statistics for Tax Variables, in Dollars

Region	Urban Status	Size Class in Acres	Statistic	TXPDA	INTXPD	PINTXPD
Mountain	Rural	20-49	Mean	8	0	4.6
			Std. Dev.	7.8	3.0	28.2
			Range	36	47	339.9
		50-99	Mean	4	0	3.4
			Std. Dev	3.5	1.1	27.9
			Range	19	17	320.6
		100+	Mean	5	0	8.6
			Std. Dev	7.5	1.8	98.1
			Range	39	24	1472.9
	Interface	20-49	Mean	5	0	27.2
			Std. Dev	5.0	1.5	151.4
			Range	26	20	2341.3
		50-99	Mean	4	0	19.3
			Std. Dev	4.5	1.0	64.4
			Range	28	11	712.7
		100+	Mean	2	0	17.2
			Std. Dev	1.9	0.5	55.8
			Range	13	6	409.1
	Urban	20-49	Mean	14	0	1.2
			Std. Dev	11.1	2.4	21.1
			Range	53	23	196.2
		50-99	Mean	7	0	31.5
			Std. Dev	6.5	3.4	264.0
			Range	31	51	3389.4
		100+	Mean	6	0	3.1
			Std. Dev	7.9	1.9	42.8
			Range	37	24	447.6
Piedmont	Rural	20-49	Mean	9	0	4.0
			Std. Dev	9.0	1.1	10.6
			Range	39	14	127.5
		50-99	Mean	6	0	7.5
			Std. Dev	5.0	4.3	57.7
			Range	56	103	1049.8
		100+	Mean	4	0	4.0
			Std. Dev	2.2	0.5	9.6
			Range	9	5	99.9
	Interface	20-49	Mean	8	0	4.2
			Std. Dev	7.7	1.3	72.6
			Range	34	18	1189.5

Appendix B. (continued)				TXPDA	INTXPD	PINTXPD
Piedmont	Interface	50-99	Mean	6	0	-1.4
			Std. Dev	4.2	0.7	16.0
			Range	18	6	107.3
		100+	Mean	4	0	-1.8
			Std. Dev	2.5	0.7	16.8
			Range	11	6	143.4
	Urban	20-49	Mean	9	0	6.0
			Std. Dev	14.7	9.2	38.5
			Range	129	200	423.9
		50-99	Mean	3	0	14.0
			Std. Dev	3.9	1.5	79.8
			Range	17	22	655.5
		100+	Mean	4	0	6.3
			Std. Dev	6.1	1.1	52.8
			Range	29	15	591.0
Coastal	Rural	20-49	Mean	5	0	6.4
			Std. Dev	4.1	3.0	57.2
			Range	39	70	858.1
		50-99	Mean	6	0	6.9
			Std. Dev	5.5	1.1	72.0
			Range	32	19	1051.6
		100+	Mean	5	0	3.3
			Std. Dev	4.1	1.5	41.5
			Range	23	27	724.8
	Interface	20-49	Mean	10	0	5.8
			Std. Dev	17.2	1.0	39.8
			Range	125	13	482.2
		50-99	Mean	6	0	4.2
			Std. Dev	4.0	1.1	27.1
			Range	18	17	269.6
		100+	Mean	5	0	3.5
			Std. Dev	2.7	0.8	23.5
			Range	12	11	305.9
	Urban	20-49	Mean	7	0	26.6
			Std. Dev	9.2	3.1	283.8
			Range	48	37	3810.4
		50-99	Mean	6	0	14.6
			Std. Dev	8.5	2.2	77.3
			Range	50	20	621.0
		100+	Mean	4	0	2.8
			Std. Dev	5.5	1.5	56.2
			Range	34	25	901.2

**Appendix C. Summary Statistics for County Population Variables,
in Persons per Square Mile**

Region	Urban Status	Statistic	DEN	INDEN	PINDEN
Mountain	Rural	Mean	57	1	1.0
		Std. Dev.	2.2	1	1.3
		Range	6	3	4.6
	Interface	Mean	156	1	0.6
		Std. Dev	4.2	2	1.2
		Range	12	6	3.9
	Urban	Mean	281	3	1.1
		Std. Dev	10.0	2	0.6
		Range	29	6	2.1
Piedmont	Rural	Mean	81	1	0.8
		Std. Dev	2.9	1	1.6
		Range	9	5	5.9
	Interface	Mean	117	2	1.5
		Std. Dev	5.2	1	0.9
		Range	16	4	2.5
	Urban	Mean	590	23	4.1
		Std. Dev	54.7	6	1.3
		Range	169	20	4.2
Coastal	Rural	Mean	29	0	-0.3
		Std. Dev	0.4	0	1.1
		Range	1	1	3.8
	Interface	Mean	116	4	2.9
		Std. Dev	10.3	2	1.2
		Range	32	6	4.0
	Urban	Mean	674	17	2.6
		Std. Dev	48.7	4	0.6
		Range	145	13	1.8