

Abstract

LOCATIONAL ASPECTS OF ADAPTIVE REUSE: THE CASE OF NORTH CAROLINA'S TEXTILE MILLS

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This thesis examines the adaptive reuse of historic textile mills in North Carolina. The decline of the textile industry, which employed over 300,000 North Carolinians at its peak, has left scores of mills abandoned on the state's landscape. Many of these abandoned mills possess value that derives from a combination of their architectural splendor, their cultural significance, and their ability to reduce environmental impacts when creatively reused.

Historic textile mills within North Carolina are inventoried. This unique inventory includes the precise location of 611 historic mills, their current uses, and a host of site and situational factors that might affect the probability of reuse. Reused mills are statistically contrasted against abandoned mills using logistic regression and key situational factors that could affect investment decisions. The model correctly predicts the reuse of 87 percent of abandoned mills. The key predictors of mill reuse are: local age, ethnicity, educational attainment, poverty, distance to nearest stream, and location within a historic district. Analysis of errors indicates a troublesome frequency of false negatives, i.e., reused mills that are predicted to be abandoned. This is attributed to a lack of key site variables in the logistic model, e.g., structure size, lot size, and architectural quality. The model is then used to guide selection of abandoned

mills that are good candidates for reuse. Each of these five candidates is found to have considerable reuse potential and this emphasizes the need to consider preservation over demolition.

The inventory suffers from errors of omission, i.e., 80 percent of all historic mills are included. The inventory also suffers from possible errors of commission, i.e., a few mills might be inaccurately located or their current use misclassified. However, the inventory is unique in terms of its scope and quality. The false negatives can be reduced with measurement and inclusion of appropriate site characteristics. In sum, the approach developed here is transferable in terms of geography (other states) and sectors (other industries such as tobacco). This research is devoted to preserving the value of historic mills through their adaptive reuse. The inventory assembled and the modeling applied should prove useful in assisting with that goal.

**LOCATIONAL ASPECTS OF ADAPTIVE REUSE: THE CASE OF NORTH
CAROLINA'S TEXTILE MILLS**

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The Faculty of the Department of Geography

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by

Justin M. Briggs

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CHAPTER 1:
INTRODUCTION

Old buildings, old people on a front porch -- strange how old, obsolete buildings and plants and mills, the technology of fifty and a hundred years ago, always seem to look so much better than the new stuff. Weeds and grass and wildflowers grow where the concrete has cracked and broken. Neat, squared, upright lines acquire a random sag. The uniform masses of the unbroken color of fresh paint modify to a mottled, weathered softness. Nature has a non-Euclidian geometry of her own that seems to soften the deliberate objectivity of these buildings with a kind of random spontaneity that architects would do well to study.

– Robert Pirsig (1974)

Throughout *Zen and the Art of Motorcycle Maintenance*, Pirsig (1974) wrestles with the concept of quality. How are some things determined to have quality, while others are disregarded as worthless? Quality, in the sense of value and importance, is an entirely subjective notion. The research of this thesis is based on the assumption that abandoned textile factories frequently do have quality, and that quality, when present, is worthy of preservation. While some may argue that abandoned textile mills are useless and should be destroyed, these mills are often more interesting than the cookie cutter edifices that currently dominate much of the contemporary American landscape. The quality of abandoned historic textile mills in North Carolina is multifaceted in nature. Whether it derives from their architectural splendor, their historical and cultural significance, or their ability to reduce environmental impact through reuse, many of the old textile mills of North Carolina are full of quality.

During his travels across the United States, the narrator in *Zen and the Art of Motorcycle Maintenance* comes upon old abandoned buildings. While the casual observer might feel that

they are eyesores on the landscape and see no inherent value, or quality, the narrator pauses to admire the beauty in these structures. Time and the elements have shaped and changed them, giving birth to a whole new character. It can be argued that this romantic perception of textile mills, and other old structures, glosses over the probable social injustices and environmental degradation that frequently accompanied American industrialization. However, there is no doubt that these buildings' imperfections result from decades of wear and tear and come to reflect the imperfections that molded society's present state. These historic remnants assist in creating a sense of place that is impossible to recreate with new development. Although recently built shopping centers and neighborhoods may seem neat and shiny, they can also seem sterile and void of character. The authenticity associated with "non-Euclidean geometry" and "random spontaneity" of the old cannot be replicated without seeming fake.

This study examines the adaptive reuse of historic textile mills in North Carolina. Adaptive reuse is the practice of finding new uses for abandoned and unused properties. By cataloguing and assessing their individual attributes, a set of relationships will be revealed that can be used to understand why some abandoned textile mills are reused for other purposes. These empirical relationships, in turn, can be used to suggest where additional redevelopment might take place. There are key attributes of historic textile mills that should normally attract investment and a systematic assessment of these key attributes is needed. Factors such as local demographics, accessibility to major roads and retail areas, and building characteristics and conditions may all contribute to a textile mill's potential for redevelopment. As such, this thesis is devoted to old places and their qualities in a way that might save many of them, and in so doing, might help us to preserve a sense of place. This work lies at the intersection of

economic and historical geography. It is innovative in its use of virtual field techniques and their inclusion within a statistical analysis.

Textiles' Significance in North Carolina

Following the Civil War, North Carolina was left in destitute condition. Although much of North Carolina was virtually destroyed, its citizens were left with an opportunity to rebuild. This clean slate enabled a new merchant middle class, and as members of the merchant middle class continued to accumulate wealth, they looked to other investment opportunities to further their fortunes. One favored endeavor was the development of textile mills. The textile industry grew into a giant, with hundreds of thousands of North Carolinians working in mills at its peak in the 1960s and 1970s.

The textile industry began experiencing relative and then absolute decline in employment, especially in North Carolina, in the later 1970s. What began as a trickle slowly gained momentum until the textile industry virtually collapsed around the turn of the twenty-first century. The flight of the textile industry resulted in the vacancy of scores of mills across North Carolina. Textile manufacturing helped facilitate urbanization across the state, and its mills were frequently the focus of social and industrial activity in these towns. Despite the decline of this integral part of North Carolina's industrial landscape, contemporary environmental, social, and economic processes lend new possibilities for these often majestic structures.

The rapid abandonment of textile mills also comes at a critical juncture in our nation's, and the South's history. With strong threats from climate change, petroleum dependence, and

environmental degradation, sprawl development and its culture, which has dominated America's post WWII growth, appears increasingly unsustainable. In order to calm the rapid expansion outward, it is necessary to start examining areas that are already developed for reuse. The adaptive reuse of historic textile mills can certainly help to alleviate the need for continued low-density sprawl.

In addition, because of their significance to North Carolina's history, the textile mills and the culture surrounding them have become a powerful icon for North Carolina and its people. North Carolina did not have the automobile industry like Michigan or the coal mining of West Virginia, so textile mills frequently become the backdrop when telling the life stories of the state's leaders, legends, and common folk. One cannot view a documentary on the life of Dale Earnhardt Sr. without his hometown of Kannapolis and its textile mills being mentioned and pictured. Cannon Mills in Kannapolis, once the largest textile mill in the world, is utilized to frame Earnhardt's humble beginnings, which then serves as a foundation to build upon his legend (ESPN 2010). Humble beginnings are often the textile mills for the families of North Carolina.

On September 16, 2003 John Edwards announced his candidacy for President of the United States in front of the Milliken Mill in Robbins, North Carolina. Edwards, a successful attorney and U.S. Senator, purposely used the historic mill as the backdrop for his campaign launch, because his father worked in that mill during his childhood (Appleman 2003). His self-depiction as "the mill worker's son" became an integral theme for his campaign. Successful politicians seem to rely on such humble beginnings, whether a farm or a factory. In one ad Edwards states that "I'm running for president, because for 54 years of my life, I have

believed in my soul that the men and women who worked in that mill with my father were worth every bit as much as the man that owned that mill” (<http://www.youtube.com/watch?v=qobwf-QOzJg>). He used that historic mill and its labor as a symbol to convey that he related to the working class men and women of America. These old places surely have value. They have value for legends, for politicians, for common people, for environmentalists and as a direct result, these old places have value for investors.

Thesis Overview

This thesis entertains several primary research objectives. The first objective is to create a systematic inventory of historic textile mills in North Carolina. This inventory will contain information on historic mill locations as well as their current status. These inventoried features, historic mills and their current uses, will be the focus of analysis to secure the second objective. The second objective of this research is to estimate a location model that will accurately predict the adaptive reuse potential of historic textile mills. The mills in the database are analyzed through an explicitly spatial-statistical modeling process. By comparing the characteristics of adaptively reused mills to abandoned ones, key explanatory variables that influence the likelihood of reuse are revealed. These predictive variables then are used to identify abandoned mills that share the qualities of reused ones. Such a geographic profile is used to indicate whether abandoned mills are good candidates for redevelopment. A selection of these mills is then carefully evaluated on an individual basis to illustrate their unique qualities as good candidates for reuse.

The organization of this thesis is as follows. The second chapter provides a review of relevant literature. First, the textile industry's history in North Carolina is described, followed by literature related to the adaptive reuse of textile mills and its many facets. Adaptive reuse is cast in terms of Smart Growth and Location Analysis. The third chapter describes the methodology employed in the research reported here. The data collection and database development process are described in detail because the creation of an adequate historic mill inventory is central to success. This chapter also highlights the modeling techniques used and the methods required to nominate reusable candidates. Chapter four describes the results of the modeling process. First, a large selection of location variables, potentially useful in predicting adaptive reuse, is examined through an exploratory process. This is followed by the construction of a multivariate logistic model involving the final selection of key explanatory variables. Based on this probability model, abandoned mills' reuse potentials are estimated and then the "best" candidates for reuse are identified. Each of these candidates is examined in great detail. The fifth and last chapter provides a summary of the research effort and offers a concluding discussion of the methods and findings. This includes a statement about the uses for the historic mill inventory assembled, the location model developed, research limitations, and good directions for future research.

CHAPTER 2: REVIEW OF RELEVANT LITERATURE

This chapter provides a basic review of existing literature needed to contextualize and situate the current study of the adaptive reuse of textile mills in North Carolina. The first section briefly describes the historic ascent of the textile industry in North Carolina. Textiles were a driving force in the industrialization and urbanization of the southern Piedmont. The location of mills influenced the spatial distribution of population within the state that carries over to the present. Former textile centers present valuable examples of reused facilities as well as new opportunities for mills that sit abandoned. The second section will describe the relatively rapid decline that the American textile industry experienced at the end of the twentieth century. A number of factors such as increased foreign competition and improvements in technology (increased productivity) contributed to its demise. The “flight” of the textile industry from the South and its remnant mill facilities provide opportunities for new uses of these frequently abandoned structures. The third section of this review will provide the foundation for suggesting key factors in the success of new uses for old mill buildings. In this regard, the adaptive reuse of mills will be examined through the conceptual lenses of Smart Growth and Location Theory. This portion of the review will confirm that the redevelopment of old mill properties can spur economic growth and preserve an important part of community heritage. The literature suggests that under the right conditions and proper planning, these abandoned properties can be successfully rehabilitated into significant community resources.

The Rise of Textile Mills in North Carolina

Following the Civil War, North Carolina was left in shambles. Having supplied a disproportionate share of supplies and men to the “Lost Cause,” North Carolina faced an arduous road to recovery. Although much of North Carolina was virtually destroyed, its citizens then had the opportunity to rebuild. This relatively clean slate enabled a new merchant middle class to arise with the establishment of the crop lien system. While farmers frequently were forced further and further into poverty, the merchant middle class generally prospered. As the merchant middle class continued to accumulate wealth, they looked to other investment opportunities to further their fortunes. One such endeavor involved the development of textile mills. This option was promoted by the Cotton Mill Campaigns beginning in 1880. The Cotton Mill Campaign was a call by state leaders and newspapers to attract business to North Carolina (Mitchell 2001). Afraid of falling even further behind northern states in terms of development, Tar Heel leaders began pushing for new opportunities to bolster the economy. In general, they equated industrialization with progress, and mills were envisioned as a tool that would bring prosperity not only to the owners, but whole towns as well (Hall 2000). Cotton mills had proven to be profitable in North Carolina prior to the Civil War and there was always a large supply of cotton, so factories became an increasingly common landscape feature across the Piedmont (Escott 1988).

At least two common misconceptions occur when discussing the development of the textile industry in the American South (Wright 1981). The first misconception is that the owners of textile mills in the north basically uprooted their northern mills and moved them to southern states. On the contrary, southern textile mills were almost entirely owned by local businessmen. The other misconception is that the products of southern mills were inferior and

could not compete with mills in the north. By the time southern textile mills began competing with their northern counterparts, the increasing automation of the industry enabled southern workers to produce textiles of comparable quality to the north despite their disadvantage in experience.

With an increasing number of job opportunities to be found, people left their farms in order to do “public work” in the textile mills. For instance, from 1870 to 1900, Greensboro’s and Winston’s populations grew from less than 500 residents to over 10,000 in each case. Additionally, Charlotte added over 14,000 residents during that same thirty year period (Hall 2000). The first people to work at these mills tended to be the most vulnerable. Widows and female-headed households were among the first to arrive at the mills in the 1870s and 1880s. Facing the stark reality of being unable to provide for their families by farming, male-headed households then began moving to mill towns for wage-work in the 1880s and 1890s (Mitchell 2001). Whole families went to work in the mills, including the women and children, making the textile industry the most gender integrated industry in the country in the late 1800s. Mill owners took full advantage of these families by employing every able bodied family member. Rather than paying each member, wages were often assigned to the entire family. Because they employed multiple family members, the owners were able to utilize substantial quantities of very cheap labor.

A common theme that spans the textile industry’s history in North Carolina is the paternalistic culture embedded in its early operations. Starting with the social elites in the nineteenth century, many mill owners viewed their enterprises as a form of salvation for the New South. It often was considered a moral obligation to save rural North Carolinians from their backwards ways through a steady wage and a more disciplined industrial work environment.

Furthermore, the paternalistic culture strongly influenced the location of many mills during this period. Owners frequently established mills in relatively remote areas, at least in part, to inhibit workers from organizing, e.g., labor unions. As a result, company towns were commonly established in areas that had little or no appropriate industrial infrastructure (Porteous 1970). Because they were located in such remote locations, the owners were then often obligated to provide the key resources needed to build the facility and attract sufficient labor. As a form of labor attraction, mill owners often built amenities such as community centers, organized programs, and provided social services. Large mills were so successful at integrating “welfare work” into their companies’ operations and facilities that eight of those historic mills in the Piedmont were rated among the top companies to work for in the entire United States (Hall 2000). Although workers seemed to benefit, mill owners harbored ulterior motives. By expanding their sphere of influence even further into the mill workers’ lives, owners insured the perpetuation of a cheap, relatively docile labor supply and prevented labor unions from gaining influence in their mill communities.

While this type of social contract generally worked well, there were certainly mill owners who did not execute the contract very well and there were certainly areas of considerable labor unrest. For example, a large number of textile labor strikes swept the Piedmont South between 1929 and 1931 (Huber 2008). The worst of these incidents involved the Loray Mill in Gastonia, North Carolina, during which 1,800 workers struck. Governor Gardner, a mill owner in his own right, called out the National Guard and over thirty deaths resulted, including Gastonia’s Chief of Police. The anti-union stance of most mill owners was at the heart of their insecurity and even by 2003 North Carolina had the lowest labor representation in unions within the country at just over three percent (Graham 2004). So, labor history is a very important part

of the cultural legacy of the textile industry and the mills it left behind. Unfortunately, this particular struggle is infrequently commemorated.

The growth in demand for semi-skilled workers, coupled with a lack of household mobility, motivated mill development beyond the original manufacturing centers toward untapped rural areas. Workers underwent a period of adjustment when mills arrived, and after these workers adjusted to life in mill towns the assimilation of future generations of mill workers was made easier (Carlson 1981). Johnson (1990) reemphasizes this very point concerning the pioneering role played by the textile industry in socializing southern labor for other industrial activities in general. After 1900, owners had nearly exhausted the initial supply of inexperienced labor, so they began moving the mills still farther from the original centers to areas on the far periphery of urbanized areas. For example, Figure 1 shows the distribution of textile mills across the American South around 1930. Notice the dispersion of mills away from important textile centers like Charlotte, Burlington, and Greensboro into the outlying rural areas.

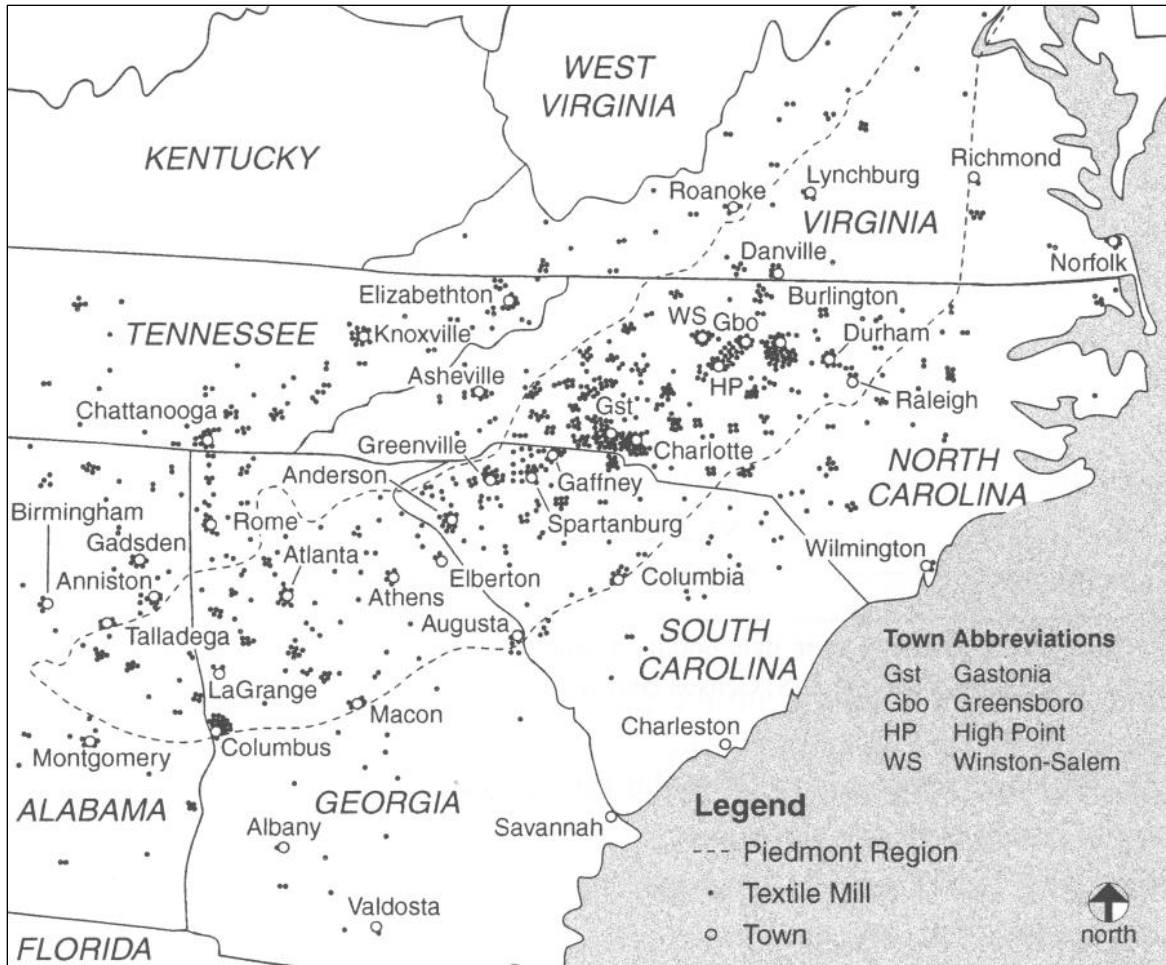


Figure 1. The spatial distribution of southern textile mills circa 1930. Source: Ingalls and Moore 2001, after Lemert 1933.

With the maturation of the textile industry, many millworkers began reaping the lifestyle improvements that most millworkers earlier had been denied. Mill owners originally believed that by simply cutting labor costs, larger profits could be achieved not only in the short term but the long term as well. So, they provided inexpensive and generally sub-standard company housing, and they generally exploited the workers through a contrived system of financial indebtedness, e.g., in rents and company store purchases. However, through time owners slowly came to the realization that keeping their workers satisfied could significantly improve

employee retention and productivity. This reality, perhaps driven by increased competition for labor, brought about the previously mentioned concept and practice of “welfare work” in the textile industry. Thus, employees received community and individual benefits such as schools, churches, and medical care (Phillips 1985). Through the welfare work provided by the mill owners, workers were given opportunities to socialize with one another outside the mill that the original generation of mill workers were not afforded. As a result, these mills and their surroundings emerged as social and cultural centers.

Textiles’ predominant position in the manufacturing sector of North Carolina’s economy started to show signs of erosion in the closing decades of the twentieth century. In 1973 the state’s textile sectors employed 293,600 workers, but the number of jobs declined in the following decades (Glass 1992). Although employment decreased, there were still as many as 140,000 workers in the state’s textile industry in 1996. By 2007 there were only 69,656 employees within the textile industry, representing a loss of over 76 percent of the workforce in little more than 30 years (Guillory 2009). Especially important for this project, the number of mills experienced significant losses during this time period as well. In 1975 there were 1,271 mills operating in North Carolina, but by 2005 this number had shrunk to 686 (Guillory 2009). The trend in mill losses during this period is shown in Figure 2 below. While the number of mills surged a bit between 1985 and 1990 with an upswing in the domestic economy, the general demise is evident and the rapid decrease in mills after 1990 is startling, 44 percent in 15 years.

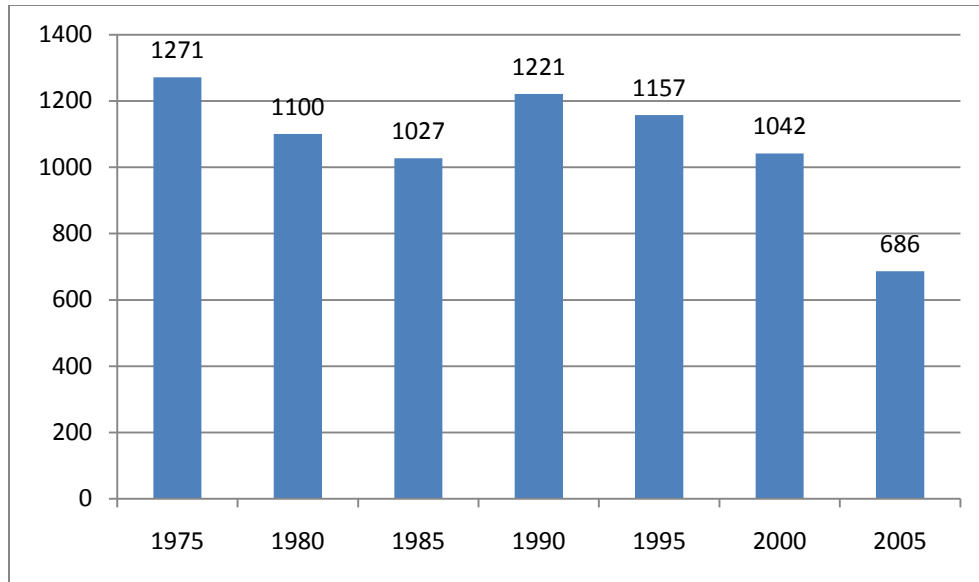


Figure 2. Textile Mills in North Carolina 1975-2005. Source: Guillory 2009, p. 3

Decline of the Textile Industry

The textile industry began experiencing relative and then absolute decline in employment, especially in North Carolina, in the 1970s. What began as a trickle slowly gained momentum until this manufacturing industry virtually collapsed around the turn of the twenty-first century. Like New England a few generations before, North Carolina's mills began to "leave" in favor of cheaper, and in this case foreign, labor. While earlier employment losses are primarily attributed to business restructuring and improvements in technology, the industry began hemorrhaging jobs in the mid-1990s. Despite these losses, the emergence of other industries within the South provided somewhat of a buffer for textile job losses.

The decline in the importance of the textile industry was partially due to, and certainly contributed to, the diversification of North Carolina's economy. Along with the tobacco and furniture industries, textiles dominated the state's economy, accounting for nearly two-thirds of its manufacturing activity in 1977 (Walden 2008). In addition to a growing regional market,

the surplus of relatively socialized and non-unionized labor began attracting varied new industries to the state. As workers' productivity and skills improved, increasingly capital intensive manufacturing tended to locate in those places formerly dominated by textiles. With the arrival of higher skilled employment and better pay, low skilled textile jobs were relegated to even more peripheral rural locations. Ultimately, even these remote textile manufacturing sites, which had been pioneered by textiles mills, attracted new industries that were frequently branch plants of large multi-locational corporations. For instance, high tech firms began locating in rural areas of the South during this time (Johnson 1989), and they surely benefited from the existence of the socialized labor pool found there. By 2005, textiles, tobacco, and furniture accounted for only seven percent of the state's manufacturing. North Carolina's new industries included chemical products (pharmaceuticals), technology components, food processing, and vehicle parts. Those new sectors accounted for about 43 percent of the state's manufacturing activity by 2005 (Walden 2008). Although the job losses in the textile industry were devastating for some, especially rural, communities, the growth of other industries assisted in mitigating some of the negative effects.

The liberalization of international trade proved to be troublesome for much of the United States textile industry in the later decades of the twentieth century (Rivoli 2005). Since the 1970s most United States' markets have become increasingly open to foreign goods, i.e., reduced tariffs and quotas. Despite these reductions to general trade barriers, textiles and apparel were significantly protected through the Multi Fiber Arrangement (MFA), which regulated the international textile trade beginning in 1973 (MacDonald and Volrath 2005; Nordas 2004; Pelzman 1982). The MFA effectively limited textile exports from developing nations to industrialized nations. However, the Agreement on Textiles and Clothing (ATC) of 1985

gradually reduced the MFA's protective quotas until it fully expired in 2005 (MacDonald et al. 2001). The North American Free Trade Agreement (NAFTA, 1992) eliminated all tariffs and quotas on goods traded between Mexico, the United States, and Canada. Textile manufacturers utilized access to this new source of cheap labor by "relocating" some mills and locating new capacity in the maquiladoras (factory towns) of Mexico. Burlington Industries, despite their pledge to maintain U.S. mills as their primary production units, invested at least \$250 million in new Mexican manufacturing capacity between 1996 and 2000 (Bair 2002). The establishment of the World Trade Organization (WTO) in 1995, with its free trade mission, resulted in further reductions in trade barriers. This enhanced opportunities for goods from other countries, such as China, to enter U.S. markets (Nordas 2004). China's admission into the WTO in 2001 removed textile quotas, which effectively depressed the average price per square meter of textiles from \$5.79 in 2001 to \$3.24 (44 percent) just a year later (ATMI 2003; Mok and Yeung 2004).

In the 1970s and 1980s, the textile industry experienced a dramatic restructuring which resulted in the loss of many jobs. As noted earlier, the initial decades of the industry's presence in North Carolina had been dominated by a paternalistic culture (Anderson 2001). Mill owners had a vested interest in the operation of their firms and the lives of their employees. This type of social contract and operational culture changed as increased international competition and new technology required the industry to undergo extensive restructuring. In general, individually owned mills were no longer competitive, due to comparatively inadequate economies of scale and scope, so corporate manufacturers grew in scale and became substantially more capital intensive (Pelzman 1982). Frequently publicly owned, these large corporations were primarily concerned with enhanced profits, and did irreparable damage to existing local mill cultures. Cannon Mills, for example, is considered the quintessential example of changes in ownership

and their effects (Glass 1992; Anderson 2001). Charles Cannon, a fixture in the textile industry for fifty years, died in 1971. His death led to the sale of Cannon Mills to David Murdock, an entrepreneur from California. Not interested in maintaining the carefully constructed social order of prior decades, Murdock cut employee benefits, eliminated more than 2,000 jobs, and sold off company housing before selling Cannon to Fieldcrest Mills after only four years of ownership. This type of firm “flipping” is now commonplace in most U.S. economic sectors, including manufacturing.

Advances in technology had a profound impact on the textile industry. With the accelerated development of automated production techniques, fewer workers were needed to operate the looms and spinners. These technologies relied less on human oversight and more on computer and robotic processes (Glass 1992). In addition to the increased labor efficiency that technology provided in the production process, manufacturers also used sophisticated digital analyses and just-in-time logistics to determine the mixes, type, and quantity of goods that they produced. Prior to this development, owners dictated the textile quantities and styles made in their mills, with little regard for the good’s current demand within the market. Precise tailoring of production runs to current market demands allows manufacturers to cut inventory costs and eliminate unprofitable lines. Despite a 50 percent increase in the volume of textile production and an 80 percent increase in apparel production from 1977 to 1994, employment in these two sectors decreased by twenty percent during the same period (Walden 2008).

As indicated previously, the most significant job-loss period for textile workers began in the 1990s and continues to the present. From 1996 to 2001 alone, North Carolina’s textile workers suffered nearly thirty percent job losses, with an additional twelve percent gone in just

2001-2002 (ATMI 2003). These deep job losses created difficulties for newly unemployed textile workers and their communities. For example, in the case of Guilford Mills, almost one-third of employees released in 2001 remained unemployed two years later (Morse 2004). Despite this large percentage of unemployment, workers who had prior knowledge of their termination were more likely to have obtained new employment with better pay and better hours (Morse 2004). While these layoffs can be devastating to individuals and communities, the presence of other newer industries along with availability of job training, does give workers employment options. The end of the textile industry's prevalence has created a multitude of challenges, but the state's economy is adapting in order to mitigate damages.

Redevelopment Factors

The "flight" of the textile industry has resulted in the vacancy of scores of mills across North Carolina. Textile manufacturing helped to encourage urbanization across the state, and its mills frequently became the focus of economic and social activities within these mill towns. Despite the decline of this integral part of North Carolina's economic landscape, contemporary environmental, social, and economic processes generate new possibilities for these often majestic structures. In recent years, a rapidly growing number of historic textile mills have become the subjects of redevelopment (see Table 1). By adapting these structures for alternative purposes, a part of North Carolina's history is being preserved, and resources conserved, while providing communities with places to work, play, and reside. That being said, textile mills' geographic locations across the state and within their respective communities have significant ramifications on the feasibility of their adaptive reuse.

<u>Type of Use</u>	<u>Number</u>	<u>Percent</u>
Vacant, no known proposed use	13	11
Vacant, some limited use of structure parts	2	2
Demolished or destroyed	16	14
Reused as manufacturing/industrial/mining	13	11
Reused as textile manufacturing	44	37
Adapted, reused for alternative(s) to manufacturing	26	22
Adaptation and reuse proposed	4	3
Total in sample	118	100

Table 1. Charlotte Metropolitan Area Mill Uses, 2001. Source: Ingalls and Moore 2001

Preservation

Textile mills provide desirable locations for reuse due, at least in part, to their valued architecture. Many of the structures' qualities are aesthetically pleasing, such as the high ceilings, large windows, detailed brick work, and massive wood beams (EPA 2006). Due to their architecture, most mills do not undergo significant external changes during the redevelopment process (Ingalls and Moore 2001). Mills were originally designed with floor plans that could be adapted to new manufacturing technologies, which generally simplifies the redevelopment process (Mellor 2005). The large size of some mills makes the possibility of mixed use not only feasible, but ideal in many cases. For instance, the Highland Park Mill No. 3, the largest historic mill facility in Mecklenburg County, sits on over nine acres of land. The buildings on the site are now being used in a variety of capacities. The dye house serves as a retail establishment and the bleachery was converted to dining and entertainment space (Ingalls and Moore 2010).

Textile mills and their ancillary buildings can provide spaces of commemoration and as museums representing past history. For instance, Caunce (2003) discusses the use of old mill houses as museums in Yorkshire, England. These locations are representative of the evolution of the local economy in Yorkshire, and vividly illustrate that owners and residents played a significant role in the region's history. Although these structures are the workers' and owners' houses rather than mills, they are used to show how the wool industry impacted the local landscape. Much like the residential museums in Yorkshire, the Mill Museum in Willimantic, Connecticut conveys a (selective) portion of the history of the textile industry in New England. By preserving the mill structures and nearby housing, visitors are offered a glimpse into the daily lives of the workers (Mill Museum 2008). The Cooleemee Mill Village Museum in (Davie County) North Carolina also attempts to convey the southern mill worker way of life. First opened in 1898, this mill operated until 1969. The mill village was incorporated as a town in 1985. The Cooleemee Museum intends to remind visitors of the hard work of previous generations and the traditional values that they embodied (Textile Heritage Initiative 2010). The interpretation of the mill and mill-town life is largely uncontested

Our elders tell us that Cooleemee was "like one big family." Depending on one another got them through calamities such as the 1908 mill fire, the 1918 Flu Epidemic, and Cooleemee's occupation by the National Guard in 1934. There were certainly plenty of conflicts. But neighbors did help neighbors, families stuck together and no one was afraid to go out at night.

Thus, an important aspect of mill preservation is the essential heritage that mills represent. Bodurow (2003) discusses the importance of conserving these resources, due to their indelible mark on the American landscape. These buildings assist in telling a selective story of the development, expansion, and demise of the textile industry within the region. As tangible representatives of the history of the textile industry, these mills also represent an important part

of North Carolina's history. Historic preservation plays an important role in creating views of the past, whether these views are accurate or not. The Cooleemee Mill Museum is a prime example. Historical places act as a selective reminder of the way things used to be, and preserved industrial sites pay homage to their economic and social achievements (Barthel 1996). By idolizing the way of life at the industry's peak, the Mill Museum downplays the many hardships and injustices that workers endured. Having opened in 1898, the Cooleemee Mill almost certainly employed child labor. Furthermore, textile mills throughout the South maintained a highly segregated labor force. Black workers were seldom hired into these industrial settings, and according to Merrill Johnson (1990), blacks only comprised five percent of the textile labor force as recently as 1950. Despite some interpretive shortcomings, the Cooleemee Mill Museum is a source of pride for much of the local community and the adaptive reuse of the structure yields an important cultural (heritage) and economic (tourism) resource.

While industrial heritage preservation on a regional scale is often not a high political priority, there are some instances where it has been attempted with success. These regional designations allow multiple parties to plan and develop these larger areas in order to more effectively commemorate past ways of life (Bodurow 2003). This regionalization of the dispersed heritage resource is a clear strategy for scaling up and creating a critical mass sufficient to attract (at least) a threshold level of tourists. For example, The MotorCities Automobile National Heritage Area is spread across thirteen counties of Michigan, and commemorates the history of automobile manufacturing. In a similar vein, The Blackstone Valley, a key center of textile activity in New England prior to the industry's "migration" south, was identified as a National Heritage Corridor in 1986 (Billington 2005). In turn, Blackstone's National Heritage Corridor designation provided eligibility for federal assistance, which

exceeded \$21 million by 2005. Within the South, plans are now underway to create a 700 mile long textile heritage corridor, starting in Richmond, Virginia and extending southwest along I-85 to Montgomery, Alabama. This textile corridor's main objectives are to create opportunities for further coordination, preservation, and redevelopment of the historic mill buildings and villages left behind.

A key factor that must be considered during the rehabilitation planning process involves constraints that a historical designation might have on the mill site and its surrounding area. In many instances, the redevelopment of historic mill properties provides benefits to surrounding areas. However, historically designated properties can be subject to significant development regulation and limitations. This often involves severely limiting the types of uses that redevelopment efforts may pursue. In their study of costs for rehabilitating historic buildings, Cyrenne et al. (2006) found that facilities located further away from historically designated buildings were actually more likely to be redeveloped. While this does not account for previous rehabilitation efforts, the inability to substantially alter historic buildings frequently adds disincentive, with added construction complexities and increased costs (EPA 2006).

Environmental Considerations

The abandonment of textile mills happens to coincide with a critical juncture in our nation's history. With threats of climate change, petroleum dependence, and environmental degradation, sprawl development, which has dominated America's post WWII growth, appears to be increasingly unsustainable. In order for North Carolina to mitigate against the large hidden costs associated with sprawl, sustainable development, often labeled as Smart Growth, could become a guiding principle for planning and regulating future forms of development.

Although frequently contested, most Smart Growth policies are intended to minimize growth's longer-term negative consequences for the environment while fostering social and economic progress. Several Smart Growth principles can be achieved when reusing abandoned textile mills. Smart Growth principles have been compiled by an assortment of groups (e.g., Smart Growth Network 2001 and 2006) and can include:

- mixed land uses;
- compact building design;
- a wide range of housing opportunities and choices;
- walkable neighborhoods;
- attractive communities with a strong sense of place;
- open space, farmland, natural beauty, and critical environmental areas;
- direct development in the direction of existing communities;
- a variety of transportation choices;
- development decisions that are predictable, fair and cost effective; and
- public/private collaboration in community development decisions.

The redevelopment of old textile mills utilizes Smart Growth principles through adaptive reuse, which serves to find new uses for old buildings. In an important survey of the Charlotte Metropolitan Area, Ingalls and Moore (2001) found that a quarter of the old mills were currently being used for something other than manufacturing (see Table 1 above). Much of the infrastructure needed to support human activity is already in place at these old sites, so green field development is unnecessary and ill-advised. Abandoned mill areas tend to be in poor condition, which often leads to the associated decline of neighboring areas. The redevelopment of textile mills can create new economic opportunities, and might contribute to a revitalized local community.

The redevelopment of textile mills often complements a Smart Growth strategy with an emphasis on mixed land use. Mixed use developments are ideal in a smart growth community, because area residents have local access to shopping, services, and some employment without

the use of automobiles. Due to their size and architecture, some old textile mills are excellent candidates as sites for mixed use. Moore and Ingalls (2010) discuss the conversion of mills into mixed use developments in Charlotte, North Carolina. The mills included in the study were successfully redeveloped into vibrant living and commercial spaces. For instance, the Charlotte Cotton Mills Complex, which has not served as a mill since the Great Depression, is now home to an architectural firm, a bar, and 120 residential lofts. Its strategic location within Charlotte's corporate limits makes it an attractive place to live, with some units' rent almost double the city's average (Moore and Ingalls 2010).

An important issue in adaptive reuse of textile mills is the possible, ensuing neighborhood gentrification process. For the surrounding areas, mill reuse can be both a blessing and a curse. Gentrification can bring about positive changes to surrounding mill communities. For instance, Charlotte's South End was a beneficiary of gentrification (Moore and Ingalls 2010). Previously abandoned and deteriorating, the South End is now a vibrant community. Although the surrounding area may experience a widespread revitalization which improves the quality of life for most residents, it also frequently results in higher rents and costs of living in general (Hamnett 1991). Because of increasing property values, those unable to pay the increased taxes, or increased rents, are forced out. This form of residential displacement can place a heavy burden on the poorest members of the local community.

In order for the redevelopment of old textile mills to be fully successful, a cooperative relationship between public and private partners is usually necessary. A balance should be struck between protecting the larger public interest and providing private entities with the right conditions to invest in a (risky) redevelopment project. While governments may initiate the

redevelopment process, they normally do not have the capacity to orchestrate and fund the actual property improvements. Therefore, private developers are normally needed in order to realize these potential adaptive reuses. In particular, the provision of incentives, such as local/state tax rebates and federal aid, are frequently used to attract interested parties. Additionally, local government needs to maintain a calm economic and political environment to guarantee that the redevelopment process moves forward smoothly (Smart Growth Network 2006).

In general, the public should remain involved throughout the redevelopment process to insure that their input is properly considered. Local governments are normally tasked with the need to insure that developers are keeping the public's broader interests in mind during the redevelopment process (McCarthy 2002). Two of Smart Growth's principles involve fair and equitable expenditure decisions and encouragement of cooperation between the community and the private developers (Smart Growth Network 2001). Staying vigilant in monitoring developers' decisions can eliminate unnecessary parts of projects, which reduces spending. Additionally, tracking developers' progress closely insures that the renovated spaces meet the community's originally expressed vision. Close cooperation throughout the process allows the community's vision to better guide developers' decisions and helps to resolve conflicting opinions. Moreover, active citizen participation in any planning process helps to insure that rights will be protected (Hakim 2007). While redevelopment can lead to new opportunities for a community, it can also create new strains, e.g., residential displacement. These sorts of indirect problems can be minimized through effective partnership between private developers and public agencies.

Location Factors

There are two categories of characteristics typically used to evaluate the viability of a potentially reusable textile mill. The first involves *site characteristics* and these are used to describe conditions of the mill and its immediate location, i.e., the property. These characteristics can include mill size, mill age, mill architectural quality, lot size, topography, vegetation, street access, visibility, and drainage (Buckner 2003). Site characteristics can directly affect a mill's reusability and are essential features of the mill itself. The other type of locational attributes that can be used to evaluate old mills' potential for reuse are referred to as *situational characteristics* and these are used to describe the setting in which the mill property is situated. (Buckner 2003). Situational characteristics can include factors such as distance to the nearest interstate, distance to nearby retail, a mill's location next to a river or stream, and neighborhood characteristics such as demographics and crime. Despite this distinction between site and situational characteristics of abandoned textile mills, they can strongly influence one another. For instance, an abandoned mill property, which has been neglected for an extended period of time, will generally influence property values in a negative way within the surrounding area. Conversely, a local government may designate a redevelopment corridor that includes an abandoned mill, which then prompts investment and rehabilitation of that mill. Salvaneschi (2004) provides several factors that are essential for a successful (profitable) real estate investment. These factors can be applied to the decision to invest in the adaptive reuse of an historic textile mill. Such factors include:

- Visibility
- Accessibility
- Density
- Regional Exposure
- Regional Growth
- Operational Convenience
- Safety and Security
- Adequate Parking

So, a critical factor facing the reuse of all historic textile mills is their location in geographic space, which can be assessed at two levels. The first assessment level is at a regional scale and clearly addresses the spatial distribution of the historic textile industry across the state. In this regard, the decision to rehabilitate a textile mill can partially be understood through central place theory. Central place theory involves an ordering system that attempts to explain the spatial distribution of towns or other central places. It proposes that a hierarchy of centers exists, and a center's importance is related to its centrality within a region (Wheeler et al. 2004). When applied to the spatial distribution of textile mill locations in North Carolina, only mills located in higher order centers will normally have access to the resources needed to support redevelopment efforts. Larger centers possess a larger number of central functions provided to the locale, i.e., agglomeration economies.

Central place theory would propose, in general, that a textile mill's likelihood of adaptive reuse diminishes as distance from any regional nucleus (agglomeration) increases. While this empirical regularity could arise for a number of reasons, decreasing densities and market potentials are most influential. In this fashion, it is unsurprising that Ingalls and Moore (2001) found that mills located in rural portions of the Charlotte metropolitan region were far more likely to be used for manufacturing purposes and less likely to be adaptively reused than their urban counterparts. Additionally, most mills reused with new manufacturing capacities were still devoted to textile manufacturing, despite that sector's decline. This can lead to the conclusion that rural mills have little chance for rehabilitation (EPA 2006); however, this is not necessarily the case. Rural textile mills have been (e.g. Saxapahaw is a completed mixed use development in Alamance County) and are in the process of being (e.g. Glencoe is a mixed use development currently underway in Alamance County) successfully redeveloped. So, rural

projects should be carefully scrutinized to reveal site and situational characteristics that encourage investment.

The second assessment level for adaptive reuse is at the local scale, and it is used to examine the relative position of a mill within a town, a city, or a larger metropolitan area. Although central place theory primarily addresses regional hierarchies, it is also applicable within a metropolitan framework (Wheeler et al. 2004). With post-WWII sprawl, metropolitan areas rapidly expanded out from the city center towards the periphery, and the gravity of commercial centers generally diminishes with distance from the center of this urban field (Wheeler et al. 2004). The central business district has historically acted as the preeminent commercial location, and it is surrounded by the remaining hierarchy of major regional centers, smaller shopping centers, community centers, and very small neighborhood centers. Location within or near these primary and secondary centers enhances investment potential for the adaptive reuse of historic mills. This aligns with the notion that the functional completeness of a location is also critical in determining its profitable success on a local scale (Salvaneschi 2003). Functional completeness refers to the proximity and accessibility of employment, retail, residential, cultural, and recreational opportunities to a potentially reused mill site through public and private forms of transportation.

The research conducted and reported in this thesis will place heaviest emphasis on the key situational characteristics that seem to drive investments in historic mill rehabilitation. The primacy of these features was illustrated early on in the data acquisition and emerged as a clear focus of the empirical effort, i.e., it's about location, location, location! A high level of situational quality must be achieved as a necessary condition for any real estate investment including adaptive reuse. The relative locational situation of these historic structures appears to

dominate investment decision-making and as a result, greater emphasis is placed on appropriate measurement of these situational features and then their appropriate inclusion in a predictive model of mill adaptive reuse. However, any unexplained variability left-over by the final model will certainly contain important aspects of the individual sites that have not been statistically controlled for, e.g., mill size and architectural quality.

CHAPTER 3: DATA AND METHODS

This chapter provides a relatively detailed overview of the data collection process and the methodology employed in the explicitly spatial analysis of historic textile mill redevelopment. The first section describes the process involved in the identification of historic textile mills and their current status. Historic mills were identified using the *North Carolina Directory of Manufacturing Firms* (North Carolina Department of Labor 1944) from here on referred to as *The Directory*. Precise mill locations were specified with the use of historic Sanborn Fire Insurance Maps and Google Earth. Once identified and geo-coded, current mill status was determined using several sources including Google Maps, Bing Maps, various digital data bases, and individual county GIS data.

The second section of this chapter describes the full assemblage of predictor variables used to represent the situational conditions that encourage mill redevelopment. These variables place clear focus upon the current situational characteristics that describe the sites of the inventoried historic textile mills. Some of these situational characteristics were compiled using online public and private databases (e.g. U.S. Census and Simply Map) while others were derived with the use of existing digital geo-spatial data. Finally, the third section of this chapter describes the methodology used to assess the likelihood of historic textile mill adaptive reuse, and is approached with quantitative spatial analysis. This study employs a binary logistic regression in order to isolate factors that distinguish adaptively reused mill locations from those that have been left abandoned. This approach not only distinguishes key investment

(situational) factors but also permits identification of lost opportunities and future investment opportunities, i.e., mills that have already been destroyed.

Primary Data Collection

There are two main steps in the identification of historic textile mills and their contemporary uses. The first step involves finding the locations of the historic mills. This was done using a combination of *The Directory*, the Digital Sanborn Map database, Google Earth, and various city directories. Note that the decision to employ *The Directory*, by definition, limits the use of the term “historic” to those mills whose construction pre-dates 1944. The second major step of the primary data collection identifies the current use of these historic mills. This procedure relied heavily upon Google Maps and its Street View utility, Bing Maps and its Bird’s Eye View utility, various digital data bases, county GIS websites, and occasional telephone calls to the host communities.

The reader should note that the use of large online geographic data sources in this thesis represents an early and innovative adoption within formal research methodologies. Google Earth is a virtual globe, map and geographic information program originally created by Keyhole, Inc, a company acquired by Google in 2004. It maps the Earth by the superimposition of images obtained from satellites, aerial photography, and GIS. Google Maps is an online mapping service application and technology provided by Google, that powers many map-based services. It offers street maps, a route planner for traveling by foot, car, or public transport and an urban business locator for numerous countries around the world. Both Google Earth and Google Maps provide street level views of selected landscapes (Street View). These images can be quite useful when investigating the current condition of historic mills. Bing Maps is a web

mapping service provided as a part of Microsoft's Bing suite of search engines and powered by the Bing Maps for Enterprise framework. Maps include certain points of interest and landmarks. Searches can involve public collections, businesses or types of business, locations, or people. Like Google's capabilities, Bing Maps provides street level views which can be useful when investigating current conditions of historic mills (Bird's Eye View).

This study, as mentioned above, uses several primary data sources to establish a reasonable and realistic inventory of historic mills within North Carolina. *The Directory* was prepared by the Division of Statistics within the North Carolina Department of Labor, and it arguably provides the earliest, accessible, systematic snapshot of textile and apparel manufacturing in North Carolina. While earlier sources do exist, they are incomplete in all cases and cannot provide the sort of comparative and quantitative spatial analysis that is desired here. The 1944 version of *The Directory* lists 761 textile mills located in North Carolina. *The Directory* provides valuable information regarding the name and the number of mills within a county, the specific towns that they are located in, and the number of employees that worked at each mill. However, *The Directory* does not include clear site information, e.g., no address that would permit the identification of the specific (point) locations of individual mills. Therefore, related and informative historical maps were needed to determine these specific locations, i.e., Sanborn Fire Insurance Maps.

The next primary data source is the online Digital Sanborn Map database for North Carolina (accessed at <http://sanborn.umi.com>). This important database consists of Sanborn Fire Insurance Maps from the early twentieth century, and includes most of North Carolina's urbanized areas. Sanborn Maps provide a street address and business location on a grid of the

town, and this cell, in turn, corresponds to a map number where that specific mill can be found in substantial detail. A search was conducted for each mill listed in *The Directory*, in those cases where Sanborn Maps were available.

For instance, the Firestone Mill (formerly Loray) is identified in the Sanborn index of Gastonia. As indicated, this mill is located on map number 24, which is then accessed as a pdf file (see Figure 3). Because this mill's street address changed between the creation of the Sanborn Map and the present, a search of approximate street addresses was conducted using Google Earth. The Firestone Mill is visually identified (see Figure 4) using the software's satellite imagery, and a point feature is then created using keyhole markup language, i.e., a kml file is created. Please note that kml is a XML based language scheme employed in contemporary online mapping environments. It is particularly useful in transferring geographic data from online environments to mainstream GIS environments. Note that the Firestone Mill is located on South Vance Street relatively close to the railroad tracks. First, South Vance Street is identified in Google Earth, and the satellite imagery is reoriented toward the same direction as the historic Sanborn Map. The mill is clearly located two blocks from the railroad tracks running parallel to West Airline Avenue, and these key landmarks are used to verify the location of the historic mill on Vance Street.

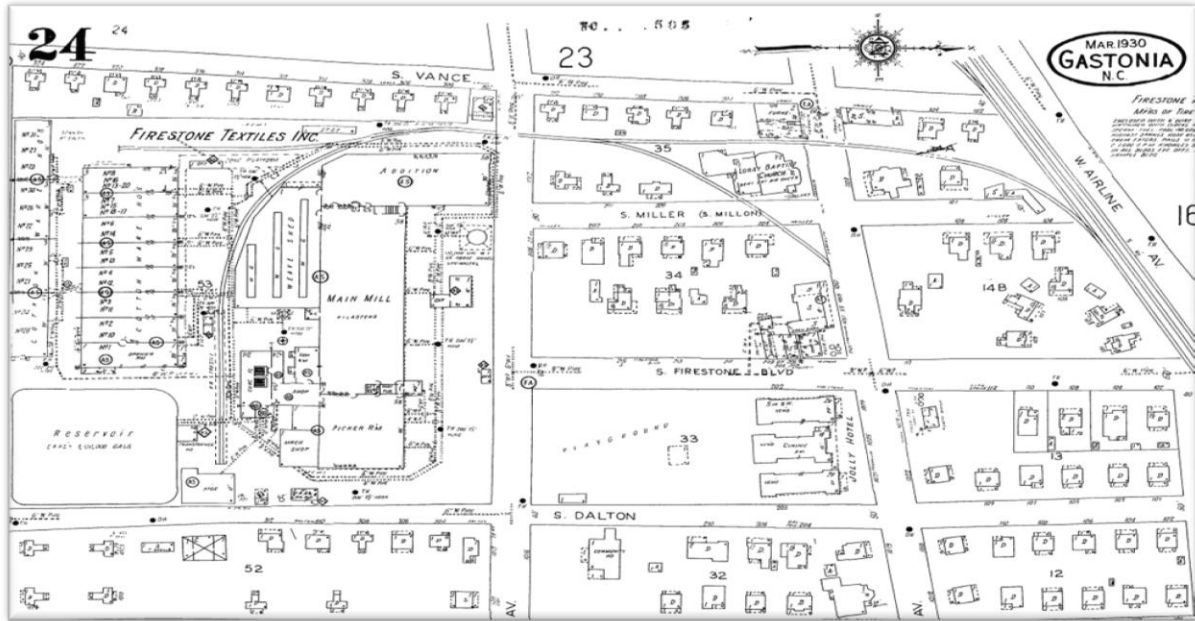


Figure 3. Sanborn Map showing Firestone Textiles, formerly Loray Mills.



Figure 4. Google Earth screenshot of Firestone Textiles, formerly Loray Mills.

Although the combination of Digital Sanborn Maps and Google Earth satellite imagery proved to be an efficient and effective sequence for identifying the vast majority of the inventoried textile mills, there were several shortcomings to be reconciled. First, the Sanborn Maps did not include every mill that was listed in *The Directory*. This is partially due to the remote location of some mills in rural areas. Many mills were located outside of towns and are not included in any of the municipalities' Sanborn Maps. Other shortcomings associated with use of the Sanborn Maps are the years of their creation and the occasional lack of subsequent updates. For instance, *The Directory* lists 35 mills for Charlotte, North Carolina. However, the Charlotte Sanborn Maps were published in 1929 and were not updated again until 1951. Although most of the 1944 mills did not change during this time interval, some were unlisted under their 1944 names and this required additional detective work.

The missing mill locations that resulted from the Sanborn/Google sequence are addressed using various city directories, primarily from the Hill Directory Company, for the available year closest to 1944. The North Carolina Collection at the University of North Carolina at Chapel Hill has the most complete collection of historic city directories, so this portion of the data acquisition was carried out there over several days in July of 2009. Thankfully, the city directories collectively provided street addresses for the lion's share of mills unavailable in the Sanborn Map database. Once a mill was identified within the city directory, its address was found in Google Earth and a point feature was created. Although this method proved to be highly successful, some addresses and street numbers changed between 1944 and the present, so a few searches were inaccurate. In order to correct for inaccurate locations within Google Earth, Sanborn Maps were used again to determine these historic locations. In order to rectify

this situation, street names that remained unchanged during this time period are identified (primarily major roads) and mills are identified in relation to these known street names.

Despite this intensive data collection process, some mill locations simply could not be determined. As a matter of the time constraint associated with the research design, an eighty percent threshold of identified mills was adopted, and accordingly 611 mills were ultimately identified (see Figure 5). Those mills included in *The Directory* but not included in the final digital inventory used in this thesis were examined for possible “non-response” bias and none is thought to exist in terms of size (employees) or location (county). The mills’ locational coordinates were imported into Arc Map. In order to import mill coordinates, the kml file containing point features was opened in Microsoft Excel as an xml document. That spreadsheet contains the mills’ names, coordinates, and representation style within Google Earth. The names and coordinates were saved to a new spreadsheet, and this spreadsheet was opened as a table in ArcMap. These X and Y coordinates were used to create a new layer, and this layer was then exported as a shapefile. As a result of these data management steps, historic mill locations provide the capacity to spatially investigate current mill uses and their associations with supplementary location data describing situational attributes.



Figure 5. 1944 North Carolina Textile Mill Inventory (611 of 761 mills, 80 percent sample). Source: Compiled by author.

While the location of historic textile mills is established with the process described above, their current uses also must be determined. Current uses are identified and categorized to create a usable database for analysis. The identified mills initially were assigned to categories that include: 1) abandoned, 2) destroyed, 3) reused for manufacturing, 4) reused for commercial, 5) reused for residential and 6) mixed reuse. This process relies primarily on the use of Google Maps (not Google Earth), because point features indicating business locations are conveniently and directly provided within Google Maps. For instance, Burlington Mills (in Burlington) is still owned and operated by the Burlington Manufacturing Company (see Figure 6). This mill's point feature listed within Google Maps includes a functional description which permits the categorization of the mill as still being used for manufacturing.

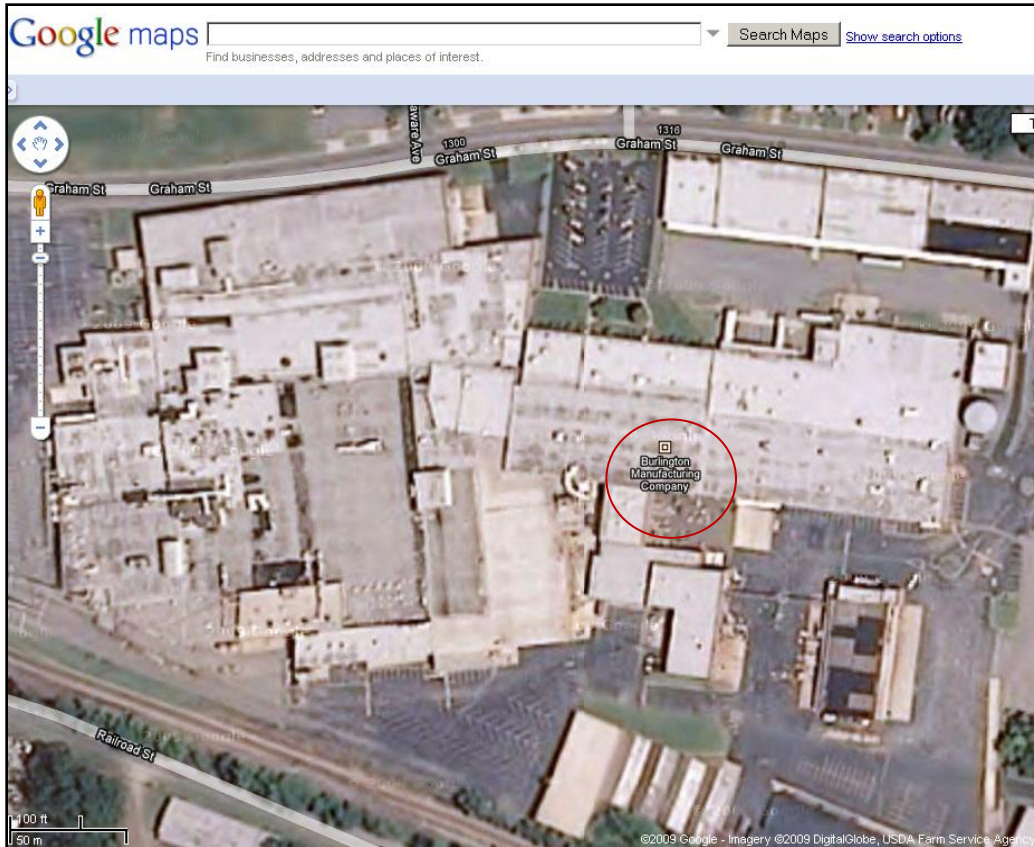


Figure 6. Burlington Manufacturing Company as identified in Google Maps

Business points within Google Maps do not include all businesses in all towns, so several additional activities were necessary to determine some mills' current uses. For example, the Street View feature within Google Maps is used to examine some mill structures at eye level, and several landscape indicators are then used to estimate their current use. In some cases, signage and external advertising near or attached to the structures indicate that they were for sale or for rent and thus are taken as indicators of "current" inoccupation. Furthermore, traits such as broken and boarded up windows, or a fenced and weed-infested parking lot, are taken as indicators of abandonment (e.g., Figure 7). If the current status of a textile mill could not be determined using Google Maps, then phone calls were placed to nearby businesses or the

municipal government in order to determine the mill's current status. Approximately 25 of such identifying phone calls were successful.



Figure 7. Google Street View of Spray Cotton Mills, Rockingham County.

Explanatory Database Development

The primary dataset contains the locations and the contemporary uses of North Carolina's historic (built on or before 1944) textile mills. However, a secondary dataset of explanatory variables is required to reveal the characteristics of textile mills that might encourage (or discourage) adaptive reuse. As indicated earlier, this secondary dataset consists primarily of variables that reflect important situational attributes. These characteristics were discussed in the literature review, but a brief summary is provided here. Situational attributes describe the conditions surrounding the mill's site, and include things such as population demographics of the locale and distances to nearby interstate segments or retail centers.

Block Group Variables

Explanatory variables require a sufficiently fine spatial resolution in order to adequately capture conditions that might influence real estate investments. Census block groups are the smallest scale available for most important demographic measures, so the most proximate situational characteristics of textile mills are measured at this level of census geography. Although a detailed spatial resolution is necessary, reuse also can be influenced by conditions beyond a mill's immediate surroundings. To account for influences outside the host block group, a second set of explanatory variables are constructed by spatially weighting values found in surrounding block groups, i.e., the queen's case for contiguous block groups. Other situational factors in this secondary dataset address the location of mills in relation to other important phenomena across space, so distances to key landscape features are measured to examine their possible impact on the likelihood of redevelopment, e.g., distances to limited access highways, streams, or commercial centers.

Census block group data are compiled from several sources. North Carolina is made up of 5,263 block groups, and 471 (almost 9 percent) of these contain (one or more) textile mills still in use, abandoned, or otherwise. An assortment of demographic indicators from Summary File 3 of the 2000 Census of Population and Housing is used to profile existing and abandoned reused mill locations. Although data can be downloaded from the census website, block group data downloads for entire states are quite awkward. In order efficiently to obtain this information, a Microsoft Access database template and state tabular data were downloaded from the Census' ftp site. While useful, census data do not include all block group attributes that might influence the probability of mill redevelopment. Additional data was acquired using the

online mapping engine and associated rich database, SimplyMap (<http://simplymap.com/main.php>). SimplyMap charges a subscription (available in this case through ECU Joyner Library) in order to provide mapping capacity and the use of impressive proprietary business and consumer data at the block group level and has been included here to complement the census data.

While the block group data may shed light on some of the factors contributing to textile mill redevelopment, there is potential for a variable's spatial field of influence to be underrepresented by the block group unit. Economic and social processes are not necessarily confined to one block group, so such influences also should be addressed on a larger scale, i.e., surrounding block groups. To account for the surrounding area's influences, the census block group data is spatially weighted. A weighted average was calculated for each variable using the queen's case method within Geoda (Anselin 2006). Geoda provides an automated tool for creating these spatially weighted variables. The queen's case method averages the values of a variable across all block groups touching (point or line) an individual block group in any direction. The inclusion of such spatially weighted variables in the analysis will aid in determining factors that might influence textile mill adaptive reuse at a larger scale.

Distance Variables

In addition to the block group data described above, several distance variables are included in the set of location factors. These variables are derived using the historic textile mill locations, existing geospatial data, and assorted location information from the EPA and SimplyMap. Using ArcGIS, distance tables were compiled for the identified textile mills. The measurement of proximity to interstates is examined first. Interstate polylines were imported from ESRI's geospatial database (see Figure 8), and a near distance table was

generated. The cells of a near distance table indicate the shortest distance between a point feature (mills) and another selected feature type (e.g. rivers, interstates, and shopping centers). Mill locations relative to water is then addressed. Although ESRI provides data for North Carolina's rivers and streams, a visual evaluation suggested that it might be relatively inaccurate. Using NCGIA BasinPro hydrology data, higher order rivers and streams were selected and exported into a separate shapefile. Mill distances to these rivers and streams (Figure 9) were then generated in a near distance table.

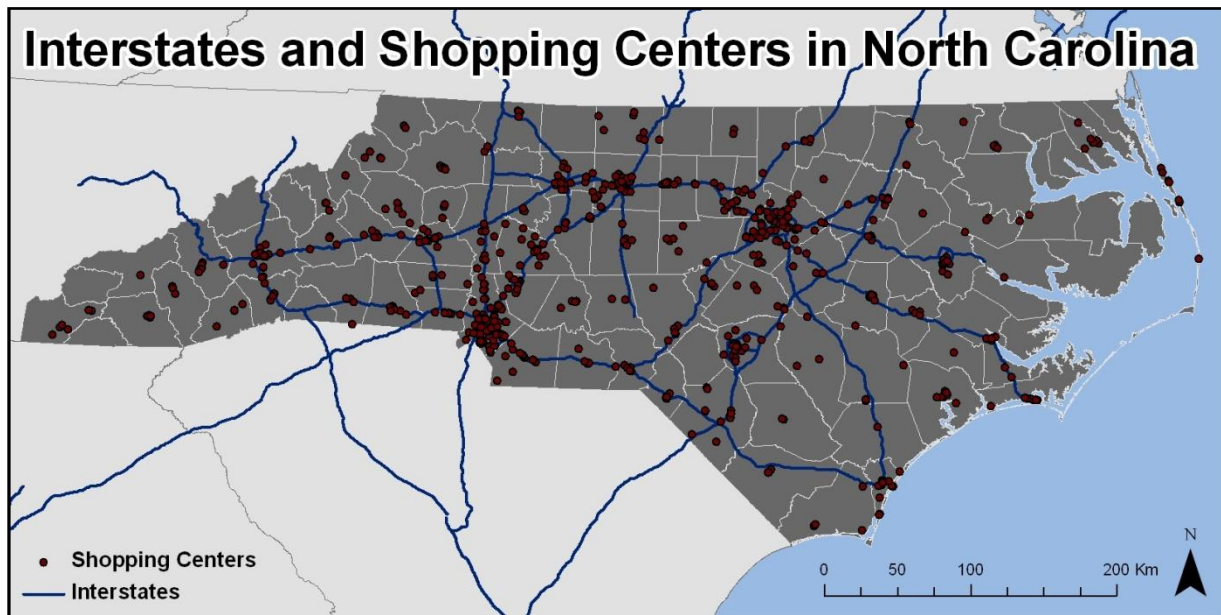


Figure 8. Interstates and Shopping Centers in North Carolina. Sources: ESRI and SimplyMap

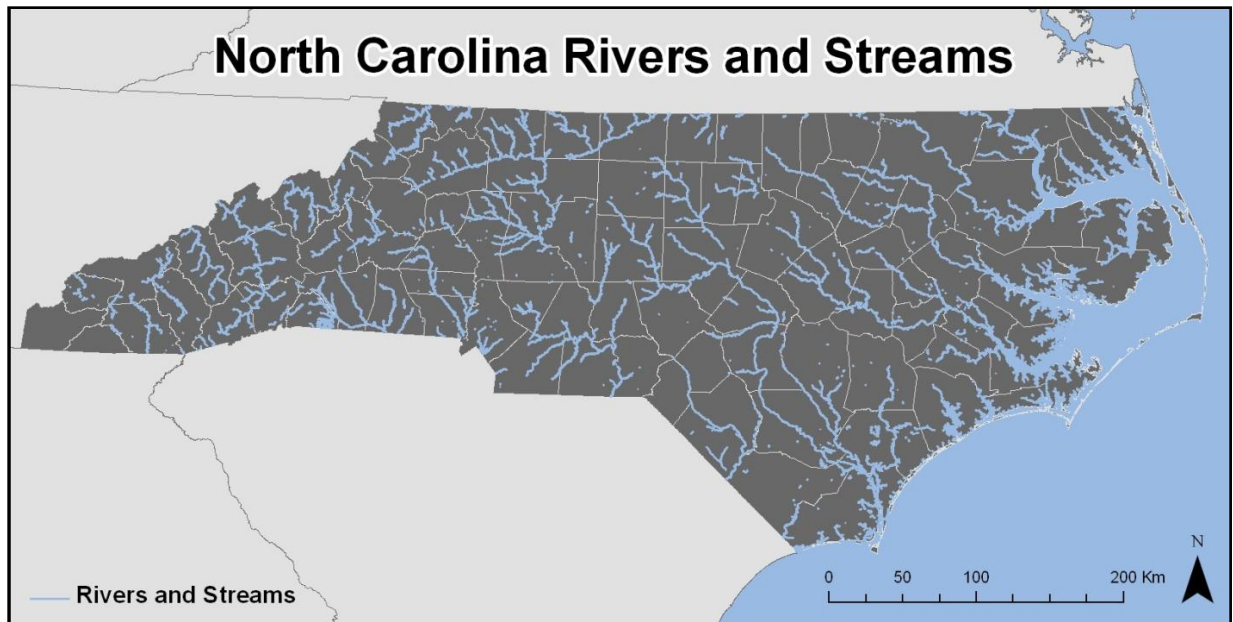


Figure 9. Rivers and Streams in North Carolina. Source: NCGIA, BasinPro

Although interstate and hydrology data are readily available for analysis, other distance measurements require additional steps. Abandoned textile mill sites are frequently contaminated, and the presence of brownfields might influence the likelihood (cost) of redevelopment. So, a list of North Carolina's brownfields was downloaded from the Environmental Protection Agency's Superfund database (<http://www.epa.gov/superfund/sites/cursites/>) as a Microsoft Excel file. The brownfield data was not geographically referenced although the addresses were provided. In order to map these sites, the BatchGeo service is used to create geospatial data for further analysis (<http://www.batchgeo.com/>). The EPA's database is downloaded to the BatchGeo website which creates point features to a kml file (see Figure 10). The coordinates of brownfield locations are then extracted using Excel and imported into ArcMap and then saved as a shapefile. A near distance table for brownfields was then generated.

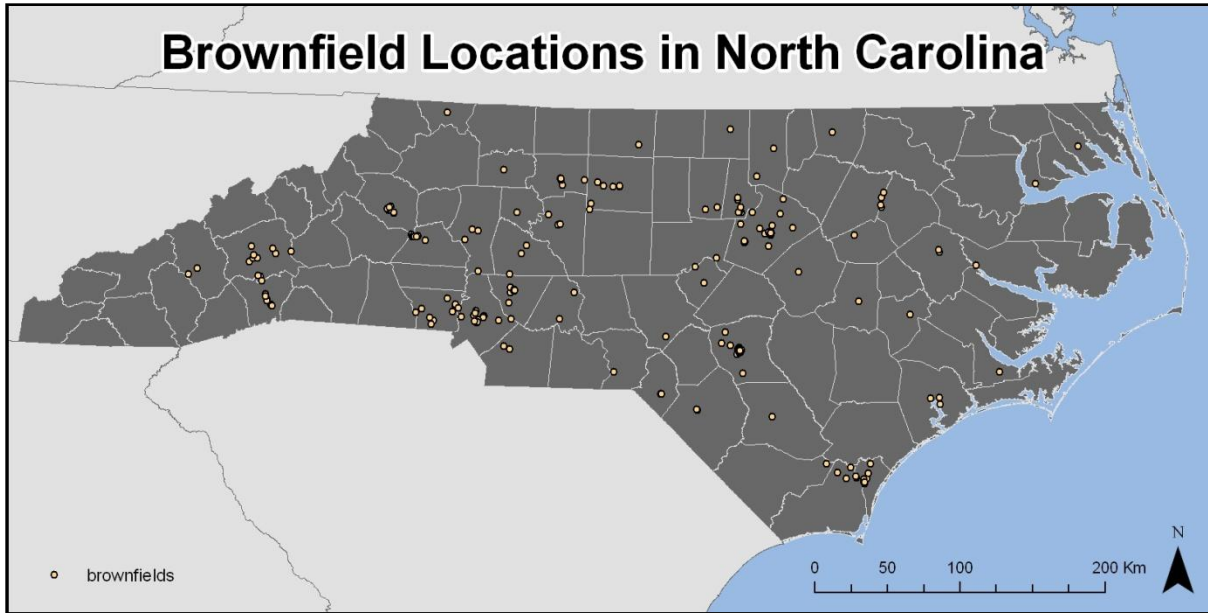


Figure 10. Spatial Distribution of brownfields in North Carolina. Source: EPA

The location of historic mills in relation to existing commercial activity is also considered. Like North Carolina’s brownfield sites, shopping centers are not readily available in geospatial form. SimplyMap contains business information, and compiling the locations of large department stores produces a variable that effectively represents shopping center locations (see Figure 8). First, searches in SimplyMap using the North American Industry Classification System (NAICS) codes for department stores (452111) and discount department stores (452112) were conducted. Department stores and discount department stores are frequently anchors for shopping centers, so their locations generally suggest the existence of major retail centers. To insure the inclusion of all shopping centers, the legal names of major retailers found in the department store lists were queried and then added to the department and discount department store lists in those cases where needed. Stores were exported as point features to a kml file using BatchGeo, and were then imported into ArcMap. A near distance table for shopping centers was then created.

Another possible contributing factor in the reuse of textile mills is the presence of other reused textile mills nearby, suggestive of a contagion form of spatial diffusion. Multiple redeveloped mills in close proximity to one another suggest the occurrence of clustering, which is examined through the generation of near distance tables in ArcMap. Adaptively reused mills are exported to a new shapefile, and the distance to the nearest (but not itself) reused mill is recorded.

The location of a mill site within a designated historic district may have a profound influence on the potential of the mill's adaptive reuse. North Carolina's National Register of Historic Districts data was acquired from the North Carolina Historic Preservation Office. These polygon files were used in order to differentiate between mills that are located within or outside of designated historic districts. Mills were selected by location, and if they fell within a historic district (point in polygon), then they were given a value of one (1) in a new field within the shapefile. Conversely, if they were not located within a historic district, a value of zero (0) was assigned. This completes the description of the explanatory variables, which are assembled for summary and convenience in a data dictionary (as seen in Table 2).

Data Dictionary		
Variable	Definition	Source
Hist_Dist	Mill's Location in a Historic District	NC Historic Preservation
Brown	Mill's Distance to nearest brownfield	EPA and ArcGIS
Shopping	Mill's Distance to nearest shopping center	Simply Map and ArcGIS
Reused	Mill's Distance to nearest reused mill	User Derived in ArcGIS
Interstate	Mill's Distance to nearest interstate	ESRI
RiverDist	Mill's Distance to nearest river	BasinPro and ArcGIS
Pct_urban	Percent Urban, 2000	Census SF3 2000
Pop2000	Population, 2000	Census SF3 2000
Popdens	Population Density, 2000	Census SF3 2000
PerWhite	Percent White, 2000	Census SF3 2000
PerBlack	Percent Black, 2000	Census SF3 2000
PerHisp	Percent Hispanic, 2000	Census SF3 2000
PopGrowth	Population Growth from 2000 to 2005	Simply Map
HouseAvg	Average Household Size, 2000	Census SF3 2000
HouseMed	Median Household Size, 2000	Census SF3 2000
AdultAge	Median Age of Adults 18+, 2000	Simply Map
CrimeIndex	Total Crime index in 2008	Simply Map
QualityLife	Quality of Life Index in 2008	Simply Map
HighSchool	Percent of Adults with a High School Diploma, 2000	Simply Map
EdAttain	Percent of Adults with a Graduate Degree, 2000	Simply Map
SameHouse	Percent of Population Living in Same House from 1995-2000	Simply Map
SameCounty	Percent of Population Living in Same County from 1995-2000	Simply Map
SameState	Percent of Population Living in Same State from 1995-2000	Simply Map
Income	Median Household Income in 1999 (in Dollars)	Simply Map
PerPov	Percent of Total Population under poverty level, 2000	Census SF3 2000
BlackPov	Percent of Black Population under poverty level, 2000	Simply Map
WhitePov	Percent of White Population under poverty level, 2000	Simply Map
TextileBus	Total Number of businesses in Textile and Apparel in 2008	Simply Map
TextileLabor	Total Number of employees in Textile and Apparel in 2008	Simply Map
Apartments	Apartments with 20+ Units in 2008	Simply Map
OldHomes	Number of Houses built before WWII in 2008	Simply Map
MedianRent	Median Contract Rent (in Dollars), 2000	Census SF3 2000
YearMovedIn	Median Year Moved in., 2000	Simply Map
Moved1969	Percent of residents who moved in before 1969	Simply Map
RentOccupied	Percent of Housing that is Renter Occupied, 2000	Simply Map
OwnerOccupied	Percent of Housing that is Owner Occupied, 2000	Simply Map
YearBuilt	Median Year residences were built, 2000	Simply Map

Table 2. Data dictionary describing explanatory variables used in the location analysis.

Final Database Assembly

Upon completion of the secondary data collection, mill locations and uses are assembled in a single database with the explanatory variables in order to permit an effective spatial analysis of adaptive reuse potential. This final database assembly requires three steps: the joining of distance variables to mill point features, the joining of all block group variables to block group polygon features, and a spatial join which combines the block group features with the mill point variables. First, distance variables are joined to the mill points within ArcGIS. Each distance measurement was exported as a near distance table, and these tables are joined to the mill points using the mill's identification number and the corresponding identification number in the near distance table. The mill points are then exported to a new shapefile in order to make the measurements permanent.

Next, the block group data is compiled. Block group shapefiles of North Carolina are extracted from ESRI's Basemap USA project file and then joined with other Census and SimplyMap data using block group Federal Information Processing Standards (FIPS) codes. The joined block group data are then exported in order to create a new shapefile with all census block group level variables now contained in the attribute table.

The historic mill locations, current uses, and distance variables are rendered in one shapefile, and the block groups and their variables are in another shapefile. These two data sets must be combined in order to facilitate the desired location analysis of textile mill redevelopment potential, and this is achieved through a spatial join. A spatial join takes the point mill features and adds the attributes of overlapping polygon features. In this case, the block group polygons'

attributes are added to the textile mill points' attribute table, resulting in a single master database ready for statistical analysis.

Proposed Model Construction

A spatio-statistical modeling approach is used to formally relate mill adaptive reuse to important location factors. A binary logistic regression is used in order to isolate factors that distinguish reused mill locations from those mill sites left abandoned. Logistic regression differs from the typical ordinary least squares regression, primarily because it accommodates and operates on a discrete (in this case binary) outcome. In logistic regression, the binary categorical outcome is recast as the probability of a positive outcome, i.e., the probability of an abandoned mill being reused, and is represented in the following equation:

$$P_i = e^{\beta X_i} / 1 + e^{\beta X_i}$$

Equation 1. Probability model of a mill being adaptively reused.

The probability of a mill being adaptively reused (P_i) is expressed as a continuous and nonlinear function of the linear combination of selected locational (situational) factors. The locational factors are contained in the matrix (X) and the relative influence of each factor on the probability of reuse is reflected in the size of its estimated coefficient (β). The response of this probability to the linear combination of locations factors is expressed graphically as in Figure 11.

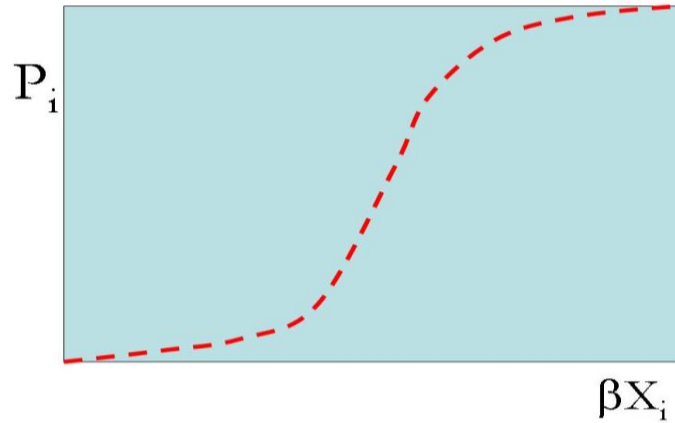


Figure 11. Logistic curve relating probability of adaptive reuse to situational attributes.

Now, this probability expression is typically linearized by first forming the odds, i.e., the ratio of the probabilities for the two possible outcomes ($P_i / 1-P_i$) and then taking the natural log of these odds, i.e., $\ln(P_i / 1-P_i)$. This expression is known as the logit and can be expressed as:

$$\text{Logit}(i) = \ln(P_i / 1-P_i) = \beta \mathbf{X} = \beta_0 + \beta_1 X_1 + \dots + \beta_k X_k$$

Equation 2. Logit equation relating the log of the odds of mill reuse to mill characteristics.

Logistic regression uses the properties of the logits to produce best linear unbiased estimators (BLUE) of the unknown influences of situational location factors (β). The desired estimates are achieved using maximum likelihood estimation (MLE). The likelihood function (LF) provides a maximization problem in β such that the estimated joint probabilities align best with the actual binary outcome. The reported estimates indicate the impact of each location factor on the log odds and if their direct impact on the probabilities is desired, then the logit equation needs to be exponentiated, i.e., by taking the antilog of the estimates. Exponentiated estimates are automatically provided from most standard statistical packages. Because the effect of a unit change in any location factor on the probability of reuse varies, i.e., the logistic

response accelerates and then decelerates as depicted in Figure 11, the actual influence of any factor can be expressed as:

$$\delta P / \delta X_j = \beta_j * P * (1-P)$$

In addition to these estimates associated with location factors, the estimated probability of adaptive reuse is generated for each mill in the inventory, i.e., based on its situational profile. In those cases where location (situational) factors are “good,” a higher probability of reuse will be predicted. These probabilities are associated with all abandoned, destroyed, and reused mills and are mapable. They provide a basis for suggesting mill locations for potential redevelopment in the future. In fact, those abandoned sites with high probabilities of reuse (and no reuse attempted) can be assembled to reveal possible obstacles to redevelopment and policy needs can then be addressed. In those cases where a high probability of reuse is estimated but the mill has been destroyed, an unfortunate resource loss is suggested. These probabilities of reuse and their associated residuals are reported in the next chapter along with the revelation of important situational factors.

CHAPTER 4: EMPIRICAL RESULTS

This chapter provides basic empirical results and discusses the construction of a model that accounts for the probability of adaptive reuse of abandoned and historic textile mills in North Carolina. The first section describes summary statistics of potential explanatory variables, i.e., location factors. The summary statistics provide an initial indication of factors that might influence the rehabilitation of textile mills and variables that show a strong correlation with reused mills are examined more closely. These variables offer a preliminary, albeit incomplete, basis for thinking about the individual parts of the final, inductively generated, multivariate location model. The final section reports on the construction of the binary logistic model that best predicts the likelihood of reuse for abandoned textile mills. As such it can be viewed as a location model which isolates key decision variables and also can be used to assess the potential for additional reuse development or the loss of important cultural resources.

Although the values of explanatory variables were gathered for all (currently used, destroyed, abandoned, and reused) textile mill sites that existed in 1944 in North Carolina, the resulting database required further trimming before appropriate binary logistic modeling could be engaged. The first alteration to the final database (used for model construction) involved the elimination of textile mills that are still used for manufacturing. These mills are neither abandoned nor reused, so they have no direct statistical influence on the likelihood of reuse. Mills in the master database that continue to be used for manufacturing were deleted from the modeling exercise. The second adjustment to the master mill database is aggregation within the two primary categories of abandoned mills and reused mills. Reused mills were originally

categorized by the specific type of reuse: commercial, residential, or mixed use. Abandoned mills include those that remain standing as well as those that have been destroyed. Thus, the resulting aggregated mill variable categorizes each mill as being either reused, with a value of 1, or abandoned, with a value of 0. These data provide the basis for distinguishing between historic mills that have been adaptively reused and those that have been abandoned.

Independent Samples, Analysis of Means

Before reuse potential can effectively be modeled, a preliminary assessment of the data is instructive. Comparative summary statistics for each of the location factors provide an initial glimpse of situational conditions that are best suited for textile mill redevelopment. The mean, median, standard deviation and skewness were generated for each of the potential explanatory variables. Differences in these statistics also are analyzed to suggest which variables possess relatively strong relationships with textile mill reuse. This step in the examination of results will initially clarify the factors that seem to influence the likelihood of redevelopment and assist in identifying candidate variables for the desired location model. This analysis is achieved with use of a series of independent-samples, t-tests for the difference between two means, i.e., situational differences between abandoned and reused mills.

The independent-samples t-tests compare the means for two groups of outcomes, i.e., comparing differences between reused mills and abandoned mills (see Table 3). The means of variables for abandoned mills, and then reused mills, are compared using the t-statistics where unequal variance (heteroscedasticity) is assumed, i.e., the least restrictive test. This is the more conservative statistical approach and there is no compelling logic to (apriori) assume the unlikely condition of homoscedasticity. Additionally, within this section, the t-statistics associated with

spatially weighted variables also are generated to determine whether phenomena measured over a larger scale (less local) might illustrate potential impacts on the adaptive reuse of textile mills. With such a large assortment of potential situational location factors, and in order to begin the process of excluding some of these for modeling purposes, only variables with t-statistics above an absolute value greater than 2.5 are examined here.

Variable	Block Groups				Spatially Weighted			
	Group Means		t-statistic		Group Means		t-statistic	
	No Reused	With Reused	Equal Var	Unequal Var	No Reused	With Reused	Equal Var	Unequal Var
Historical	0.13	0.32	-4.03	<u>(-3.24)</u>				
Brown	13246.82	9625.26	2.21	2.47				
Shopping	3572.4	2851.68	1.39	1.71				
Reused	14207.51	12532.85	0.63	0.66				
Interstate	5528.76	5092.21	0.43	0.45				
RiverDist	3313.4	4465.05	-2.92	-2.35				
Urban	0.84	0.9	-1.26	-1.38	0.79	0.86	-1.94	-2.08
Pop2000	1205.93	1152.75	0.74	0.77	1505.23	1918.3	-2.93	<u>(-2.78)</u>
Popdens	1608.96	1840.58	-1.37	-1.41	1636.14	2139.32	-3.15	<u>(-2.87)</u>
PerWhite	0.64	0.64	0.16	0.17	0.65	0.66	-0.31	-0.34
PerBlack	0.28	0.28	-0.04	-0.04	0.28	0.28	0.17	0.19
PerHisp	0.07	0.07	-0.23	-0.25	0.06	0.06	0.63	0.71
PopGrowth	-0.02	-0.01	-0.92	-0.91	-0.01	0.01	-1.24	-1.12
HouseAvg	2.32	2.23	1.21	1.3	2.41	2.34	1.83	1.85
HouseMed	2.61	2.52	1.39	1.34	2.71	2.61	2.96	<u>(-2.77)</u>
AdultAge	43.06	40.62	4.05	<u>(-3.47)</u>	43.16	42.15	2.02	1.7
CrimeIndex	144.03	144.36	-0.05	-0.05	133.62	135.94	-0.41	-0.4
QualityLife	121.09	121.92	-0.67	-0.78	121.58	122.17	-0.6	-0.71
HighSchool	0.3	0.27	2.29	2.09	0.3	0.27	4.4	<u>(-3.61)</u>
EdAttain	0.04	0.06	-3.25	-2.13	0.04	0.07	-6.43	<u>(-3.97)</u>
SameHouse	0.16	0.2	-3.8	<u>(-3.00)</u>	0.16	0.18	-4.16	<u>(-3.28)</u>
SameCounty	0.25	0.24	0.9	0.92	0.24	0.23	0.59	0.56
SameState	0.48	0.43	3.08	<u>(-3.07)</u>	0.52	0.43	3.98	<u>(-3.69)</u>
Income	28000.69	30205.9	-1.72	-1.37	31946.57	33502.57	-1.59	-1.39
PerPoverty	0.36	0.23	1.52	2.1	0.33	0.19	1.96	<u>(-3.29)</u>
BlackPov	0.28	0.28	-0.1	-0.1	0.23	0.22	0.71	0.73
WhitePov	0.16	0.17	-0.59	-0.57	0.13	0.14	-1.08	-1.03
TextileBus	0.31	0.15	0.84	1.3	0.32	0.29	0.42	0.49
TextileLabor	20.46	8.37	0.81	1.4	23.09	16.95	0.86	0.97
Apartments	105.03	109.3	-0.77	-0.77	96.87	103.87	-2.71	-2.41
OldHomes	134.3	138.18	-0.88	-0.79	111.02	114.6	-1.22	-1.13
MedianRent	348.68	385.11	-2.79	-2.32	357.87	405.04	-3.11	<u>(-2.89)</u>
YearMovedIn	1992.67	1993.63	-2.42	<u>(-2.53)</u>	1985.2	1989.54	-0.81	-1.06
Moved1969	0.14	0.12	1.24	1.36	0.14	0.12	2.78	<u>(-2.70)</u>
RentOccupied	0.48	0.53	-1.57	-1.6	0.41	0.46	-2.09	-2.04
OwnerOccupied	0.52	0.48	1.57	1.6	0.59	0.54	1.95	1.93
YearBuilt	1960.65	1957.36	2.18	1.81	1958.02	1959.67	-0.32	-0.4

Table 3. Results for difference in means, t-statistics. Those underlined and within parentheses are highly significant and more closely examined.

Situational Differences Between Reused and Abandoned Mills

The demographic makeup of the block groups that contain mills is examined below. The reader is reminded that most of this information reflects 2000 census data. In 2000, the mean number of residents in block groups with reused mills was 1153, which is modestly smaller than block groups with abandoned mills, 1215 people. However, block groups with reused mills had a much larger population density. Block groups with a reused mill had an average of about 1841 people per square mile while block groups with abandoned mills exhibited only 1488 people per square mile (approximately 24 percent less). The discrepancies in results between population and population density highlighted here illustrate that reuse investments are very likely based, at least in part, upon population density considerations at the localized level.

The location of old mills within formally declared historic districts appears to be an important indicator in their possible reuse. Although approximately 13 percent of all mills are located in historic districts, a much larger portion (32 percent) of reused mills is found within historic districts. Yet, the estimated standard deviation of the reused mills being located within historic districts is considerably larger and this is attributed to the highly varied outcomes associated with the reused group. This difference yields a very large t-statistic of 3.24. Block groups that possess an historic district are much more attractive as recipients of mill redevelopment investment. This outcome is in stark contrast to the literature's conventional wisdom, which suggests that adaptive reuse avoids the restrictiveness (and costliness) of historic districts. The reader is reminded that the temporal tags associated with the data used here are insufficient to investigate the order of causality between the creation of historic districts and the reuse of mills.

The age of block group residents also emerges as a potential factor in the reuse of textile mills. In block groups with abandoned mills, the average median age of adults (>18 years) is 43 while the median age of adults in block groups with a reused mill is 40. This indicates that the adult populations in areas where mills have been redeveloped are generally younger. This difference is relatively large and results in a t-statistic of 3.47, which suggest a strong negative correlation between redevelopment and age structure, i.e., areas with larger concentrations of younger adults are much more likely to have witnessed investment in reused mills than otherwise.

Another trend that appears among the demographic variables is the probable influence that local educational attainment has on the redevelopment of mills. For example, block groups that host reused mills also exhibit population with substantially higher educational attainment levels than block groups with abandoned mills. Approximately six percent of adults in block groups with a reused mill have a graduate degree of some sort and eleven percent of these adults have a college degree. This contrasts greatly with abandoned mill block groups, with a mean of only four percent having a graduate degree and only seven percent having a college degree. Do note that the spatially weighted (surrounding block groups as defined by a queens case weight matrix) educational attainment variables show even stronger correlations than their local (block group) counterparts. Within the spatially weighted variables, there is a very strong correlation between abandoned mills and block group populations with just high school diplomas, with a t-statistic of 3.61. In contrast, the highest educational attainment levels of residents are exhibited most strongly in block groups with reused mills. The t-statistic of 3.96 indicates a very strong positive correlation between areas with high concentrations of graduate degrees and the likelihood of historic mill reuse.

Poverty conditions exhibit a very strong difference between block groups with reused mills and those that possess abandoned mills. Note that the un-weighted (locally measured within the block groups) variables did not provide significant contrasts between abandoned and reused mills. The significance of this feature only surfaced when the percent of poverty was considered as a spatially weighted indicator, i.e., the importance of poverty conditions in the surrounding areas. In the block groups surrounding reused mills, there was just a 19 percent poverty level while block groups surrounding abandoned mills exhibited a very large poverty rate of 33 percent. This contrast results in a t-statistic of 3.29. This feature indicates a strong negative correlation between the likelihood of adaptive mill reuse and poverty within the surrounding region, so these reused mill areas are generally situated within more affluent regional portions than their abandoned counterparts are.

Recent mobility of the block group population also shows a strong correlation with mill reuse. These mobility variables explicitly measure residential status from 1995 to 2000. Each measures the volume of movement to the block group from just one type of origin: from within the county, from within the state, and from within the country. In each of these mobility cases, the spatially weighted variables (non-local) are more significant, so they are the ones focused upon here. First, the mean percentage of people living in the same house (from 1995 to 2000) in the block groups with an abandoned mill was 15.5 percent of the resident population, and those with reused mills was substantially higher at 18.2 percent of residents. This yields a t-statistic of 3.28, which indicates a strong positive relationship between the likelihood of reused mills and net in-migration.

The percent of residents living in the same state illustrated a very different relationship with reuse. Fifty-two percent of residents in block groups with abandoned mills were residents of North Carolina from 1995 to 2000. However, only 43 percent of residents lived inside the state in 1995 within block groups that contained a reused mill. This gives a t-statistic of 3.69, illustrating a relatively strong relationship between interstate residential mobility and mill reuse. In essence, the ability to attract a more mobile population is suggested as a location factor when considering the potential for mill redevelopment. Interstate mobility seems to be a key in this regard.

Housing characteristics also showed some strong differences between block groups with reused and abandoned mills. Rent indicated a strong positive correlation with the likelihood of reuse. The spatially weighted median rent around block groups with reused mills was significantly higher than those with abandoned mills. For example, median rent in block groups with abandoned mills was about 358 dollars per month, whereas median rent in block groups with reused mills had a median rent of 405 dollars (in year 2000). Once again, a spatially weighted t-statistic of -2.89 indicates a pricier housing stock in block groups surrounding reused mills.

Predictive Model Development

With initial examination of the candidate explanatory variables completed, development of the final model is now addressed. Individual relationships, like those examined above, while instructive, can mask the explanatory substitutability and complementarity that are inherent in a complicated multivariate outcome like real estate investment and adaptive mill reuse.

So at least initially, all explanatory variables (see Table 2) are considered for entry into a binary logistic regression. This liberal approach is accomplished using a number of stepwise procedures including several forms of forward inclusion and several forms of backward elimination. In the forward approaches, variables are added one at a time in sequence of explanatory power. The model is enlarged until no additional significant influence can be found among the set of variables not included. Using the backward methods, the starting model includes all candidate variables and one is eliminated during each step in order of minimum explanatory power. The backward elimination procedures generally result in large models while the forward inclusion models are generally smaller. Both approaches, regardless of specific empirical criteria, generally yield empirically sub-optimal statistical models because once a variable is included in the forward approach, it cannot be removed, and once a variable is eliminated in the backward approach, it cannot be re-entered. These purely empirical approaches to model building simply permit the analyst to see how individual explanatory variables might substitute or complement one another. Regardless of the specific stepwise approach used, each step was carefully evaluated in terms of ability to predict whether an historic mill had been reused or abandoned. Additionally, common analytic measures, such as the Wald Statistic were used to determine the significance associated with individual explanatory variables, i.e., situational location factors. The best model constructed must: 1) provide a reasonably good set of predictions, i.e., fit, 2) only contain parts (variables) that are significant, and 3) must be capable of sound logic when interrogated as location factors influencing mill reuse investment decisions.

The variables possessing strong influences on the likelihood of a textile mill's reuse, in combination with others, are incorporated into candidate models. Literally hundreds of models,

each a subset of all possible situational location factors, have been considered. As noted earlier, situational characteristics of the mills’ surroundings are included in the final model selected. However, all variables admittedly interact with one another (as explanatory substitutes and complements) and can become important factors in the mill reuse decision-making process despite their low initial (t-test) explanatory assessment. The final location model selected indicates that the likelihood of historic mill reuse is a function of factors including: residents’ age, residents’ educational attainment, status within a historic district, residents’ poverty levels, proximity to water, and residents’ ethnicity (see Table 4).

Variables in the Adaptive Reuse Location Model

	B	S.E.	Wald	Df	Sig.	Exp(B)
AdultAge	-.081	.033	6.02	1	.01	.922
WEdAttain	17.44	3.96	19.44	1	.0001	3.736E7
Historical	1.39	.34	16.54	1	.0001	4.009
WPerPoverty	-1.26	.61	4.20	1	.04	.284
RiverDis	.0001	.00001	9.16	1	.002	1.000
WPerWhite	1.54	.73	4.46	1	.03	4.654
Constant	-.59	1.39	0.18	1	.67	.553

Table 4. Variables, Parameter Estimates and Significance of Situational Factors in the Final Location Model. Source: Parameters estimated by author. ‘W’ prefix indicates that the factor is spatially weighted, i.e., a larger scale regional influence instead of a localized influence.

The variable with the largest impact on the likelihood of redevelopment is the level of educational attainment achieved by residents living around the mills (WEdAttain). This spatially weighted variable measures the percentage of population with a graduate degree and is highly significant, with a Wald statistic of 19.44. The estimated parameter for population with a graduate degree is 17.44, which also indicates a very strong positive relationship. It is clear

that investors seek out neighborhoods (and then attract residents) with highly educated populations nearby.

The next most significant variable is a mill's location within a historic district (Historical). This is not surprising, with all preliminary assessments showing a strong positive relationship between mill reuse and association with a designated historic district. The Wald statistic verifies that this is the case with a large value of 16.54. A beta weight of 1.39 also verifies that the relationship is indeed significantly positive. Location within or nearby a historic district increases the attractiveness of the mill investment, *ceteris paribus*. This result contrasts strongly with results reported in the existing literature.

Median adult age (AdultAge) is another variable with a strong relationship to a mill's probability of being adaptively reused. Its Wald statistic of 6.02 indicates that it is an important factor. As previously discussed, block groups with reused mills tend to have younger adult populations. This is reflected in the beta weight, with a negative value of -0.08. As age among the adult population increases, the probability of mill adaptive reuse decreases. These redevelopments target young adults and attract them into these settings.

The racial makeup of the area surrounding a mill also proves to be a major influence on the probable redevelopment of mills. The spatially weighted percentage of population that is white (WPerWhite) resulted in a Wald statistic of 4.46, making it another important factor in the final location model. Reused mills tend to be located in areas where the population is predominantly white, which is captured in the final model. The beta weight shows a strong positive relationship between the concentration of white people and the probability of reused mills, with a value of 1.54.

The prevalence of poverty in the neighborhoods surrounding mills (WPerPoverty) is shown to be a major negative factor in the likelihood of mill reuse as well. The final model produces a Wald statistic of 4.20. Reused mills tend to be located in more affluent areas, and this is reflected in poverty's beta weight of -1.26. This illustrates that there is a strong negative relationship between poverty rates and the probability of a mill being adaptively reused.

Distance to the nearest stream (RiverDis) provides an estimate of unexpected sign and interpretive difficulty. The sign of the estimated parameter is positive and it is a relatively strong result with a Wald value which exceeds nine. The positive sign suggests that the probability (log odds) of mill reuse actually increases as we move farther away from water. At a general level, this is counterintuitive, i.e., water within a view shed can add considerable value to property (Bin et al. 2008). In general, this outcome probably reflects the need for an urbanized setting for feasible reuse and the historic commercial and industrial development that normally took place outside of flood zones once water power was displaced by boilers/steam and electricity in the 1900s. However, it is also true that a few of the most impressive mill redevelopment examples within North Carolina are located aside stream channels, e.g., Saxapahaw in Alamance County. Thus, this estimate should not be interpreted as an unqualified disutility associated with location near water, e.g., water views are frequently preferred. Rural opportunities, like Saxapahaw, might actually seek and require the advantages (amenities) associated with location nearer water.

In order for the binary logistic regression to properly predict the mills that have been selected for redevelopment, the outcomes must be converted to a nonlinear format. This is achieved through the creation of a probability model (see the discussion in the Methods Chapter

3). In order to provide an estimable form relating the probability of mill reuse to selected location factors, the log of the odds is formed, i.e., the logit. Maximum likelihood techniques are used to estimate the unknown parameters which relate the location factors to the probability of adaptive reuse. The logistic regression returns the log of the odds that an abandoned mill has been reused and is written using estimates from Table 4 as:

$$\begin{aligned} \text{Log of odds of reuse} = \ln(P/1-P) = & -0.59 - 0.08(\text{AdultAge}) + 17.44(\text{WEEdAttain}) + .0001(\text{RiverDis}) \\ & + 1.39 (\text{Historical}) - 1.26(\text{WPerPoverty}) + 1.54(\text{WPerWhite}) \end{aligned}$$

Equation 3. The logit model of adaptive reuse.

The logit model behaves largely as expected. Adult age has a negative influence on the log of the odds. Areas with young adults are attractive for this form of redevelopment. High levels of educational attainment also improve the log of the odds that a mill will be redeveloped. If a mill happens to be located within a block group that also possesses a formally designated historical district, then the log of the odds increases markedly. The level of impoverishment within an area, severely reduces the probability of attracting redevelopment investment. The model also indicates that an area's ethnic composition influences the log of the odds of redevelopment, i.e., percent white has a large positive influence on this probability. As mentioned above, distance to water provides the only unexpected result, i.e., positive at the statewide level.

The performance of this location model is summarized in a table commonly referred to as a confusions matrix or classification table (see Table 5). This matrix illustrates correctly and incorrectly predicted adaptive reuse given the situational location factors included in the model.

Overall, the model does very well and predicts nearly 87 percent of mill reuse status correctly. This type of number serves as a summary of model performance (fit) like an R^2 value in OLS regression analysis. However, do note that the model's success is a bit asymmetric. It predicts abandoned mills quite well (99 percent of the cases with only 5 false positives). In contrast, it only predicts 27 percent of the adaptively reused mills correctly (with over 50 false negatives). A discussion of this inadequacy will take place later in the next chapter but must largely be attributed to the absence of site characteristics within the explanatory framework and the statistical model.

Observed		Predicted		
		Reuse		Percentage Correct
		No	Yes	
Reuse	No	360	5	98.6
	Yes	53	20	27.4
Overall Percentage				86.8

Table 5. Classification Table or Confusions Matrix. Source: Calculated by the author.

Once the model is estimated, i.e., parameters are estimated, the probabilities of any mill being reused can be calculated using Equation 4. Once estimated parameters (β values) are known, individual mill attributes (expressed here as matrix X of situational characteristics) are simply substituted in. Thus:

$$P_i = e^{\beta X_i} / 1 + e^{\beta X_i}$$

Equation 4. Probability model of adaptive reuse.

The probabilities are now expressed correctly, and they can be mapped and analyzed to determine which mills are indeed the best candidates for redevelopment. In this particular case, the location model designates five mills as false positives, i.e., the estimated probabilities for reuse each exceeds 0.5 but they have not been redeveloped. These are mills (see Table 3) that have not been redeveloped but given their positive situational characteristics, they should be. We take this condition to suggest that they are the best, or at least good, candidates for future redevelopment and adaptive reuse. The false positives are now briefly examined to see if they are indeed good candidates for mill redevelopment.

Good Mill Candidates for Adaptive Reuse

Good mill candidates for rehabilitation are revealed through an elimination process. In order to compile a list of the good potential investment mill sites, several factors must be considered that determine the feasibility of redevelopment. The first step for suggesting potential mill reuse is examination of the false positives delivered from the binary logistic regression. The final model predicts five sites that should be redeveloped, although they are currently abandoned. Unfortunately, upon closer inspection four of the five sites must be eliminated from consideration simply because these mills were earlier destroyed. Please recall that destroyed textile mills were combined with other abandoned (standing) mills as one category. As a result, it can certainly be asserted here that the four destroyed mills represent a substantial loss of opportunity for community redevelopment and historic preservation. This outcome illustrates another important use of the modeling approach, i.e., identifying the unnecessary loss of important cultural resources. The only mill that remains from the group of false positives as a candidate for redevelopment is the Grey Hosiery Mill located in

Hendersonville. According to the location model estimated here, this mill is North Carolina's single best candidate for redevelopment. Examination of the Grey Hosiery Mill opportunity occurs later in this chapter along with several other adaptive reuse opportunities.

Because four of the five false positives already have been destroyed, examination of mills that still exist and possess relatively high probabilities for adaptive reuse, given their situational attributes, are selected for careful consideration as reuse candidates. Several assessments are required in order to insure that these candidates are suitable for redevelopment. Using Google Map's Street View and Bing Map's Bird's Eye View, six mills (including Grey Hosiery) with a high probability for redevelopment are qualitatively evaluated for investor suitability. For example, one mill that the model predicted to be a good candidate for reuse but may be of questionable utility is Roanoke Mills, Mill Number 2, located in Roanoke Rapids, North Carolina. Although the original mill maintains the characteristics of many other historic mills, there have been extensive additions to the structure through time. These additions to this historic mill are one story and windowless, which renders the mill as a poorer candidate for reuse than the model suggests (see Figure 14). If these structural additions had been minor, the mill might be deemed as reusable. However, these costly one story structures have grown to engulf practically the entire property and devalue its historic significance.

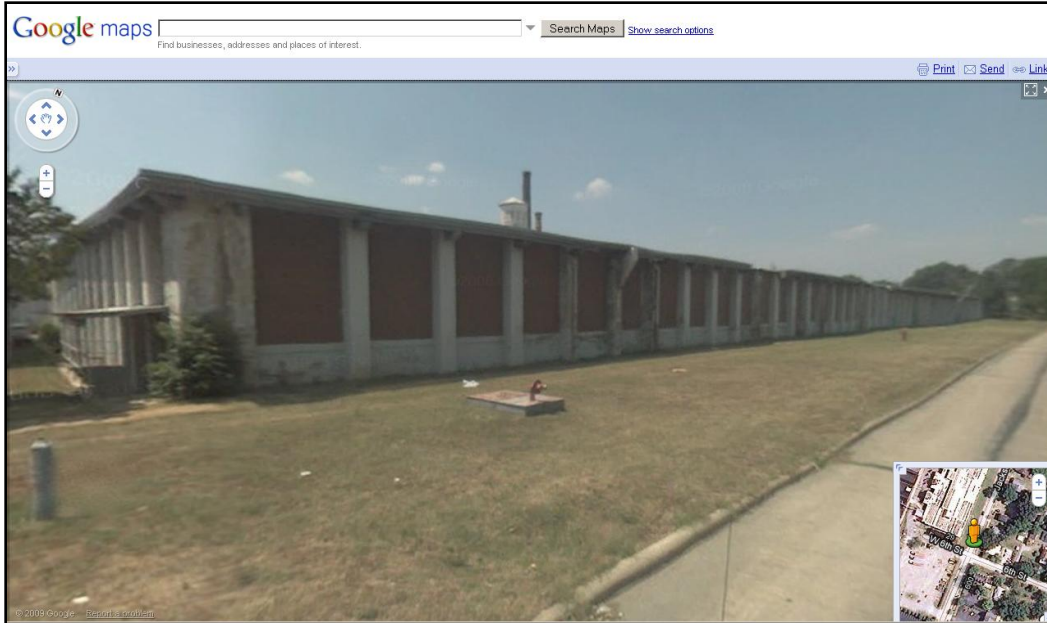


Figure 12. Roanoke Mills

With estimated parameters in hand, equation 4 permits calculation of the probability of any historic mill's adaptive reuse. As a result, we will examine mills that have a high probability of reuse but are still abandoned. These mills are good candidates for immediate investment. In the interest of brevity, only five historic mills are examined as good candidates for adaptive reuse. As indicated earlier, Grey Hosiery Mill, which is located in Hendersonville, is a very good candidate for adaptive reuse. Statistically, it is the best candidate for reuse, being the only false positive to remain intact. The next best candidate is the Walton Hosiery Mill located in Hickory. The Kendall Company Mill in Mecklenburg County, the Koonts Hosiery Mill in Lexington, and the Monroe Mills Company in Union County round out this selection of mills indicated to possess significant potential for adaptive reuse. Their locations across North Carolina can be seen in Figure 13.

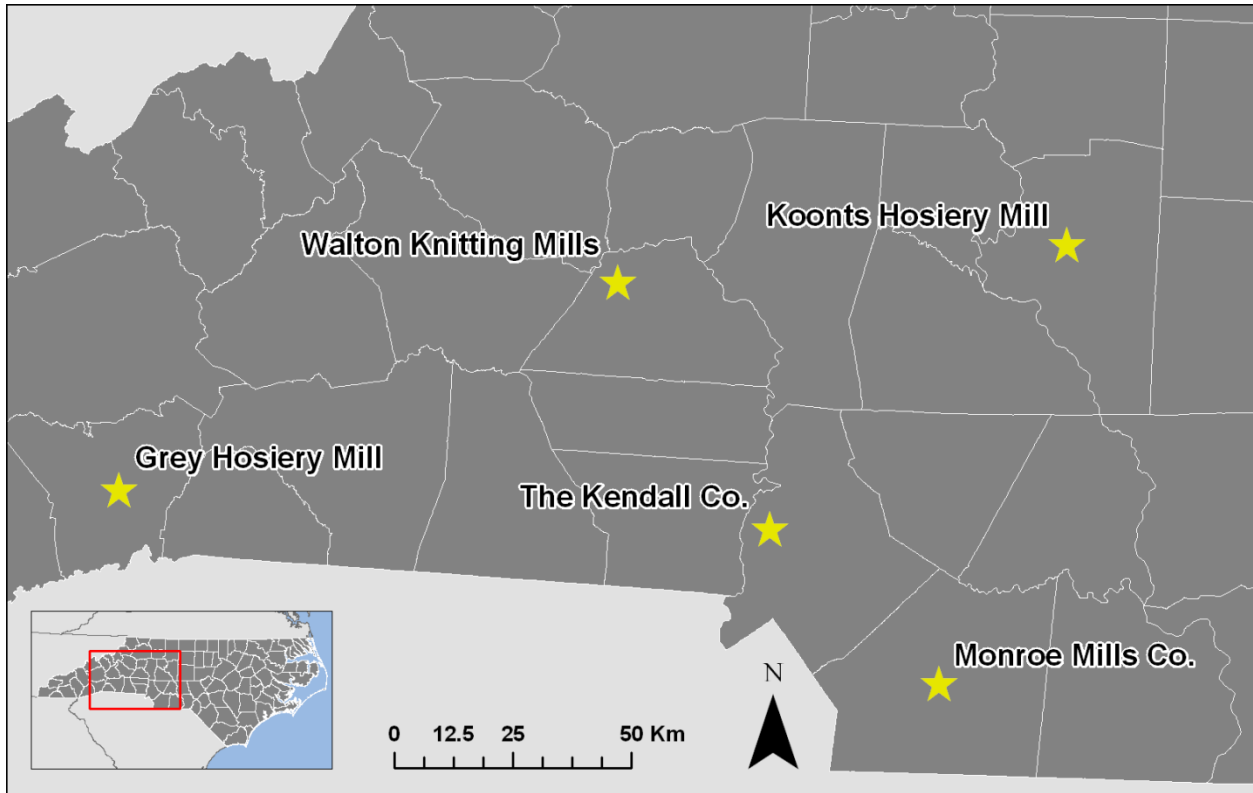


Figure 13. Selected mill reuse candidates in North Carolina.

The Candidates

Now that several good mill candidates have been statistically identified, additional factors that make them good candidates for redevelopment are assessed, case by case. Recall that these mills were identified as strong candidates with emphasis placed upon their situational attributes. The logistic regression model intentionally ignored mills' individual physical characteristics and these are now evaluated to determine if these candidates are, in fact, highly suitable for adaptive reuse. These candidate mills do represent a diverse array of sizes and existing conditions, which can serve as lively topics for discussion.

Grey Hosiery Mill

The first candidate is The Grey Hosiery Mill, located near downtown Hendersonville, and it is the top statistical candidate predicted from the model. It is the only standing mill that the logistic model predicted as a false positive, i.e., given its situational attributes it should already be adaptively reused. Currently, this historic mill appears almost abandoned and the structures generally are not used. There are several work trucks and pieces of heavy machinery on the property and the lots are likely used for storage. There are several key features that make this mill an excellent candidate for redevelopment. In terms of situational attributes, it is located nearby a vibrant commercial district and it is found within a designated historic district. Notice that the point feature representing the mill is only about thirty meters from the address of a brown field. So, the site is probably contaminated, which also opens the possibility for funding from the EPA.

Additionally, the Grey Hosiery Mill's structure is representative of historic textile mill architecture. The building's façade is made of brick and there is an abundance of windows on all sides. Furthermore, there appear to be no major (relatively) recent additions to diminish the historic character of the mill. Notably, the City of Hendersonville announced on May 7, 2010 that it was accepting qualifications from teams interested in redeveloping the Grey Hosiery Mill site (www.cityofhendersonville.org). This news release and web announcement confirms that the model can accurately distinguish historic textile mills with excellent characteristics for adaptive reuse. It's also comforting to know that Hendersonville realizes that it possesses a cultural resource worthy of preservation.



Figure 14. Grey Hosiery Mill, image captured from Bing Maps.

Walton Knitting Mills

Walton Knitting Mills, located in Hickory North Carolina, is the next candidate with strong potential for adaptive reuse. Although it is not located in Hickory's central business district, this mill is in close proximity to a wide variety of commercial activities and services, such as a chiropractor's office, a florist, and various restaurants. The architecture of the mill is not the typical historical style which often attracts redevelopment. So, the individual character of this structure may limit the flexibility of adaptive reuse. However, this does not suggest that the mill cannot be reused. While it is unlikely that the site can be converted to a residential use such as loft apartments, there is still potential for adaptive reuse as a commercial space.

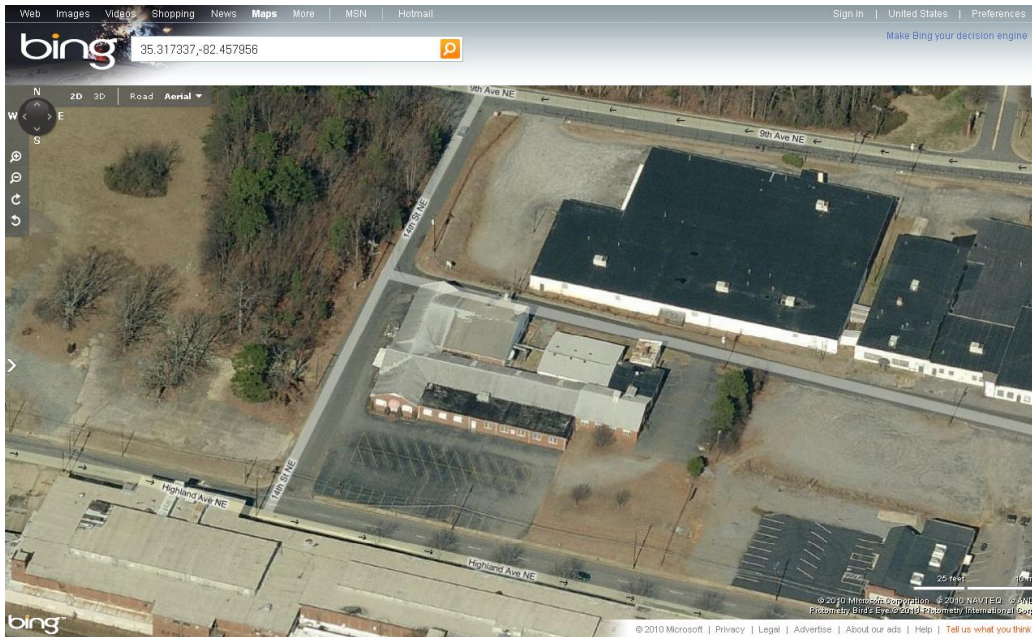


Figure 15. Walton Knitting Mills, image captured from Bing Maps

The Kendall Company

The Kendall Company Mill is located near Paw Creek in Mecklenburg County. A small portion of the site is currently used as a warehouse, so it does remain in nearly an abandoned state. This mill is located in a relatively sparsely populated area of Mecklenburg County, which makes some forms of redevelopment more challenging. However, this historic mill is located within a residential area with limited commercial resources in the surrounding areas. The redevelopment of this property for commercial uses could provide a needed retail resource for the surrounding community. However, this Kendall Company Mill is only about seven miles from Charlotte's city center and approximately one and a quarter miles from I-485, so it is readily accessible to a variety of employment centers. Its proximity to a major urban center and major limited access highways make it a very good candidate for residential development.

Additionally, the mill's structure and site size provide for a wide variety of redevelopment possibilities. The mill includes buildings that are large multi-story structures with desirable historic mill architecture. The large volume of square footage in multiple buildings makes it a good candidate for mixed use. The multi-story building (seen on the left in Figure 16) and single story building (foreground on the right) could be used for retail purposes, and the structure in the back corner of the property could be converted to housing. The size of the lot improves the site as a good candidate, because this property can provide ample on-site parking for potential commercial activity in addition to greenspace for potential residents and the mill's neighbors.

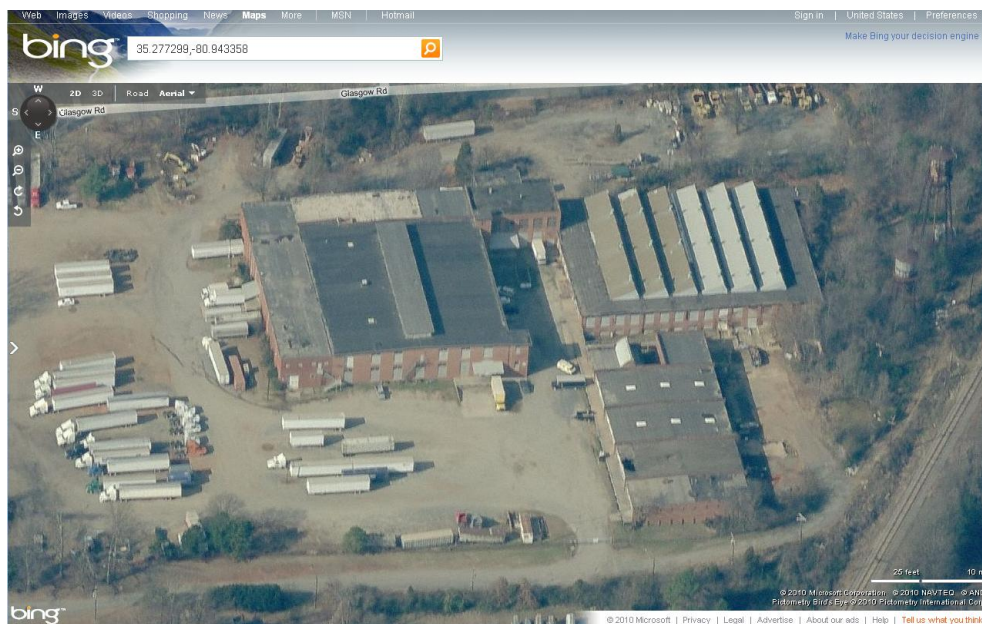


Figure 16. The Kendall Company Mill Site, image captured from Bing Maps

Koonts Hosiery Mill

The Koonts Hosiery Mill in Lexington North Carolina is another good candidate for adaptive reuse. Based on the building's outward appearance, it is currently abandoned. The

building is consistent with historic textile mill architecture, but it is noticeably smaller than the other mill candidates currently under consideration. The mill's small size may bode well for its redevelopment, because a smaller investment is required to successfully rehabilitate it. This mill is located adjacent to a residential area, so it potentially could be converted to apartments or a small residentially oriented retail function. However, it is also located next to a church and a supply yard, so it could be used for other commercial purposes as well.



Figure 17. Koonts Hosiery Mill, image captured from Google Maps Street View

Monroe Mills Company

The Monroe Mills Company is located in the town of Monroe, in Union County North Carolina, and it is currently being used strictly for storage. This historic mill shows great potential for rehabilitation on several counts. First, it shares the architecture of historic textile mills that frequently have been redeveloped. The building is four stories and its rectangular shape makes it an excellent candidate for division into apartments. This mill is within a half mile of the downtown area, so potential residents would have easy access to restaurants and

shopping. Although Monroe is a small town, it is only 25 miles from Charlotte’s city center. This makes Munroe relatively accessible to metropolitan job opportunities for people willing to commute to work. With wooded areas bordering it and a park across the street, the Monroe Mills site would be an excellent place for people interested in trendy loft apartments, low maintenance, and those desiring a rural setting.

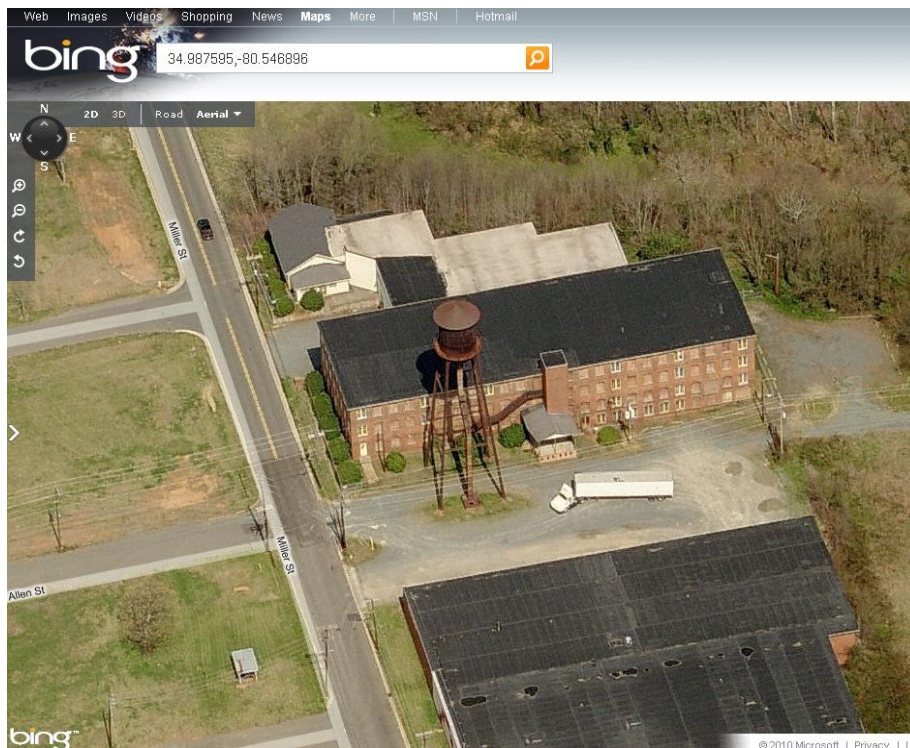


Figure 18. Monroe Mills Company, image captured from Bing Maps

Collectively, examination of these six historic mill candidates helps to illustrate the utility of the approach adopted here. First, employing situational variables within a probabilistic model of adaptive reuse effectively nominates candidates for closer inspection. Then, candidates are assessed in terms of detailed site characteristics including structural size, lot size,

and architectural detail. With the utility of the approach illustrated, the final chapter of the thesis will provide a summary of findings, limitations, and recommendations for future research.

CHAPTER 5:

SUMMARY AND CONCLUSIONS

The purpose of the research reported in this thesis is to create an inventory of historic (existing prior to 1944) textile mills in North Carolina, to determine their contemporary use, to develop a probabilistic location model of adaptive mill reuse, and based on that model to identify abandoned mills that are good candidates for future adaptive reuse. An explicit spatial statistical modeling approach was adopted to achieve these primary research goals.

The Directory provides the basic sampling frame for the development of the historic mill inventory. Ultimately, 611 of the 761 mills (slightly over 80 percent) listed in that directory are successfully located and documented using an innovative sequence of historic Sanborn Fire Insurance Maps, Google Earth and Maps, city directories, municipal and county GIS sources, and telecommunications. Each of the mills is then profiled with a large series of primarily situational location factors (demographics and distances to important landscape features such as limited access highways and streams). This data base permitted the development of a very successful logistic regression model that correctly distinguished between abandoned and adaptively reused mills 87 percent of the time. The geographic profile of reused mills permitted identification of historic textile mills with substantial potential for redevelopment. Abandoned mills that are associated with relatively high probabilities for adaptive reuse were carefully evaluated within a virtual setting, and those with structural and site characteristics consistent with previously rehabilitated mills are included in a selective list of good reuse candidates. As a result, six abandoned mills were successfully identified as strong potential candidates for adaptive reuse.

Based upon the approach adopted here, abandoned historic textile mills showing strong potential have similar geographic profiles to those mills already redeveloped. For instance, rehabilitated mills are far more likely to be located within historic districts. This is an interesting finding in the sense that the existing literature, which is largely based on individual case studies, suggests that mills found within historic districts are less likely to be reused because of severe development restrictions and additional costs incurred. This study, based on a large inventory of varied mills, demonstrates that historic designation significantly improves the chances for adaptive reuse. This seems logical because the purpose of an historic district is to preserve the existing landscape and applying this designation is pointless if it actually contributes to the deterioration of the area. Moreover, the designation should create a positive external development environment in which individual investment decisions are less risky even if more costly.

The other situational characteristics that explain the probability of adaptive reuse include key demographics of the immediate abandoned mill block group and the larger area surrounding the mill site. Reused mills tend to be located in areas with relatively young, affluent, and well educated populations. This is not surprising because most adaptively reused mills are found within redeveloping urban areas. This particular segment of the population, especially young professionals, frequently prefers to reside close to employment and entertainment opportunities that are not typically found in the suburbs, so they are increasingly likely to live in denser urban centers. Residential offerings in rehabilitated mills are generally upscale apartments and condominiums, and affordability is a clear market sifting mechanism. Commercial activities found in these mills provide opportunities for social interaction and work in close proximity to housing, so these mixed land uses are quite attractive to young

professionals with larger incomes, tight time budgets, and fewer family responsibilities. As a consequence of these investors' dominant preferences, the likelihood of displacement of disadvantaged residents is an appropriate concern. As indicated earlier in this thesis, a close collaboration between public and private partners should occur during the planning process in order to avoid severe negative consequences for disadvantaged residents. Some of these adaptive reuses are of sufficient scale to attract additional investments, gentrification, and larger scale displacement. Again, these social concerns should be an important part of the planning process.

Uses of the Data and Model

The essential products of this research can be used for several different purposes. The first and most apparent use is for the identification of mills that might be good candidates for rehabilitation. This type of information then can be used to propagate the redevelopment of abandoned mills or mills that are about to become abandoned. Rehabilitation projects run the obvious risk of failure. By assessing the circumstances that produce positive outcomes prior to redevelopment, the potential for failure is significantly reduced. The geographic profiling of successfully reused mills and the identification of abandoned historic textile mills that share similar characteristics can substantially reduce the chances for failure. These positively profiled mills should be considered excellent investment opportunities for redevelopment, and ideally their adaptive reuse will become a reality.

As important, this research also resulted in a rich inventory of historic (pre 1944) textile mills in North Carolina. This inventory is a potentially valuable resource for understanding what happens to old industrial facilities and their communities, the dynamics of change. Until

recently, the textile industry was one of the economic backbones of North Carolina and many of its cities. The rapid departure of this industry has often proved detrimental to the general economic and social health of these abandoned communities. The identification of historic mill locations provides an inventory of places that can be more closely examined to better understand the consequences of the loss of industry and how communities might adapt to such circumstances and thus better inform public policy.

The mill database is also a valuable resource for potential identification of points of interest for commemoration and possible heritage tourism development. Other sectors have taken advantage of the desire of many people to witness (at least a version of) history, e.g., living plantations and coal mines. The inventory of historic textile mills and the subset of reused mills provide a multitude of opportunities for those interested in the state's history and its current cultural resources. These mills can be, and should be, promoted to attract visitors who are probably unaware of their existence. A simple example of this promotional potential is illustrated by the creation of a brochure promoting a few of the Triangle area's historic textile mill sites (see Figure 19). The key graphic from such a brochure provides a map and important information about textile mills in and around the Triangle and provides a heritage trail that interested parties can follow to view these historic properties firsthand. The mills included in the map provide a wide variety of locations, uses, and current states that help tell the story of an important part of North Carolina's past. For instance, rural mill villages and urban mill types are both included, and some are reused while others remain abandoned. In this particular case, visitors following the trail will see the vibrant community center that the Weaver Street Market in Carrboro has become as well as the remnants of the mill at Bynum, which is known as "the

funky mill village that time forgot.” As this part of the state’s industrial past continues to fade, places such as these can serve as reminders of the way things were.

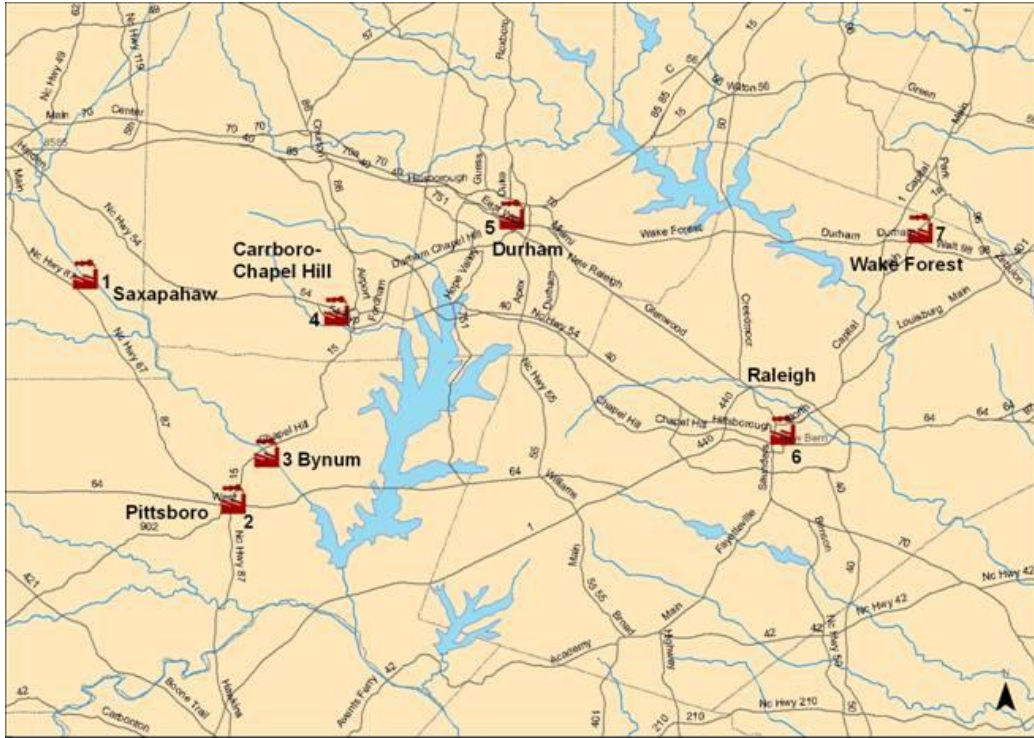


Figure 19. Hypothetical Triangle mill trail based on small portion of the inventory created.

Thesis Limitations

Although a relatively complete historic mill inventory was assembled, a good location model was estimated, and the model provided promising results for identifying candidates for adaptive reuse, there are several limitations to the study that should be noted here. First, two major limitations are associated with the mill inventory, and these weaknesses result primarily from the data collection process employed: incomplete inventory and inaccuracy in determining current mill status. Another research limitation is found in the focus of the explanatory framework and the concentration on situational characteristics to the relative exclusion of site

characteristics. Despite these limitations, selected mills identified as strong potential candidates are confidently proclaimed in this work.

As indicated above, most of the results' limitations can be attributed to the mill location and identification processes used. First, all of the textile mills included in the *North Carolina Directory of Manufacturing Firms 1944* are not included in the analytic database. *The Directory* provided a list of 761 mills and 611 (80 percent) were successfully identified for use in this thesis. The 150 mills excluded from the inventory resulted primarily from significant time constraints that operated on this thesis research project. In addition, data collection efficiency was inhibited by the lack of information for many counties and many more municipalities. Attempts were made to locate every North Carolina historic mill. However, some rural portions of the state were not included in the Sanborn Map collection and no city directory existed prior to 1940. Additionally, Sanborn Maps were irregularly updated which violated the spirit of a singular 1944 inventory. Murphy, North Carolina illustrates one of the worst cases of this type of temporal difficulty. Murphy's Sanborn Maps were created in 1914 and never updated after that. Furthermore, no city directory for Murphy could be located. Although attempts were made to find other information regarding the historic textile industry in Murphy, this research proved fruitless and a diminishing return quickly compelled abandonment of the task. While not very frequent, a few of these types of temporal difficulties do exist in the inventory.

Another limitation of the study is the occasional inaccurate identification and classification of textile mills within the inventory. While nearly all mill locations and current statuses were correctly identified, there is no claim to 100 percent accuracy. For example, mills were frequently located outside city limits and their exact locations were not always depicted

accurately on the Sanborn Maps. If these mills were included in Sanborn's business directory, then their locations sometimes were identified with a note on roads of the main map at the edge of town. Although a distance was given, often using the town's post office as a bearing, it typically was not exact and made identifying several mill facilities quite difficult. In these cases, approximate locations were used, and if a promising structure could be identified then it was assumed to be the textile mill being sought.

Reliance on remote identification through Google's tools and Bing Maps also proved to be an infrequent limitation while compiling the historic mill inventory. Reliance on these contemporary tools was unavoidable because visiting each site was infeasible. In most instances, either Google Maps' Street View or Bing Maps' Bird's Eye View provided relatively clear images of mills and their "current" states. However, in a few instances neither was available, so county GIS websites were then used and subsequent telephone calls were made to municipalities or nearby businesses to verify 1) that the structure was a textile mill at one time and 2) that it is either abandoned or still in use. Although these efforts frequently confirmed mill locations, the unavoidable subjectivity created a relatively small margin for error.

The inclusion of destroyed mills with abandoned mills in the database limits the study's potential findings, i.e., with a clear focus on the decision to reuse a mill once abandoned. This was most evident in the model's results, which identified four destroyed mills as false positives, or good candidates for adaptive reuse. It was still possible to identify other mills as good candidates for rehabilitation although the fact that four of best candidates no longer exist is disconcerting at two levels. First, the inclusion of these destroyed mill sites alters the outcome of the model and possibly conceals some mills (especially some used for manufacturing) that

have strong potential for reuse. Second and perhaps more importantly, these destroyed cultural resources, which have been shown to possess investment potential, are lost to opportunities that most communities sorely need, especially in the context of Smart Growth.

The explanatory framework that guided this research effort placed clear focus on situational location attributes to the relative exclusion of site characteristics. Thus, the type of data collected for the explanatory variables hindered the explanatory power of the final analyses and the location model developed. A more complete representation of a textile mill's reuse should engage its situation within the local social landscape and its site characteristics. The situational factors that influence mill reuse are thoroughly examined while mills' individual traits (e.g., facility size, lot size, and architectural style) were not adequately addressed. Much of the unexplained variability in the probability of reuse and the preponderance of false negatives must be associated with exclusion of key site attributes from the model. Admittedly, the lack of site characteristics is largely due to the feasibility of collecting the information and its availability. For instance, acquiring the square footage of the buildings for every site was not feasible within the confines of the current research design. Situational characteristics, such as census data, are more readily available, so there was a lopsided reliance on this type of factor. Having said that, situational characteristics (relative location features) would dominate the statistical model even if site characteristics were included, i.e., this is what is implied by the phrase location, location, location!

Future Research

This research can be regarded as an early step in the study of historic preservation and rehabilitation of textile mills as well as other industrial sites, e.g., tobacco warehouses, in North

Carolina and elsewhere. It follows the first steps taken by Ingalls and Moore (2001, 2010). As research continues, an increasing number of explanatory characteristics will be revealed, which will refine the accuracy of any location model of adaptive reuse. Furthermore, the loss of jobs in the textile industry occurred across the United States, so there are many more mills to be cataloged and examined outside of North Carolina. Finally, other industrial sectors have nearly vanished from the economy, leaving gaping holes in the economic landscape and aiding in the deterioration of some communities. These former industrial sites permit the implementation of research methods and analyses similar to those used here.

Future research will permit the refinement of the historic mill inventory and the inclusion of excluded (site) characteristics that may more accurately predict the likelihood of adaptive reuse. For instance, the location of a mill between two metropolitan areas was not considered in this analysis. However, such a location might play a major role in investment potential in general and whether a mill is rehabilitated in particular. For example, the Saxapahaw River Mill is located approximately mid-way between the Triangle and the Triad regions. It has emerged as a popular residential selection of two-earner households with one earner working in Chapel Hill and the other working in Greensboro. In order to reduce the burden of a long commute for either, they can reside in Saxapahaw. In this very regard, a large portion of historic textile mills fall within the state's Urban Crescent, which stretches along the Piedmont from Raleigh to Charlotte. It is not unrealistic to assume that other mills are located at mid-way points between large urban areas and with good investment potential as a result. This can enhance the estimated probability of adaptive mill reuse above the level predicted by the current model.

Despite the clear focus on North Carolina in this study, the research topic is by no means limited to this state. The textile industry played a prevalent role in the industrialization and urbanization across much of the Southeastern United States. While other states were not home to the same density of textile mills as found in North Carolina, textiles also were a major part of their economies. The abandonment of these mills brought adverse effects to communities in the southern piedmont, and now they provide opportunities for rehabilitation. Using similar data collection techniques and analyses, textile mills in other states can be inventoried and assessed in order to determine their potential for reuse as well. In fact a regional approach to such activity is preferred. Adaptive reuse is already occurring in places outside North Carolina, such as Valley, Alabama (Drye 2005). The Langdale Mill in Valley is the focal point of a revitalization project which will serve as “the downtown area the City has never had,” according to their municipal website (City of Valley 2010). Although research concerning the adaptive reuse of individual textile mills exists in the literature, statewide analyses are nonexistent and they will provide further opportunities for rehabilitating these cultural resources and revitalizing local economies.

Textile mills are not the only historic industrial buildings that can be successfully rehabilitated and reused. Like the textile industry, North Carolina’s tobacco industry suffered tremendous losses in the closing decades of the twentieth century. Durham, once a major manufacturer of tobacco, has redeveloped several tobacco factories with critically acclaimed success. The American Tobacco Historic District, once the home of Lucky Strike cigarettes, has received awards for mixed use development, best renovated commercial property, and best redevelopment project (American Tobacco District 2009). Many cities in eastern North Carolina were built to serve tobacco markets and tobacco played a vital role in their

development. The Export Leaf Tobacco building in Kinston, which formerly processed tobacco before it was sent to the factory, has successfully been redeveloped into loft apartments. Despite the potential for reuse, many of these special buildings currently lay abandoned. Like textile mills, these sites are historically significant and often represent valuable cultural resources within the community. Similar studies should be conducted to inventory and examine factors that permit redevelopment in other sectors. Greenville has a large tobacco warehouse district which remains almost entirely abandoned in the middle of the city, and its rehabilitation could serve the needs of neighboring East Carolina University and other businesses if creatively redeveloped.

The research reported here is devoted to an improved assessment and understanding of key cultural resources that could vanish before their potential is realized. Historic buildings, like old textile mills, carry an important landscape signification of the past, often possess relatively rare architectural features, frequently are located in areas that are ripe for redevelopment, and are too frequently destroyed before their value can be preserved. It is in the spirit of smarter growth and development that this inventory of North Carolina's historic mills is analyzed and it is hoped that the approach is transferable to other economic sectors and geographic regions.

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