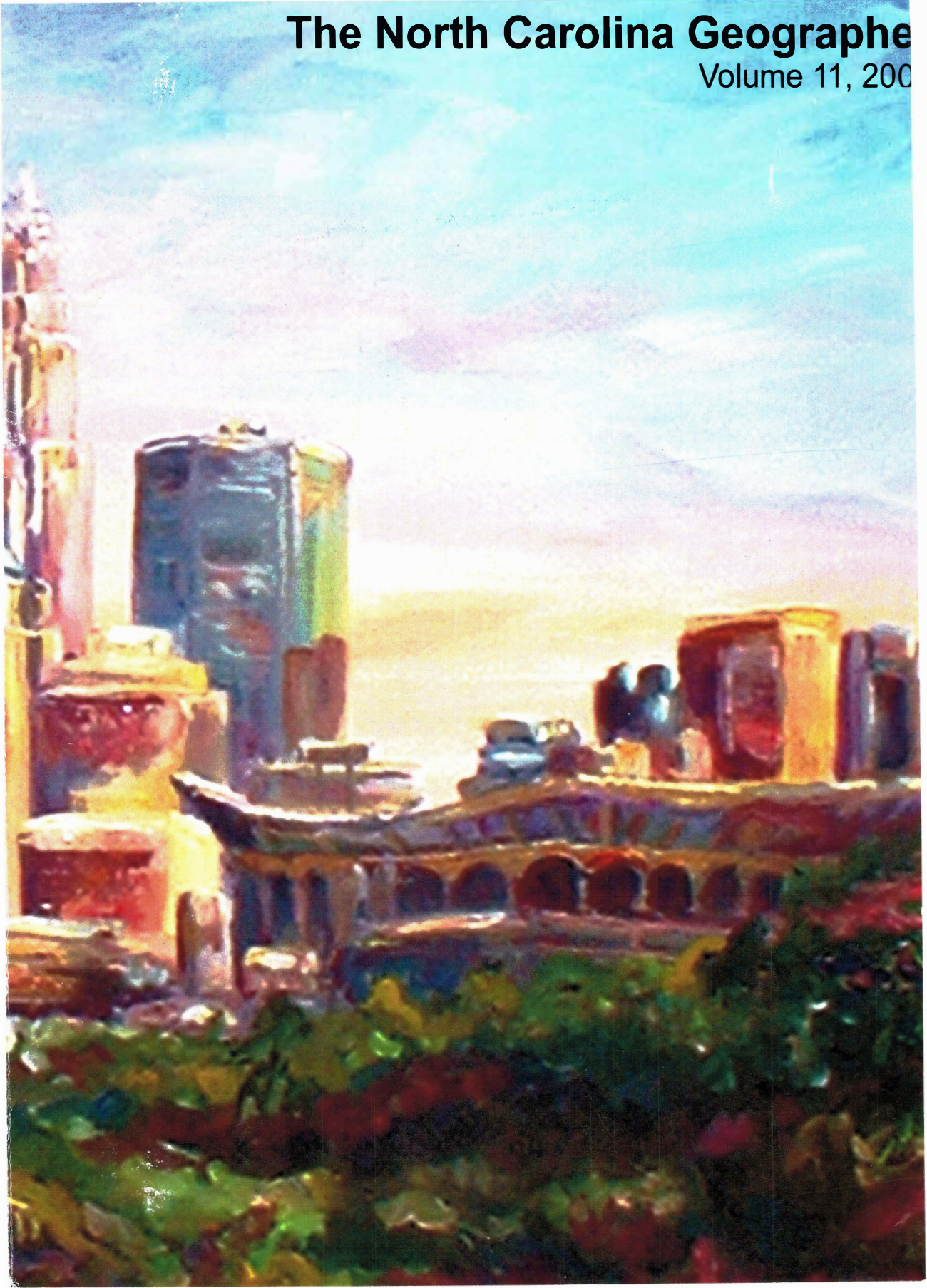
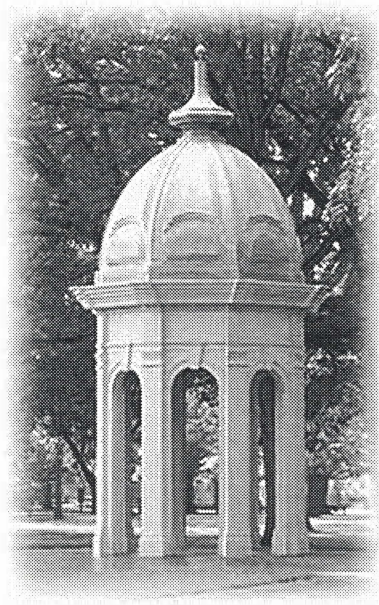


The North Carolina Geographer

Volume 11, 2000





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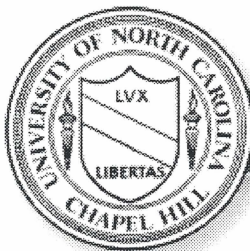
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About the Cover

To commemorate the 2003 meeting place for the North Carolina Geographical Society, this year's cover image is an oil painting titled "Charlotte Skyline" by North Carolina artist Jeff Pittman. Jeff Pittman is originally from Greenville, NC and now resides in Asheville. The editors thank Mr. Pittman for generously allowing us to reproduce his artwork for the cover. Additional information about Mr. Pittman and examples of his other works can be found at www.jeffpittmanart.com/index.html.



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The Return of Beavers to Southern Piedmont Streams: Stream Restoration or Disruption?

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The return of beaver to streams in Guilford County, North Carolina has encountered widely different responses in rural and urban landscape contexts. We found that beaver were viewed as positive agents of stream restoration in a project intended to rank potential riparian conservation easements in rural Guilford County. The response to beaver in two urban neighborhoods was to demand their eradication as a public nuisance. A primary goal of stream restoration in environmental planning is the recreation of natural conditions in streams altered by human action. Successful implementation of that goal will require clear definitions of what constitutes natural form and function, and human accommodations to the changes reintroduced species may bring to local environments.

Introduction

After being gone for over a century, beaver (*Castor canadensis*) have returned to the North Carolina Piedmont, a landscape significantly altered by human actions during their absence. Opportunistic by nature, the beaver are reoccupying both rural and urban riparian settings, transforming and restoring stream valleys to conditions more like those prior to European contact. The transformation is meeting with a mixed reaction from people living in the affected areas. While some welcome the beaver's work as a low-cost means of restoring natural functions and spatial forms to degraded riparian landscapes, others see the animals as a disruptive nuisance and are calling for their eradication. The purpose of this paper is to examine those conflicting responses in the rural and urban contexts of Guilford County, North Carolina, and discuss their implications for environmental restoration efforts in human altered landscapes.

Beaver were common throughout North Carolina before European contact, but their numbers declined rapidly throughout the 18th century because of heavy trapping for the fur trade with Europe. Trapping was followed by extensive land conversion, wetland drainage, and stream alteration to accommodate agricultural and urban

land uses, until the animal was extirpated from the state sometime around the end of the 19th century. In 1939, the North Carolina Department of Conservation re-introduced 29 beaver from Pennsylvania into the North Carolina Coastal Plain (Woodward and Hazel 1991). The animals quickly took hold in their old niche and since then have spread westward across the state, following the rivers and stream corridors upstream to the Piedmont.

Geomorphic and Ecologic Influences

Beaver obviously alter the geomorphic and ecologic character of landscapes. Butler (1995) asserted that humans are the only animals that have done more to alter the landscape characteristics and functions of North American streams, and Shepard (1986) referred to the beaver as the original Soil Conservation Service because of the sediment detainment functions of their dams and ponds. Large woody debris dams, mud-and-stick lodges, bank burrows, excavated canals, and food caches are some of the more common structures placed in, across, or along stream channels by the work of active beaver. Such activity alters the hydrology of affected streams and produces a variety of geomorphic changes, particularly in upland Piedmont streams impacted by erosional incision

accelerated by agricultural and construction practices of the past and present. Other effects of beaver impoundments include modification of bank erosion and mass wasting processes, and altered temporal and spatial stormwater runoff and flooding patterns. Reduced rates of stormwater runoff may also raise local groundwater tables, and expand the transitional wetland zone between the open water channel and adjacent uplands (Gurnell 1998; Butler and Malanson 1994; Naiman and colleagues 1988).

Not all beaver construct large dams or lodges. On smaller streams they may construct shelters by simply burrowing into stream banks. Meetemeyer and his colleagues (1998) reported on the erosional effects of stream bank burrowing and tunneling in a North Carolina Piedmont stream where beaver dams were generally lacking, finding that such activities actually contributed to bank mass wasting and erosion.

In their ecological role, palustrine wetlands formed by the work of beaver may modify the species abundance and diversity of riparian vegetation, setting in motion successional vegetation dynamics as ponds fill with sediment or dams are abandoned (Malanson 1993). Old and abandoned beaver ponds fill to become wet "beaver meadows" in some instances. Similar to other wetland environments, beaver created wetlands function as biogeochemical filters and sinks, which can be important in the environmental management of pollutant loads. They also provide habitat for a variety of wetland plants and animals, including other aquatic mammals, amphibians, fish, and a host of benthic invertebrates.

A common result of urban development or agricultural drainage schemes is the transformation of perennial flow regimes to "flashy" ephemeral flow that can decimate aquatic ecology. Beaver activity can return a measure of stability to stream flow, allowing high order predators such as fish and amphibians to move upstream and feed on insect larvae or other food. During droughts the deep water provided in beaver ponds can also serve as a refuge for fish and amphibians. Contrary to popular belief, such relationships between beaver

and aquatic life may actually serve to reduce mosquito populations (Shepard 1986; Johnston 1994).

The stream altering work of beaver sometimes presents natural hazards to human land use. Dams may function to hold back minor floods for decades or even centuries before finally being silted in. In other cases Southern beaver dams have been known to burst during major storm events, sending flash floods downstream (Butler 1989). Beaver activity in the South has had negative impacts on highway and railroad drainage structures as well (Butler 1991; Federal Interagency Working Group 1998).

What most often puts beaver at odds with people, particularly in urban settings or intensively managed forests, is their ability to take down trees. In wildland landscapes where preservation of natural functions is a stated policy goal, use of trees and shrubs by beaver may be viewed as an element of the natural landscape dynamics of an area, but in urban settings where "urban forestry" has reached the city planning agenda, trees are being promoted as valuable assets. Anything that results in reducing the inventory of trees may be viewed as a negative event requiring interdiction by city officials.

A single adult beaver can chew through a tree 6 inches in diameter in about 15 minutes, and larger trees pose only minor challenges to a determined beaver (Butler 1995). Sharply chiseled stumps adjacent to fallen or missing trees are often noticed before the animals themselves are actually seen in a new area. Beaver prefer to gather food and building material near the water, and favor some tree species over others, but they generally do not discriminate between horticultural trees in a residential yard or native trees in a natural setting. It is particularly in instances where horticultural trees are taken down that the animals quickly run afoul of homeowners and urban foresters (Gray 1990).

Beaver as Agents of Rural Landscape Change

We first encountered North Carolina beavers as agents of landscape change through a riparian land acquisition project. A consortium of non-profit groups interested in restoring streams within

the Upper Cape Fear River basin enlisted our help in assessing the condition of a stream flowing through rural areas of northern Guilford County. Their goal was to identify potential sites for acquisition by the North Carolina Clean Water Trust Fund. The Clean Water Trust Fund was set up to protect and restore riparian areas and wetlands along the state's major rivers as part of efforts to improve water quality. The consortium selected Mears Fork of the Haw River, a 3rd order stream near the headwaters of the Cape Fear River, with a drainage area of approximately 18 square miles. They chose Mears Fork because the Guilford County Natural Heritage Inventory listed it as the highest quality stream in the county (Bates 2001). That ranking was based on the critical habitat provided by the mature hardwood forests and wetlands found along the stream. Neotropical migrant birds, river otter, beaver, wild turkey, and deer are just some of the wildlife utilizing the riparian habitat. The diverse and rare riparian plant assemblages in the area are also notable, including the purple fringeless orchid (*Platanthera peramoena*), a species considered significantly rare and peripheral by the North Carolina Natural Heritage Program and discovered along Mears Fork during fieldwork for the inventory (Amoroso 2002, Bates 2001).

Our task was to assemble a spatial database of the Mears Fork drainage basin that could be used to analyze and prioritize land parcels for potential acquisition of conservation easements or fee simple title by the state. We utilized digital orthophotography and hydrologic data sets, in addition to color infra-red (CIR) aerial photography, zoning maps, and property tax maps obtained from Guilford County to create a digital spatial database of land use, land cover, and property divisions. A variety of habitat quality indices are available for stream classification, but we limited our project to illustrating how the database could be queried to identify potential parcels based on criteria specified by the Clean Water Management Trust Fund (Tricot 2001). McQuaid and Norfleet (1999) provide a review and assessment of other stream

habitat quality indices that have been applied in North Carolina.

Two criteria we examined were related to the activity of beaver: 1) the proportion of an ownership parcel within a forested riparian buffer, and 2) the presence of open bodies of water in a parcel. The forested riparian buffer was defined as the proportion of the land extending 300 feet from the centerline of the stream. It was estimated using aerial photographs. The buffer was found to be consistently wider wherever beaver were active.

Open bodies of water were shown without regards to origin in the spatial hydrology data set we obtained from the county, but field observations indicated we were dealing with two very different forms of detained water. The first was sediment detention ponds located on the upper tributaries of the Mears Fork drainage network. Many of the ponds were constructed several decades ago as cooperative erosion control efforts between agricultural landowners and the federal Natural Resource Conservation Service (then known as the Soil Conservation Service). The ponds were typically accessible to livestock, vegetative buffers were minimal, and signs of life in the water were scarce. Trampling and bank erosion, as well as pollutant loading by livestock were evident. Ponds managed specifically for private recreational fishing were an exception.

The work of beaver was the principle origin of open water bodies and wetlands within the narrow floodplain of Mears Fork. Outside of reaches with beaver, much of Mears Fork resembles other Piedmont streams in that the channel is deeply incised with undercut banks subject to mass wasting. There is a narrow transition from channel to upland vegetation and the floodway is poorly developed. Stream reaches where beaver are present are distinctly different. They include a wider and wetter transition from channel to upland, with standing dead tree snags being used by cavity nesting birds, or as roosts for wading water birds. Emergent wetland vegetation, woody shrubs, and bottomland hardwood trees are found on the wider sediment-rich floodway. Fish and other vertebrates,

as well as macro-invertebrates, are readily observed in the shallows and muds of the impounded water.

Local naturalists commonly observe beaver and other wildlife along the wider sections of the floodway during evening hours (Bates 2001). Indirect signs of active beaver are further indicated by felled trees and sharp woody stakes, dam sites and food caches, bank dens, canals cut through wet meadows, and trampled runs through the marshy areas. Wet meadows formed by the siltation of former beaver ponds were of particular interest in our assessment. Such wetlands are uncommon on the Piedmont and are habitat for many of the rare or endangered plant species of Guilford County, including the purple fringeless orchid. Because of their role in restoring the habitat of the orchid and in adding to the limited stock of wetland environments on the Piedmont, we recommended that areas with active beaver be considered for higher ranking than those with sediment detention ponds constructed by landowners. Our recommendations were favorably received by the consortium and contributed to acquisition of three conservation easements totaling 51 acres of riparian land.

In summary, our work in rural Guilford County showed that beaver can be viewed as agents of stream restoration. Their work contributed to increased landscape diversity and species richness along Mears Fork, and met the criteria for funding by the Clean Water Management Trust Fund.

Beaver as a Public Nuisance

Observations and interviews with urban residents and city foresters in Pincroft Lakes and Hamilton Lakes, two urban Greensboro neighborhoods, reveal a different reaction to stream environments modified by beaver. Both neighborhoods are outside the Mears Fork drainage and were not part of that study. However, similar to the case of Mears Fork, beaver moved into each area by natural dispersal and modified the pre-existing stream conditions. Here we review the neighborhood reactions to those modifications.

Pincroft Lakes began as a private hunting and fishing club set up outside of the city's limits in the 1920s. The neighborhood takes its name from three dams constructed across a stream running through the property in the 1930s. Sedimentation associated with urban construction and assimilation of the neighborhood into the city of Greensboro has altered the three lakes. The one furthest downstream remains an open lake, siltation of the middle lake has created a shallow wetland, and the upper most lake is silted in completely and grown up in bottomland hardwoods.

The area was annexed into the city following sale of the land to a developer in 1953. A residential neighborhood was built and the hunting lodge and outlying cabins were converted into year-round residences. Most of the older homes were constructed on large lots far back from the water's edge, but more recent construction on subdivided lots has reached into the wet margins of the middle lake.

In the early 1990s the City of Greensboro and the T. Gilbert Pearson Chapter of the Audubon Society cooperated with the neighborhood in the establishment of an educational boardwalk with interpretive signs describing the wetland functions and character of the middle lake, as well as the dynamic history of siltation in the area. Audubon hoped to highlight the wildlife habitat values of urban wetlands, including the role of an active beaver colony that had been using the area for some time. In addition, the City of Greensboro Stormwater Services Division wanted to increase public acceptance of created wetlands as an effective management practice for reducing stormwater sediment and pollutant loadings into the city's streams.

Trouble started when new homeowners on the lots reaching back into the wetland discovered that beaver were in the area. The newcomers called the city expressing alarm and complaining that their trees were at risk. Some property owners responded by placing wire fencing around their most valued trees to discourage the beaver, just as

homeowners on older properties had been doing for years with good results. Others demanded the city get rid of the beavers, citing a fear of more mosquitoes and the potential for flooded streets if the beaver were allowed to remain in the area.

The Stormwater Management Division of the Greensboro Environmental Services Department conducted a survey of neighborhood residents and found them about evenly split between those who were accustomed to the presence of beaver and willing to work towards an accommodation of the animals, and those who wanted the city to do something more decisive about the perceived beaver problem. Finally, under pressure from the most vocal neighbors, the city hired a trapper to capture and kill the beavers. He then blew out their dams to lower the water in the wetland to a level acceptable to homeowners with backyards reaching to the water's edge (Phlegar 2001).

Recent field observations at the site show signs of renewed beaver activity in the form of fresh mud and stick placement in dams blown out by the trapper. The last several years have been a period of marked dryness and low stream flows in Greensboro, however, so water levels at Pinecroft Lakes have remained low. The returning beaver are also being more discrete about taking down trees and the city has not received any recent complaints. What will happen when normal rainfall runoff patterns return, or if a nocturnal beaver is discovered gnawing on a backyard tree late one night, remains to be seen.

A similar story is playing out across town at Hamilton Lakes. That neighborhood was formed when a dam was constructed in 1920 across a wooded stream corridor. The resulting lake became the focal point of a private, upscale neighborhood noted for its leafy character and lots with views of the lake. Beaver recently moved into the area after an extensive area of wooded rural land upstream from Hamilton Lake was cleared for development. The newly arrived beaver felled several trees along the stream, including a prized cherry tree in a homeowner's yard. They also placed a low dam above the

stream's inlet to Hamilton Lake and backed up a shallow pool.

Meetings of the local neighborhood association were called to discuss the "beaver problem." As in the case of Pinecroft Lakes, battle lines were drawn between opponents and proponents of the beaver. The governing board of the neighborhood association hired a man who described himself as an animal control consultant who had given up trapping beaver for their pelts because of the low price, finding a better income could be made trapping nuisance animals. During one heated meeting of the neighborhood association he declared, "if the beaver population is left alone, they'll cut down all the trees, I'll promise you that." He added that beaver would expose residents to rabies and to an intestinal parasite that causes extreme diarrhea in humans, claiming that merely touching the water a beaver inhabits can spread the disease (Perkins 2001a)¹.

As debate continued, a sort of guerilla war was staged in the woods around Hamilton Lake by defenders of the beaver who viewed killing the animals as inhumane. At one point a dead beaver was found hung from a tree with a sign around its neck (reports of what was written on the sign conflicted and could not be verified). Defenders of the beaver responded by vandalizing traps set to capture the animals. Finally, after months of claims and counter-claims, the owner of a private wildlife preserve in rural Rockingham County offered to accept the beaver if they were live trapped and brought to his property for release. This solution seemed to appease all parties to the issue and the beaver were trapped and moved (Perkins 2001b).

Field reconnaissance in the area soon after the beaver were removed showed that they had in fact felled some wild tulip poplars and a good number of smaller alders, willows, and mulberries. Their overall affect on the wooded character of the neighborhood was minimal, however, and none of the felled trees or shrubs could be seen from the streets of the neighborhood. The tree canopy remained mostly closed along the stream corridor. The greatest damage to canopy trees resulted from

wind and ice storms, rather than beaver activity. Stumps and woody spikes left by the beaver were vigorously sprouting new stems, creating a denser understory and more potential food for the absent beavers in the form of abundant tender bark.

Within a few months of the removal of the beaver, I returned to the site and found fresh tracks in the mud, confirming that either all the beaver had not been trapped or a new group of beaver had noticed the vacant habitat and food supply and were moving in to take the place of the former occupants. As in the case of Pineroft Lakes, trapping and removal of the animals proved to be a temporary measure that satisfied local residents in the short term, but did not eradicate the animals in the long term.

Discussion

Environmental restoration has been defined as the holistic reestablishment of natural landscape functions made nonviable by human disruption (National Research Council 1992). Restoration ecologists recognize that no restoration is likely to be perfect, and all will be exercises in approximation. The principal goal is to recreate naturalistic functions as well as spatial forms. Specifically, the National Research Council Committee on Restoration of Aquatic Ecosystems stated (1992, pgs 17-18):

Merely recreating a form without the functions, or the functions in an artificial configuration bearing little resemblance to a natural form, does not constitute restoration. The objective is to emulate a natural, self-regulating system that is integrated ecologically with the landscape in which it occurs. Often, restoration requires one of more of the following processes: reconstruction of antecedent physical conditions, chemical adjustment of the soil and water; and biological manipulation, including the reintroduction of native flora and fauna, or of those made nonviable by ecological disturbances.

Our observations in rural Guilford County and urban Greensboro suggest that a fundamental obstacle to the ideal described by the committee may be variations in public perception of what constitutes natural form and function from one landscape context to another. No reference streams remain to serve as models for what North Carolina's Piedmont streams looked like during the period when beaver were a common component of the landscape and Native Americans were the only human residents of the region. Instead, several generations of people have never known a stream that was not heavily impacted by agricultural and urban development practices. What is experienced over the long term may subsequently be considered natural when no other point of reference exists. And when animals that are part of the dynamic functions and forms that were once truly natural begin to reassert themselves they are labeled as disruptive and a "nuisance" under the pretext of protecting a degraded natural landscape.

We found less public resistance to the reestablishment of beaver in rural Guilford County, though the question remains open for further study. Shepard (1986) reported that farmers in Virginia were experiencing conflicts with beavers because of loss of land for grazing and crop depredations. Along the Mears Fork, the activity of beaver is generally limited to a narrow riparian corridor whose restoration rural residents appear willing to accept, given that the dynamics of beaver activity do not directly infringe on agricultural production. Urban residents live in closer spatial contact with the landscape changes brought about by the work of beaver, particularly when homes are situated in or near streams and wetlands, and that may contribute to the greater opposition to beaver we experienced in Greensboro.

Rural and urban landowners may also differ in fundamental attitudes of mind and human perceptions of natural landscapes. In the anecdotal cases reviewed here, urban property owners appear to consider natural form to imply trees undisturbed or unmodified by the actions

of animals. Urban forestry in its most spatially static silvicultural form is the goal. Streams that have been straightened, dredged, and cleared of woody debris are considered restored to their natural function simply by allowing vegetation to grow up along the banks. Benign wildlife, such as songbirds, are acceptable and even desirable, so long as their natural history does not interfere with the perceived naturalness of the trees. But when an animal such as the beaver introduces change to the stream form, and dynamics to the vegetative composition and structure, the action is considered destructive and unacceptable. People who view themselves as protecting the trees see removal of the animals as the only viable solution. Where there was urban opposition to removal of the beaver it was grounded more in a moralistic objection to killing animals than a desire to include beaver in a policy of restoring natural functions. Removal by live trapping was an acceptable compromise for such people.

A political dimension may increasingly affect the issue as cities continue to refine the set of best management practices implemented in stormwater management plans mandated by the National Pollution Discharge Elimination System (NPDES). NPDES is a series of federal mandates requiring cities to reduce pollutant loading of streams by runoff from dispersed sources. Phase I of NPDES was first implemented in the 1990s in larger cities, and is now entering Phase II, which will include smaller towns and municipalities. Constructing stormwater detention ponds has been among the most common best management practice required of new property developments in many plans, and urban ponds now dot the Piedmont landscape in much the same way sediment detention ponds were constructed to control rural agricultural runoff in a previous generation. The ponds can be expensive to install and carry ongoing maintenance costs, leading stormwater planners to search for alternate practices, including those which incorporate natural processes and functions (Broughton and Apfelbaum 1999; Lewis and colleagues 1994).

One approach has been to encourage developers to set aside riparian corridors in

development plans and receive credit for stormwater mitigation without the need for building detention ponds. That approach most often involves considering topography and natural drainage in the clustering of building lots. A common example is the case of naturally vegetated buffers along stream corridors being set aside as common property of planned unit developments. Another variation includes preservation or construction of wetland basins rather than open water ponds.

Either scenario creates a setting that invites the work of beaver in their roles of natural stormwater detention engineers, soil conservationists, and restoration ecologists. The major difference is that the fees charged by the beaver are much less than their human counterparts. If water levels rise too high, or interfere with roads or local infrastructure, human engineering can be selectively utilized to alter the situation. For example, perforated pipes inserted through a beaver dam well below water level have been used to lower water levels without eliminating the pond or the beaver (Federal Interagency Stream Working Group 1998; Shepard 1986). Desirable trees can likewise be protected with various armoring devices, or by manipulating plantings to provide more favorable food species to decoy the beaver away from trees designated for protection.

Conclusions

Beaver are dispersing throughout both rural and urban landscapes of the North Carolina Piedmont, returning streams to conditions more like those before European contact. Natural predation is light and human trapping for furs or food lacks economic incentive, so as suitable habitat becomes available it appears likely that the beaver will continue to expand their range. Adaptable and opportunistic by nature, beaver often return to areas to rebuild when previous animals are removed or killed.

The question of when and whether beaver activity is a public nuisance or beneficial ecological restoration has much to do with attitudes of mind and the social goals of environmental restoration. The abundant geomorphic and ecologic literature on the natural functions of beaver activity seem to have been generally overlooked in the formulation

of public policy. Stormwater management planning may provide an avenue for changes in the public perception of beaver activity, but for now urban homeowners in Greensboro have generally shown themselves to view beavers as nuisance animals requiring removal rather than accommodation. Rural landowners in Guilford County appear to be less strident in opposition to the impact of beaver on streams, but their specific attitudes and perceptions remain open to further study.

End Notes

¹According to the U.S. Center for Disease Control *Giardia* is found worldwide and infects both domestic and wild animals, including dogs, cats, deer, and beaver. *Giardiasis*, the illness caused by *Giardia*, occurs when cysts of the parasite are ingested through person-to-person transmission or ingestion of fecally contaminated food or water. Waterborne outbreaks are caused by drinking water contaminated by *Giardia* cysts. North Carolina law does not require reporting of cases of *Giardiasis* to the CDC so the prevalence of the illness could not be determined. Hamilton Lake is closed to all recreational use and does not serve as a drinking water supply. (<http://www.ede.gov/epo/mmwr/preview/mmwrhtml/ss4907a1>).

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Does Size Make a Difference? Variations in the Preparation and Literacy of High School Earth Sciences Teachers

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This study expands geographical education into the area of teacher preparation and literacy in high school earth science instruction. Considerable research has focused on the impact of school size on instruction and learning; however, little work has been done in comparing school size with the degree to which high school science teachers are prepared to teach specific subjects like earth science. Indices of teacher preparation and literacy were examined across school size categories and geographic regions in North Carolina. Preliminary findings in this research indicate that a relatively large percentage of earth science teachers in small schools have never taken a course in this subject area. Survey results also show that teachers from smaller schools are not as knowledgeable about basic concepts in earth science as teachers from larger schools. It was found that the teachers surveyed were especially deficient in their knowledge of geographic concepts.

The importance of public education in general is a national concern as evidenced by the "no child left behind" policy of President George W. Bush's Administration. An important component of geographic education is the study of earth science. This paper attempts to address the issue of school size in relation to teacher preparation and literacy in earth science instruction. Recent studies on enhancing quality teaching in the classroom have focused on such pedagogical strategies as group learning, critical thinking, and the use of technology (Bain, 1998; Andrews, 2000; Robertson, 2000). While these approaches to better instruction are important to consider, a more fundamental issue is the preparation and literacy of teachers in subject areas like earth science. This paper addresses teacher preparation from the standpoint of the degree to which teachers in North Carolina high schools have prepared themselves to accomplish effective earth science instruction, by considering the number of courses they have completed in this subject area at the undergraduate and/or graduate level. Teacher literacy in earth science is measured by their knowledge of important concepts in the field. Both teacher preparation and literacy are viewed in terms of their

variation across school size categories and among geographic regions.

Much research has been done on the problems and challenges that public school teachers face, and their ability to provide effective instruction. These challenges are especially acute in impersonal environments that many large schools can create, because of the difficulty of working within burgeoning bureaucracies of large school district administrations. These difficulties are further exacerbated when science teachers are given the responsibility of teaching earth science when they have had little or no formal training in the subject. Historically, earth science has not been given the same emphasis as other sciences such as chemistry, physics and biology in high schools and in undergraduate curricula. In fact, only recently (academic year 1999-2000) has earth science become a required course in North Carolina high schools. The lack of adequate course work preparation by science teachers to teach earth science has limited their effectiveness to teach this subject.

Despite considerable research on the effect of school size on instruction and on learning, little work has been done in comparing school size with the degree to which high school science teachers are

prepared to teach specific subjects like earth science. In contrast to instructional issues, most research on this topic has addressed the difficulties in the administration of schools with extremely large student enrollments (Oxley, 1994; Portner, 1996; Howley, 1997). Larger school size is generally associated with greater challenges because of increased student diversity in ethnicity, social class, and ideologies. Larger school size has also been associated with high dropout rates (Alspaugh, 1998). Large school districts have been associated with population growth and migration patterns in the last half of the twentieth century. As people migrate to larger populated areas, new kinds of school organizations emerge that lead to "depersonalization" in larger schools (Lewis, 1999).

While it may be argued that larger schools attract more qualified teachers, the quality of instruction may be compromised because of more class time spent dealing with discipline issues rather than focusing on instruction. While discipline concerns are not exclusive to large schools, they may be disadvantaged because of more diverse student populations and impersonal environments. Many teachers are not properly trained to deal effectively with issues of interpersonal relationships and social interaction (Blair, 2000).

On the positive side, some studies document that larger schools, characteristic of larger school districts, may be more effective in student learning despite higher dropout rates. Weast (1997), for example, studied the merger of three school districts in Guilford County, North Carolina, and found that student reading, writing and math skills had improved over a three year period while the dropout rate fell to the lowest level among large districts in the state. Also, despite the challenges that larger schools face, there is some evidence that they experience higher academic achievement than small schools regarding SAT scores and on the percentage of students who take the test (Gardner et al., 2000).

In contrast to larger schools, smaller schools are said to offer more effective learning due to more positive interpersonal relationships and fewer discipline problems (Raywid, 1998; Ark and Wagner, 2000; Blair, 2000). Parents apparently agree that

smaller schools are generally better for their children's education, but indicate that the very best teachers are probably not attracted to these smaller schools (Bainbridge and Sundre, 1990). Nonetheless, small schools are likely to be more manageable, and may provide a more conducive environment for instruction. One study suggests that smaller schools have better student attendance and create a greater sense of community among teachers and students (American Teacher, 1995).

The regional variation in teacher preparation and literacy may reflect fewer resources going to smaller school districts and lower teacher salaries. Lower teacher pay, as a consequence of fewer resources in smaller school districts, tends to discourage more qualified teachers in seeking employment within rural school systems. A greater sense of belonging and caring for the welfare of students, apparently characteristic of smaller schools, has been linked to minority and less advantaged students receiving more effective instruction in these environments (Stiefel, et al., 2000). These inherent qualities in smaller schools have been linked to fewer layers of bureaucracy (Black, 1996; Lee, et al., 2000). Other studies contend that regardless of their size, schools should be more attuned to the concerns of the surrounding community. For example, the concern of parents regarding student learning has been linked to the preparation that teachers receive in providing effective instruction to their children (Gursky, 2001).

One model that suggests decreasing school size lead to more efficiency in instruction comes from British private schools. The model considers schools as "houses" and suggests that smaller houses lead to such desirable results as more effective management of extracurricular and co-curricular activities, student group activities, physical resources, administrative support, and teacher involvement (Oxley, 1994). Thus, the result of smaller school size is believed to enhance the learning potential of students (Cushman, 2000). One school administrator contends that the greatest advantage of small schools is that there are fewer layers of bureaucracy to interfere with rescuing at-risk children (Black, 1996). A review of these issues is

necessary in order for improvements to be made in classroom instruction. In North Carolina, this is especially significant given the introduction of earth science as a requirement for graduation from high school.

Methods

North Carolina was selected for this study because of a concern among public school administrators for quality teaching in earth science, which was made a requirement for high school graduation starting in the 1999-2000 academic year. This policy change in the state's public schools reflects the growing importance of earth science in school curricula. In this study, high school earth science teacher preparation and literacy are examined across school size categories and geographic regions.

The research was developed in two stages. The first stage involved the acquisition of teacher preparation and literacy data, establishment of school size categories, and division of the state into geographic regions. A package with two questionnaires was mailed to the science chairs of 310 high schools representing 117 school districts in North Carolina. One questionnaire was included for the science chair to complete, requesting information about student enrollment (to indicate school size), the number of science teachers at the school, and the number of years earth science has been offered. The second questionnaire was for all science teachers (including the science chair). This questionnaire included items concerning the preparation and literacy of science teachers as it related to their earth science teaching experience during the 1999-2000 academic year. Only questionnaires returned by science teachers who had taught earth science during this period were used in this study. A total of 75 questionnaires were returned representing 24.2 percent of the high schools originally contacted. Science teachers who taught earth science during the 1999-2000 academic year returned a total of 63 questionnaires. The data were divided into school size categories and geographic regions.

School size categories were divided into small (up to 1000 students); medium (1001 to 2000 students); and large (more than 2000 students). In order to make regional comparisons the state was divided into geographic regions based on the telephone area code map of North Carolina, and are as follows: Northeast (NE), Southeast (SE), East North Central (ENC), West North Central (WNC), Southwest (SW), and West (W).

Both the NE and SE regions are primarily rural and physiographically are part of the state's coastal plain. The W region is also rural but is largely a mountainous area. These three regions contain some of the state's smallest school districts. The three other regions (ENC, WNC and SW) lie in the piedmont and contain both the state's largest urban areas and some of the largest school districts. The SW region includes the state's largest city (Charlotte) in Mecklenburg County and also represents the state's largest public school system. The ENC region contains the second largest school system in Wake County, which has the state capital of Raleigh, which is the second largest city in the state. This region also has the Durham County and City School systems, which together form one of the larger systems in the state. The WNC region has the third and fourth largest school systems in the state in Guilford County (Greensboro) and Forsyth County (Winston-Salem).

The second stage of this research dealt with developing a set of indices for teacher preparation and literacy. To develop indices of teacher preparation, the question was asked: how many undergraduate and/or graduate courses have you taken in earth science or a related area? Tabular, graphic, and map presentations are used to show the percentage of teachers having taken earth science or a related course for school size classes and within designated regions.

To address literacy, a scale was developed to ascertain the teacher's degree of knowledge of some major concepts in earth science. Teacher literacy was addressed using the following scale of familiarity:

- *I have never heard of the concept.*
- *I have heard of the concept but do not know its definition or meaning.*
- *I am slightly familiar with the concept.*
- *I am familiar with the concept.*
- *I am very knowledgeable of the concept.*

This scale was used in the teachers' responses to their familiarity of the following earth science concepts under associated subject areas: 1) Atmospheric Science (Coriolis Effect, Greenhouse Effect, and Hydrologic Cycle); 2) Geology (Plate Tectonics, Groundwater, and Rock Cycle); 3) Geography (GIS and Spatial Analysis); and 4) Environmental Studies (Food Chain and Photosynthesis). GIS is an abbreviation for Geographic Information System, which is defined as a computer-based set of procedures for assembling, storing, manipulating, analyzing, and displaying geographically referenced information (Getis, et al., 2002). With the exception of GIS and spatial analysis in Geography, the selected subject areas are found in the basic categorization of most contemporary earth science textbooks (see Murphy and Nance, 1999). GIS and spatial analysis are considered because they form the foundation by which earth science concepts are examined spatially using current technology (Eastmond, 2000).

To determine literacy in earth science, teachers were asked to assign a number from 1 to 5, corresponding to their degree of familiarity described above, for each of the ten concepts. The number represents an assigned familiarity weight with respect to a given concept. As with any survey, the authors are assuming that the teachers are being truthful and accurate in their responses. To arrive at specific teacher literacy indices, two procedures were carried out. First, the weights each teacher recorded for the ten selected concepts were summed and divided by the total number of concepts, to arrive at an average

weight for each teacher within school size categories. Subsequently, a table was constructed to show the number of teachers within each familiarity category based on their average weights.

Second, for each teacher, their degree of familiarity for each concept within a given subject area was summed and divided by the number of concepts within that subject area. These individual averages were then summed and divided by the total number of teachers to arrive at an average familiarity for each subject area.

Findings

Teacher Preparation and School Size

Figure 1 shows the variation of teacher preparation as measured by the percentage of teachers surveyed having completed earth science or related courses at the undergraduate and/or graduate level. The most evident aspect of these data is the relatively large percentage of teachers from the small school size category that have never taken a course in earth science and who, consequently, lack the course experience to provide the most effective instruction in this subject. On the other hand, a relatively large percentage of teachers from the large school size category (four of five teachers or 80 percent) have completed five or more courses in this area. While these findings are far from conclusive based on the small number

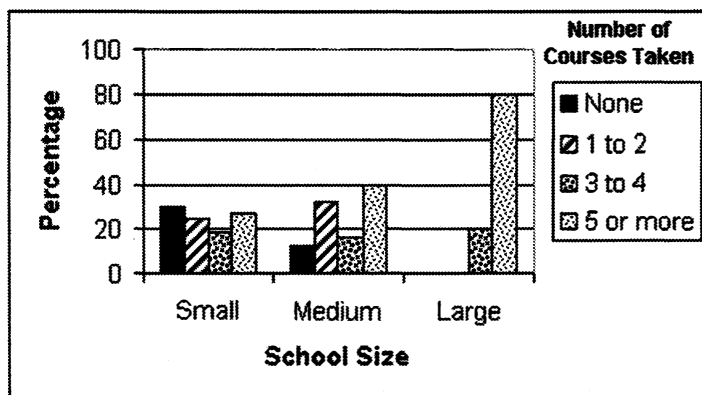


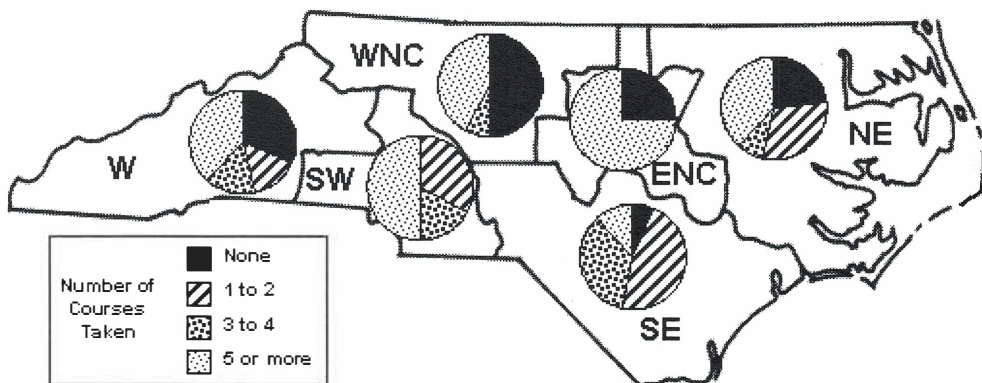
Figure 1. Variation of teacher preparation in each school size category as measured by the percentage of teachers having completed undergraduate and/or graduate courses in earth science or related areas.

of teachers responding in this category, it suggests support for the view that the more qualified teachers with better preparation in earth science are attracted to large school systems. That is, better-prepared teachers are hired by larger and wealthier school districts; so less qualified instructors end up in the smaller districts that are likely to have fewer financial resources to offer competitive compensation. This is consistent with parents' concerns that their children are not taught by the best teachers in smaller schools (Bainbridge and Sundre, 1990).

A closer examination of teacher preparation among size categories reveals that of the five teachers in the large size class who responded to the survey, four have completed five or more courses and one has completed four courses in earth science (Table 1). The lowest percentage of teachers having completed five or more courses in earth science or a related area came from the small schools at about 27 percent. Teachers from the small schools overall have the highest percentage having never taken an earth science or a related course at 30 percent. The small schools also have the highest percentage of teachers who have completed only one earth science or related course at 15.2 percent. It should be pointed out that while the numbers of respondents for small and medium school size are relatively similar (33 and 25 responses, respectively), the small number

of responses from large schools (5) may cause comparisons to be somewhat skewed.

Map 1 shows the regional variation in teacher preparation. The SW and ENC regions have the highest percentages of teachers with five or more earth science or related courses at or over 50 percent. These regions contain the two largest school systems in the state (Mecklenburg County and Wake County respectively). The regional analysis suggests teachers with more experience (with respect to courses taken in earth science) are attracted to areas with larger sized schools. In fact, the SW region, with the state's largest school district, is the only area lacking a respondent who had not completed at least one earth science or related course. The WNC has the highest percentage of teachers that have not taken any earth science or related course at 50 percent. This result may reflect the high proportion of the population in this region living outside of Forsyth County, which contains Winston-Salem, its largest city. Smaller sized schools within this relatively large region, but outside of the Winston-Salem/Forsyth County School District, may follow the pattern that small school size is associated with teachers that have taken little or no course-work in earth science. A more definitive conclusion about this association will be provided with further research at the intra-regional level of analysis. The smaller populated W and the NE regions also have relatively high percentages of



Map 1. Map of regional variation in teacher preparation. Wedges of the pie charts are proportional to the percentage of teachers who have completed a defined number of undergraduate and/or graduate courses in earth science or related areas.

teachers that had not completed a course in earth science, but did not exceed 50 percent. The SE region has less than 25 percent in this teacher preparation category.

Teacher Literacy and School Size

Table 2 shows the number of teachers within familiarity categories for all subject areas in earth science combined (refer to scale of familiarity under Methods). Each school size category has at least one teacher who was "very knowledgeable" about all ten subject areas. The large school size class has the highest percentage of teachers "familiar" with the subject areas at 80 percent; the medium size schools has the next highest percentage of teachers in this category at 68 percent; the smallest size schools has the lowest percentage at 41 percent. The small size class has a higher percentage of teachers "slightly familiar" with the concepts than the medium size category (53 percent and 24 percent respectively). There were no respondents in the "never heard" category.

Table 3 shows the weight average for teachers' responses to their knowledge of the individual selected subject areas in earth science by school size class. The most evident aspect of the table is that the larger size schools has higher averages for each subject area than either the medium or small size schools. The highest weight average for large size schools is for Geology at 4.9, followed by Atmospheric Science at 4.8 and Environmental Studies at 4.7. Geography has the lowest weight average in the large school size class at 3.5. This subject area also has the largest difference between large schools and small schools. While the weight average for Geography of 3.5 is the lowest average among the three other subject areas in the large size class, this subject's weight average for the small size schools is considerably lower at only 2.3, a difference of 1.2 points. This reflects the largest difference in weight average among the selected subject areas. In contrast to Geography, teachers in large schools score only 0.7 points higher than those in small schools in Geology. For this subject area, large schools have an average of 4.9, medium schools 4.5 and small schools 4.2. For Atmospheric Science the

variation is 0.8 in which the weight average progression is 4.8 for large schools, 4.6 for medium schools, and 4.0 for small schools. The weight averages are the most similar among the school size classes for Environmental Studies. Similar to the other subject areas, larger schools have a slightly higher weight average (4.7) than the small and medium-size school categories (4.6). This suggests teachers in all size categories have the same relative knowledge of the selected concepts in Environmental Studies (the 0.1 variation between high and low weight average for the size categories is not considered important), and that they have a fairly high literacy level in this subject area.

Overall, these findings indicate that the selected topics in Geography are the least familiar to all the respondents. This has important implications with respect to the ability of North Carolina students to comprehend major concepts in this subject area, especially the growing use of GIS in applications such as city and regional planning. Students' ability to address problem-solving issues utilizing critical thinking skills may be dramatically enhanced by knowledge of this popular tool in human geography.

Figure 2 shows the regional variation in teacher literacy as measured by the weight average for teacher responses to their knowledge of the selected subject areas in earth science by school size. A pattern that emerges is that for each region of the state there is a slight increase in the weight average with increasing school size categories. The ENC region is an exception because the respondents come from one size class. The large size schools that returned the survey come from the SW and SE regions. The weight average of teachers in the SW region is higher than for the SE region, but both regions follow the state-wide pattern of an upward progression in weight average for the selected concepts combined with increasing school size (Table 4). The weight average for the SW region is 4.7 for large schools and 3.9 for medium size schools, a difference of 0.8. The SE region has weight averages of 3.5, 4.0, and 4.2 for small, medium, and large size schools respectively. The difference in the weight average between small schools and large schools

for this region of 0.7 is slightly less than the 0.8 registered for the SW region. Other regions in the state in which small and medium size schools having submitted the survey also have increases in weight average with increasing school size class. The W region has the highest weight average among this group at 4.6 for medium size schools compared to 4.2 for small size schools. Both the NE and ENC regions have weight averages of 4.4 for the medium size class; the NE region weight average for small size schools is 4.0 while the ENC region did not have a teacher represented for this size class. The remaining region, the WNC, has a weight average of 4.2 for medium size schools and 3.9 for small size schools.

These findings indicate there is little regional variation in teacher literacy based on the selected measures. However, there is a consistent variation among size categories within regions across the state with regards to weight averages. Specifically, teachers from smaller schools have slightly lower weight averages than those from larger schools with regards to their familiarity of the concepts under the selected subject areas. It is not clear whether advantages of smaller schools such as having less bureaucracy (Black, 1996; Lee, et al., 2000) and a greater relationship with the community (Gardner et al., 2000) can overcome perceived or real limitations in teacher preparation and literacy. Also, highly qualified teachers appear to be attracted to larger

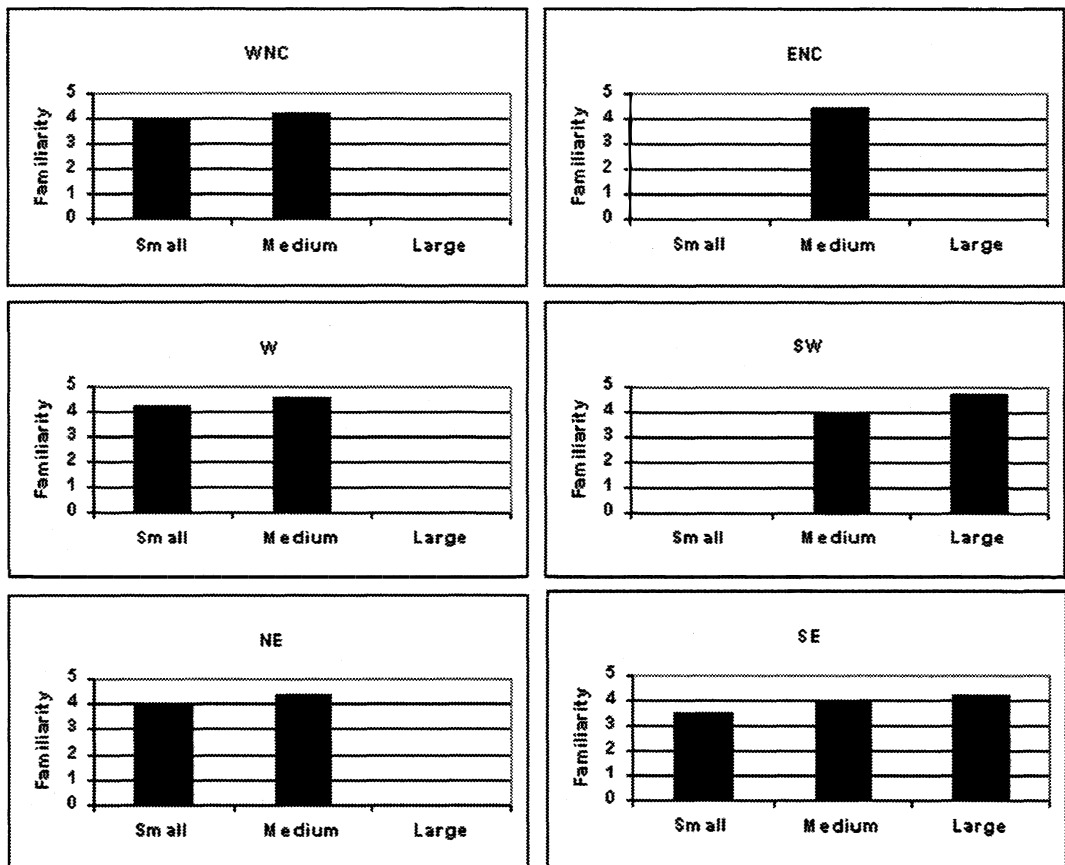


Figure 2. Regional variation in teacher literacy (familiarity) by school size category as measured by the weight average of all ten subject areas (see Table 4).

Table 1. The number of teachers having completed courses in earth science as a measure of teacher preparation by school size.

	None	1	2	3	4	5	Total
	No.	No.	No.	No.	No.	No.	No.
	%	%	%	%	%	%	%
Small	10	5	3	5	1	9	33
N=33	30.3	15.2	9.1	15.2	3.0	27.3	100
Medium	3	2	6	3	1	10	25
N=25	12.0	8.0	24.1	12.0	4.0	40.0	100
Large	0	0	0	0	1	4	5
N=5	0.0	0.0	0.0	0.0	20.0	80.0	100

Table 2*. The number of teachers within weight average categories for all concepts in earth science as a measure of teacher literacy by school size category.

	1.00-1.99	2.00-2.99	3.00-3.99	4.00-4.99	5.00	Total
	No.	No.	No.	No.	No.	No.
	%	%	%	%	%	%
Small	0	2	16	5	13	32
N=33	0.0	6.3	50.0	15.2	40.6	100
Medium	0	1	6	3	17	25
N=25	0.0	4.0	24.0	12.0	68.0	100
Large	0	0	0	0	4	5
N=5	0.0	0.0	0.0	0.0	80.0	100

Table 3*. The weight averages for teachers' response to their knowledge of individual selected topics in earth science as a measure of teacher literacy by school size category.

	Atmospheric Science	Geology	Geography	Environmental Studies
Small	4.0	4.2	2.3	4.6
N=33				
Medium	4.6	4.5	2.8	4.6
N=25				
Large	4.8	4.9	3.5	4.7
N=5				

Table 4. The weight average for teacher's response to their knowledge of the selected concepts combined by region and by school size category. --- indicates no response.

	NE	SE	ENC	WNC	SW	W
Small	4.0	3.5	---	3.9	---	4.2
N=33						
Medium	4.4	4.0	4.4	4.2	3.9	4.6
N=25						
Large	---	4.2	---	---	4.7	---
N=5						

* One respondent in this category did not complete the section of the questionnaire dealing with familiarity with earth science concepts, making the total number of teachers in the small school size category 32.

schools despite challenging issues such as discipline problems and high dropout rates (Howley, 1997).

Conclusions

This paper discusses the variations in measures of teacher preparation and literacy across high school size classes in North Carolina. For teacher preparation, it was found that the smallest schools had the highest percentage of teachers who had never taken an earth science or related course. In contrast to this finding, teachers surveyed from the largest schools had completed at least four courses in earth science. The majority of the large schools surveyed were found in the SW region of the state, which has the state's largest school district. The data suggests that smaller schools have more difficulty in attracting and retaining more experienced teachers for earth science instruction.

For teacher literacy, it was found that high school earth science teachers have relatively little knowledge of basic geographic concepts, but are quite knowledgeable about the other subject areas included in the study (Environmental Studies, Geology, and Atmospheric Science). The authors believe that a good knowledge of geography is important for teaching earth science. The fact that these teachers recorded low scores in geography has important implications as to the ability of their students to comprehend major concepts in earth science. Teacher literacy did not vary considerably among regions in the state, but teachers from larger schools consistently were more knowledgeable about all the subject areas combined than those from smaller schools. Additional research in the form of a greater number of respondents would generate a larger data set and therefore would provide a more accurate picture of the pattern of both teacher preparation and literacy across school size categories. This would provide for a more definitive conclusion to the research. However, the preliminary findings indicate that school size is an important factor in hiring and retaining teachers with adequate preparation and literacy in earth science. Moreover, the findings suggest that these factors may be at least as significant as more common measures of teaching

effectiveness, such as critical thinking strategies and the use of technology.

Given apparent deficiencies in geographic knowledge by many high school earth science teachers, the issues of preparation and literacy among these educators may be addressed by the establishment of summer workshops at local undergraduate institutions subsidized by state and/or Federal funding. This would help to enhance competency of teachers currently in charge of earth science instruction. A more long-term solution to the problem would be making earth science or a related course a requirement for the state's undergraduate science teacher education programs where no such requirement exists. In programs where the course does exist but is not yet required, the resulting increase in required credit hours would likely translate into better prepared earth science teachers.

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No Teacher Left Behind: The Implications of Porter and Rossbach

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The North Carolina Geographic Alliance is a grass-roots organization of teachers, geographers, and university educators committed to geography and geographic education. Since 1987, the organization has regularly hosted teacher-training programs while also developing and distributing educational materials. The Alliance recently sponsored a meeting in Burlington entitled "No Teacher Left Behind." The theme was a calculated response to the No Child Left Behind Act of 2001, which places great emphasis on student testing in reading, math, and science. Although the George W. Bush Administration has focused on how this new policy will benefit children and parents, there has been less discussion of its impact on teachers and the burden they will bear in terms of accountability, qualifications, and preparation. The phrase "No Teacher Left Behind" is a useful device for reminding us not to forget the often-overlooked needs of our state's public school teachers.

These are particularly uncertain times for geography teachers given that most of North Carolina's geography curriculum is taught in the area of social studies, and the No Child Left Behind legislation excludes social studies from its list of tested subjects. Fearing that they will be asked to focus on testable skills at the sacrifice of social studies, educators are exploring ways of integrating more geography into the teaching of reading and math. The Alliance meeting in Burlington addressed this very issue. Another possible strategy is for the geography education community to focus more attention on the discipline's earth science tradition and giving physical geography the same instructional importance as the other natural sciences. Again,

however, pursuing this approach requires us to assess and address the instructional needs of teachers.

The preceding research article by Porter and Rossbach takes on great importance when one considers the educational challenges I have described. The authors found significant differences in the degree to which high school teachers are prepared, intellectually, to teach earth science. Moreover, many high school teachers who teach earth science lack an understanding of basic geographic concepts. Although preliminary, their findings could help the North Carolina Geographic Alliance and other organizations identify places where teachers are perhaps being left behind and hence in need of training opportunities. The Alliance regularly holds summer institutes or workshops for K-12 teachers, often drawing a representative sample of participants from as many of the state's regions as possible. Perhaps it is time to think about tailoring and directing more of our teacher development programs toward specific populations or regions of teachers. Porter and Rossbach not only establish the need for more teacher workshops that address earth science topics, but also the necessity of ensuring that a significant share of workshop participants come from smaller schools and school systems.

Teacher preparation is not simply a product of coursework, although this is clearly important. As most educators would point out, the intellectual and pedagogical development of teachers is an ongoing process that, in some ways, only begins with graduation from college. In this respect, the knowledge limitations identified by Porter and Rossbach are correctable through collaborative

training and partnership with professional geographers. Borrowing from Hillary Clinton, who popularized the proverb that “It Takes a Village to Raise a Child,” I would suggest, “It Takes a Whole Discipline to Train a Teacher.” Addressing voids in teacher knowledge falls on the shoulders of all geographers and not just our colleagues in the College of Education. This includes the North Carolina Geographical Society, which could serve as an excellent source of content facilitators and leaders for training programs offered by the Alliance and the state’s Department of Public Instruction. By carrying out the goal of not leaving any teacher behind, we are in effect not allowing the field of geography to be left behind either.

Pocosins and Carolina Bays Compared

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Carolina bays and pocosins are two distinct physiographic features found on the Atlantic Coastal Plain of the southeastern United States. Although pocosins have been identified in the literature for more than two hundred years and Carolina bays for more than one hundred, confusion frequently still exists pertaining to the definitions of both as they are often incorrectly assumed to be indistinguishable and the terms are used synonymously. This paper defines each term and illustrates how bays and pocosins differ. In some instances Carolina bays do possess pocosin-type vegetation, in fact, most if not all have at some time past possessed shrub bog or pocosin-type vegetation. The approach used in this paper shows that Carolina bays are landform features that now vary greatly in their land cover, while pocosins are unique ecological communities.

Atlantic Coastal Plain palustrine wetlands have long been the focus of geological, botanical and ecological studies (Ash, et. al. 1983; Harper 1907; Richardson 1981; Ross 1987; Tooker 1899). The palustrine system includes all non-tidal wetlands dominated by trees, shrubs, persistent emergents and emergent mosses or lichens. These wetlands may occur as either *pocosins* or *Carolina bays* and are widespread in the Coastal Plain of the Carolinas. Pocosins and Carolina bays, however, exhibit distinctive geological and geographical differences. Because pocosins and Carolina bays occasionally occur in the same geographical areas and share soil types, floral and faunal species composition and other community attributes, many lay persons and some scholars are perplexed by the distinction and incorrectly use the terms as synonyms. *Shrub bogs*, which include all pocosin land and some Carolina bay land as well as other palustrine wetlands, are also briefly discussed as they pertain to the definitions of pocosins and Carolina bays.

Most pocosins occur chiefly in southern Virginia, the Carolinas and Georgia while Carolina bays have been identified along a broad band of the Atlantic Coastal Plain from southern Georgia to Delaware, and perhaps even to New Jersey. Troubled with the indiscriminate use by some scholars and writers of the term "pocosin" to

describe Carolina bays, Lide (1997) called upon scientists to be more precise in the designations applied to coastal wetlands, particularly of the Carolina bays. His call is supported by many whose focus of study and interest is in wetlands. In order to curtail confusion, and misinformation, scientists and journalists should use more precise terminology when communicating about coastal wetlands and minor landform features. For example, statements such as the following create the potential for confusion: "Carolina bays . . . are fragile and unique ecosystems; wetland habitats that exhibit a variety of vegetative components. Some bays are open water depressions dotted with . . . trees, . . . some are thick pocosins" (www.fs.fed.us/r8/fms/rec/bays). The problem here, of course, is that this broad definition absolutely ignores the significance of topography and geomorphological characteristics in establishing a definition for bays.

The purpose of this paper is to illustrate the distinction between pocosins and Carolina bays and to show the relationship of both to shrub bogs of the Atlantic Coastal Plain in order to provide definitions that are applicable to each of the terms, with particular emphasis upon making a clear distinction between pocosins and Carolina bays. It is hoped that the material provided here will clarify the appropriate usage for each term.

A major barrier to unequivocal definitions for pocosin and Carolina bays is that not all scholars apply the same identifying guidelines to the features being studied. Geographers, geologists, and other earth scientists are more likely to refer to a Carolina bay as a landform feature with an elliptical shape, roughly oriented northwest to southeast, sometimes bordered by a sand rim (Johnson 1942, Prouty 1952, Ross 1992, Lide 1997). Many botanists usually study only the bays that have evergreen shrub bog vegetation because vegetation is necessary for them to conduct their research; they then ignore most of the bays that have naturally in-filled with sediments and organic matter and those that have been artificially drained for agricultural and other uses (Sharitz and Gibbons 1982, Bennett and Nelson 1991, Richardson and Gibbons 1993). The implication in the publications of some botanists is that all Carolina bays must exhibit shrub bog-type vegetation ecosystems. This rationale apparently is based upon the fact that many of the places where they find shrub-bog plant communities just happen to occupy a geographic landform feature that scholars from other disciplines may call a Carolina bay. In other words, if that feature does not possess shrub-bog vegetation, some botanists do not consider it to be a Carolina bay, which could account for the relatively small numbers of bays identified in some botanical works (Bennett and Nelson 1991). Earth scientists, however, tend to aggregate all of the many forms of bays, including the dry, wet and shrub bog bays (Ross 1992, 1996, Lide 1997), and understand that bays embrace a wide continuum of land surface cover. In addition, many landform geographers,

geomorphologists and geologists are less concerned with the existence of specific vegetation communities, but are more interested in the patterns of vegetation differences among the several types of bays, as well as the soils, shapes, and patterns of occurrence of the bays themselves (Figure 1).

The definition problem has been addressed previously by several scholars from diverse academic disciplines. The most thorough studies, however, have been conducted by scientists primarily concerned with wetland vegetation communities. For example, Sharitz and Gibbons (1982) provide an excellent background to coastal wetlands and subsequently the definition problem, but their study has not been widely disseminated throughout the scientific community. Subsequently, Richardson and

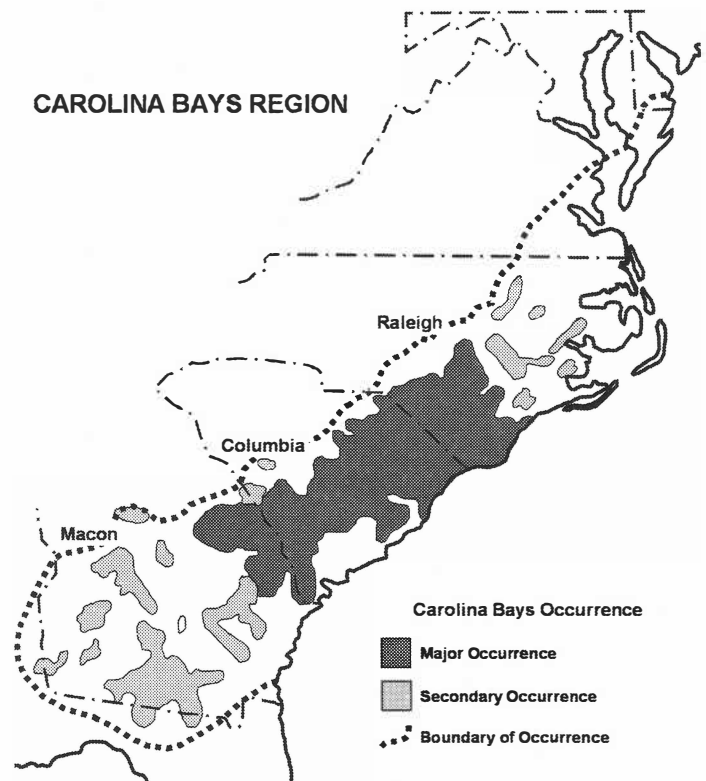


Figure 1. Carolina bays on the Atlantic Coastal Plain. The bays are concentrated in southeastern North Carolina and northeastern South Carolina, but occur as far south as northern Florida and north into Delaware, albeit in a more scattered pattern.

Gibbons (1993) examined the definition and classification problem with considerable elaboration upon the physical characteristics of pocosins and bays, and in a much more accessible medium than that of Sharitz and Gibbons (1982).

Too few scholars specializing in Carolina bays investigations have provided detailed studies of the differences between bays and pocosins, however. Johnson (1942), Prouty (1952), and Melton and Schriever (1933) have all made valuable contributions in the study, and definition, of Carolina bays and have mentioned that some bays have a pocosin-type vegetation while most do not. But the absence of significant elaboration upon the distinction between bays and pocosins in their publications only exacerbated the confusion.

In the following discussion, shrub bogs, pocosins, and Carolina bays will be described and defined. This clarification should enable scholars and others who study and write about coastal plain wetlands and Carolina bays to be more precise in their use of terminology.

Palustrine wetlands include shrub bogs, pocosins, and some Carolina bays. *Shrub bog* is a collective term applicable to wetlands in which the primary plant species are evergreen broad-leaved shrubs. In the southeastern United States, shrub bogs are found in areas with poorly developed internal drainage and usually have highly developed organic or peaty, acidic soils. Pocosins and some, but not all, Carolina bays are types or subclasses of shrub bogs that exhibit these attributes.

The precise formation mechanism of shrub bogs, pocosins, and Carolina bays is not known, but several factors combine to create a pocosin ecosystem exemplified by broad-leaved evergreen shrub vegetation such as titi (*Cyrilla racemiflora*), red bay (*Persea borbonia*), sweetbay (*Magnolia virginiana*), loblolly bay (*Gordonia lasianthus*), bitter gallberry (*Ilex glabra*), and wax myrtle (*Myrica cerifera*) overtopped by pond pine (*Pinus serotina*). The bays may indeed possess shrub bog plant communities, but they are not restricted to shrub bog. Some bays exhibit other successional stages of wetland vegetation while others include open water, or if drainage systems have been constructed, upland plants and animals.

The Venn Diagram in Figure 2 points out the overlapping nature of bogs, pocosins and Carolina bays as components of a broader palustrine wetland which may include additional vegetation communities, such as evergreen and deciduous bay forests, pine flatwoods and swamp forests. Although a simplified depiction of a highly complex phenomenon, the diagram illustrates that some Carolina bays contain two classes of pocosin-type vegetation: scrub-shrub pocosins and forested pocosins. The diagram also at the same time shows the significant differences that exist between the Carolina bays and pocosins.

Pocosins

Pocosins have historically been described as extremely poorly drained areas of highly organic soils (peaty) supporting pond pines with an understory composed mostly of broad-leaved evergreen shrubs, found mostly on the Atlantic Coastal Plain from southern Virginia to northern Florida (Ash et al.1983). These freshwater wetland

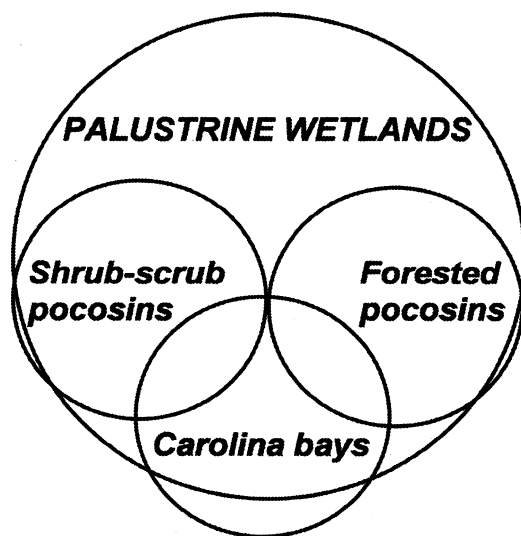


Figure 2. Carolina bays on the Atlantic Coastal Plain. The bays are concentrated in southeastern North Carolina and northeastern South Carolina, but occur as far south as northern Florida and north into Delaware, albeit in a more scattered pattern.

ecosystems occur predominately in wide shallow stream basins or on broad flat upland areas where long hydroperiods occur. Other characteristics include temporary or intermittent standing water, peat or muck fires and soils of sandy humus (Wells 1928).

Unlike Carolina bays, the origin of pocosins is somewhat more understood. It is generally accepted in the academic community that pocosin development and survival are closely related to climate and the lay of the land, or topography, of the region in which pocosins occur. Brinson (1991) demonstrated that climate and topography are both important in the development of pocosins. Climate is the variable that plays a major role in "the exchange of matter and thermal energy between pocosins and the atmosphere" (Brinson 1991). For the most part, the exchange occurs in the form of water. The bulk of the precipitation received by pocosins is eliminated through evapotranspiration. The large volume of heat consumed through evapotranspiration of the pocosins, then, impacts upon local climatic conditions. In terms of topography, Brinson contends that topography "is a consequence of the inherited landscape upon which pocosins formed. While the muted topographic relief . . . is probably the main contributor to pocosin formation, the feedback between climate and topography is likely essential." He concludes that the position of the water table, as determined by topographic position, and "the local hydrology seem to be vital controls whether due to the original landscape in which peat development was initiated or to the impeded drainage created by tertiary mire formations."

About three million acres of the Atlantic Coastal Plain, from southern Virginia to northern Florida, were once pocosin ecosystems (Richardson and Gibbons 1993). Some pocosins also are found in coastal Alabama. No detailed map showing the distribution of pocosins has been developed for the whole region; in fact, most states have not mapped their pocosin lands. The most complete mapping of pocosins has been accomplished by North Carolina (Wilson 1962; Richardson 1981). Based on that comprehensive undertaking, it is estimated

that about 70 percent of the United States' pocosins are in North Carolina and that more than 50 percent of North Carolina's freshwater wetlands are pocosins (Richardson and Gibbons 1993).

Pocosins occur in irregularly shaped tracts varying in size from less than 20 acres to several thousands of acres. They are most commonly found on interfluvies between rivers and sounds on the Atlantic Coastal Plain. Most pocosin communities thrive in the organic soil that has formed over clay-based soils in these depressions. The exact origin of the pocosin is not fully understood, but the most widely held hypothesis is that the milder climate of the interglacial period following the Wisconsin Ice Age (18,000 BP) resulted in a combination of factors (rising sea levels, peat formation and sediment build-up) that interfered with the many freshwater streams flowing across the Coastal Plain into the sounds of the Atlantic Ocean (Whitehead 1972, 1981; Richardson and Gibbons 1993). These changes were responsible for the conversion of the boreal forest of the Ice Age to wetland forests and evergreen shrub bog communities that eventually spread over the Atlantic Coastal Plain of the southeastern United States.

Daniel (1981), using carbon-14 dating, estimated the age of basal peats in the Dismal Swamp to be between 10,340 BP $\pm$ 130 years and 8,135 BP $\pm$ 160 years. Conversely, Richardson and Gibbons (1993) reported that "radiocarbon dates from much of the peat forest present today in the Dismal Swamp indicate ages under 3500 years." The difference in the two estimates is attributed to "fluctuations in peat oxidation and accumulation rates, the occurrence of extensive fires in pocosin peatlands, and a dynamic peat development history" (Richardson and Gibbons 1993).

A precise, universally accepted definition of "pocosin" is difficult to establish because several academic disciplines have developed terminologies unique to their individual discipline. Sharitz and Gibbons (1982) addressed this issue when they wrote "pine-dominated flatwoods occurring in areas with prolonged hydroperiods may be included in a forester's definition, whereas a hydrologist might consider only those shrub bogs

occurring in broad, undrained interstream areas to be true pocosins."

So what is a working definition of a pocosin? Most scholars could probably be comfortable with the following: a coastal plain wetland area of variable shape and size in an area of poor surface drainage whose vegetation is mostly broadleaved evergreen trees and pond pine growing on very organic or peaty soils.

Carolina bays

Carolina bays are shallow, elliptical depressions with generally parallel major axes oriented northwest-southeast on the Atlantic Coastal Plain. Reportedly found from southeastern New Jersey to northern Florida, most are concentrated in southern North Carolina and northern South Carolina (Johnson 1942, Prouty 1952) (Refer to Figure 1). Although the vast majority of bays possess a near uniform shape, they vary greatly in size, from less than 75 feet along the long northwest-southeast axis to more than seven miles. Estimates of the total number of bays has ranged from approximately 500,000 (Prouty 1952) to fewer than 20,000 (Bennett and Nelson 1991).

The elliptical depressions were brought to the attention of scholars in 1848 when Michael Toumey made a brief mention of them in his *Report on the Geology of South Carolina*. The first reference to "bays" in a scholarly journal was by L. C. Glenn (1895). According to Glenn:

... to the lake-like expanses the term 'bay' is usually applied, and by it is meant a perfectly flat, clayey area with a surface some two to four feet below the general level of the country and varying from a few acres in size to stretches a mile or two long and a half mile or more in width; the smaller ones being much more numerous and having usually an area of 20 to 30 acres. They are in some cases approximately round in shape, though they are usually ovoid or elliptical, and are covered with vegetation-stained water from a few inches to a foot or two deep, according to the season.

The term "bay" was applied to these depressions because of the presence of the numerous bay trees found in and around them. Sweet bay, loblolly bay, and red bay trees make up a significant portion of the plants associated with bays.

Glenn also provided some details about the sand ridges found on some bays, the effects of artificial drainage of the bays themselves, and also offered the first theory of how they were formed (see Table 1).

The origin theory of Carolina bays drew no further discussion in the scientific literature until Melton and Schriever (1933), after examination of aerial photographs taken by Fairchild Aviation in coastal South Carolina, claimed that they were meteorite scars (Figure 3). As shown in Table 1, many theories have been introduced to explain the origin, development and maintenance of these most intriguing geomorphic features. Johnson (1942) reviewed and rejected the numerous theories of origin present at the time, while making a strong case for his terrestrial- water-wind theory, which was elaborated upon by Kaczorowski (1977). Most earth scientists today reject the hypotheses that meteorites, comets, or antimatter played any role in the origins of Carolina bays. Instead, they accept that a combination of physical, earthbound physiographic factors triggered the process of development. The most widely accepted theory today is one that Kaczorowski developed after Douglas Johnson's water and wind theory. Kaczorowski argued that lakes on the Coastal Plain sediments were subjected to winds blowing from the northwest and that this created the elliptical and oriented pattern of bays. The winds were also responsible for the development of the sand rims found on many bays, most of which are higher and wider along the southeast end of the bay.

Although the literature about bays is relatively abundant, their origin remains a mystery, but many scientists accept the hypothesis that they are ancient lakebeds, most of which have dried up during the past several thousand years (Ross 1987, 2000). During periods of heavy precipitation, however, most bays collect runoff water that is ponded for several hours or days above the water table and zone of saturation (Ross 1996). Only a few bays, such as

Table 1. Some Theories of Carolina Bays Origin

<u>THEORY</u>	<u>AUTHOR DATE</u>
Spring basins	Tourney 1848
Sand bar dams of drowned valleys	Glenn 1895
Depressions dammed by giant sand ripples	Glenn 1895
Leaching of aluminum and iron in low spots on surface	Smith 1931
Craters of meteor swarm	Melton/ Shriever 1933
Submarine scour by eddies, currents and undertow	Melton 1933
Segmentation of lagoons, formation of crescentic keys	Cook 1934
Lakes in sand elongated in direction of maximum wind	Raisz 1934
Solution depressions, with wind drift forming rims	Johnson 1936
Solution basins of artesian springs	Johnson 1942
Fishnests made by fish waving fins over artesian springs	Grant 1945
Sinks over limestone solution areas streamlined by groundwater	Grant 1945
Original hollows at the foot of marine terraces	Cooke 1954
Wind action on water bodies	Thom 1970
Blackhole striking Hudson Bay, throwing ice onto coastal plain	Davis 1971
Shockwaves from cometary fragments exploding above surface	Eyton/ Parkhurst 1975
Wind and wave action on unconsolidated sediments	Kaczorowski 1977
Impact of antimatter striking the earth	Baxter/ Atkins 1978
Extended drought, fire in peat deposits, followed by eolian activity	Ross 1986
Dropping water table, geochemical weathering and silica-karst development	May/ Warne 1999

Sources: Ross, T. E. 2000. *Carolina Bays: An Annotated and Comprehensive Bibliography 1844-2000*, Southern Pines, N.C.:Carolinas Press; and Price, W. A. 1958. Carolina Bays. In *Encyclopedia of Geomorphology*. Pp. 102-108, edited by R. W. Fairbanks. New York: Reinhold Book Corporation.

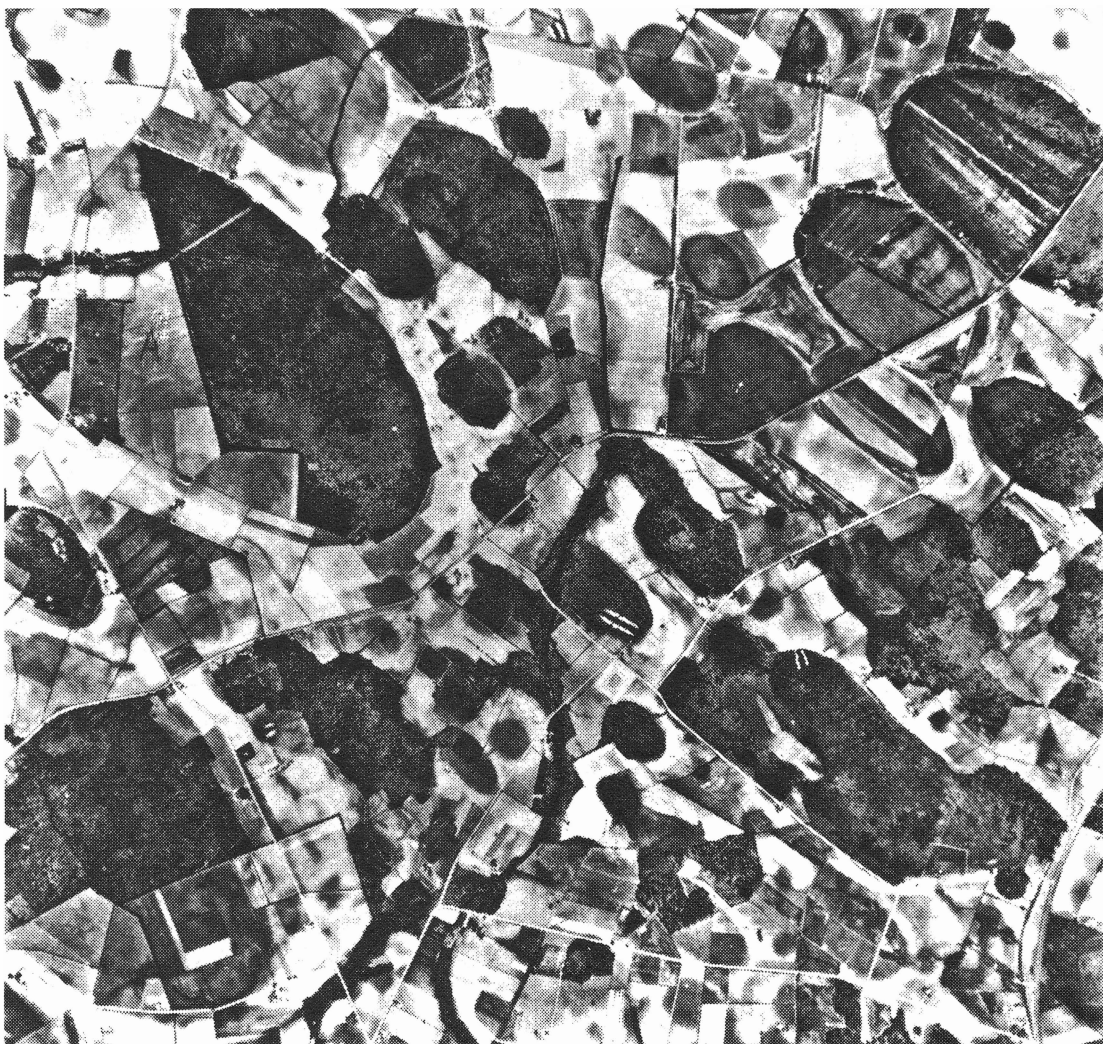


Figure 3. Aerial photograph of Carolina bays in Robeson County, NC. Observe the ellipticity, parallelism and north-west-southeast orientation of these depressions. All of the dark areas are bays. Some in this photography have been drained and cleared, others remain forested.

White, Jones, Singletary, Baytree, and Waccamaw Lakes, possess a natural, constant source of water. A dozen or so other bays are permanently ponded, while many others exhibit wetland areas that only intermittently contain water (Figure 4).

The North Carolina Heritage Program has developed the following classification for Carolina bays: (1) bays with clay-based substrata found typically in the Inner Coastal Plain; (2) “humate” bays or bays

with a sandy soil, perched water table, and spodic soil horizon; (3) peat-filled bays with shrubby vegetation; and (4) water-filled bays or bay lakes (Richardson and Gibbons 1993). Using this classification system, it is apparent that vegetation cover is not a major determinant factor in what most persons call a Carolina bay. Rather, it is the geologic and geomorphic characteristics that are used to define the bays. The large majority of the papers published on Carolina



Figure 4. A normally “dry” bay filled with water during the El Nino of the late 1990s. This is an example of a ponded bay.

bays during the past 150 years (Ross 2000) emphasize the physical characteristics, as presented in Table 2.

The variations in geographic location, soil, depth and size all help to account for the fact that no single characteristic vegetation type is associated with Carolina bays. These vegetation types run the gamut from herbaceous marshes to forests of pond and loblolly pine communities. Thus, the depressions that are called Carolina bays contain a variety of ecosystems, ranging from those associated with shallow lakes, swamps and marshes to that of cultivated cropland on bays that have been ditched and drained for agricultural, commercial, and residential use (Ross 1992).

In summary, Carolina bays are unique geomorphic features of the Atlantic Coastal Plain that are defined as shallow depressions varying in size from about 1,000 square feet to more than 7,000 acres, with an elliptical to ovoid shape generally oriented along a northwest-southeast axis, that for the most part parallels other bays. The most important components of their formation include the presence of natural lakes on a mostly flat, sandy

Coastal Plain that were subjected to winds blowing over the lakes. The photograph in Figure 3 shows the parallelism, orientation, and elliptical shape of the bays, which are all factors thought related to the direction of the prevailing winds.

Conclusion

The complexity of the definition issue is compounded because both Carolina bays and pocosins are located on the Coastal Plain and manifest similar soil types and plant and animal communities. They differ in their geological formation and present geomorphometry. Thus, Carolina bays are unique elliptical, shallow, and oriented depressions of the Atlantic Coastal Plain. Pocosins, on the other hand, are found in a wide array of geologic situations where water does not freely drain. Thus, pocosins and Carolina bays are separate and distinct ecological communities, but the terms pocosin and shrub bog are frequently interchangeable. If a particular Carolina bay contains floral and faunal characteristics associated with a pocosin, then it too can be referred as a pocosin,

Table 2. Physical characteristics of bays

-
- Most of the bays in the Carolinas are elliptical, in Georgia most are oval.
 - Some bays are highly irregular in outline.
 - All gradations in form exist, from bays of the most regular outline to the highly irregular.
 - Oval bays have axial trends almost always directed between south and east, most of them ranging between S 10 degrees E and S 55 degrees E.
 - There are wide departures from the prevailing direction; elliptical bays are the most consistent in trend, with axes directed more or less nearly southeast; ovoid bays are most variable in trend, but as a rule have axial directions more nearly southward, their narrow ends pointing in this direction.
 - Bays vary in size: some are less than 50 feet long, many are one or two miles, and some six or seven miles in longest diameter.
 - The bays are remarkably shallow in comparison with their great area extent.
 - The bays descend below the level of the surrounding plain and below the bases of their bordering rims, as if they were depressions caused by removal of part of the Coastal Plain material.
 - Bays sometimes occur in systematic groups, with a distinct group pattern apparently determined by some preexisting topography or structure.
 - Many bays are bordered by rims of sand, but many bays, similar in all other respects, have no rims associated with them.
 - The rims, when present, rarely completely surround a bay; incomplete rims are sometimes erratically distributed but normally are highest and broadest about the southeastern quadrants of the depressions.
 - Multiple rims, nearly but not quite concentric, and from two or three up to eight and possibly more in number, occur about some bays.
 - Such multiple rims tend to be developed and farthest apart toward the southeastern ends of oval or ovoid bays, converging or merging or disappearing toward the northwestern ends. In some cases the multiple rims are chiefly confined to the eastern sides rather than the southeastern ends of the depressions.
 - A wide space sometimes intervenes between an outer rim or series of rims and an inner rim or series within the same bay; this distribution pattern may be repeated in adjacent bays.
 - The rims are of relatively insignificant size, the volume of material contained in them being but a small fraction of the material removed to form the bays.
 - The convergence of multiple rims of the same bay and the junction of contiguous rims of adjacent bays do not give rise to combined rims of unusually large size. On the contrary, such combined rims may be unusually small and may locally disappear.
 - There is not systematic relation between the size of the bays and the size of their bordering rims. Large bays may have small rims or none, and small bays may have large rims.
 - Many rims are relatively flat-topped or broadly rounded in cross section, frequently with steeper slopes inward toward the depression and outward toward the adjacent plain.
 - The composition of the rims is remarkably uniform, the material consisting for the most part of clean, fairly coarse white or buff quartz sand.
 - Material composing the Coastal Plain sediments in which the bays are "excavated" is often strikingly dissimilar to the material composing the rims.
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Source: Summarized from Douglas Johnson. *The Origin of the Carolina Bays*. New York: Columbia University Press. 1942.

but as a whole Carolina bays do not have a distinctive vegetation type.

Pocosins and Carolina bays, therefore, are two distinctly different natural features; the former is a type of vegetation community or ecosystem while the latter are a geomorphic feature. Confusion in usage of the two terms is most frequently related to the occurrence of a "pocosin" or evergreen broad-leaved shrub bog vegetation type in *some* Carolina bays. The overwhelming majority of scholars who specialize in Carolina bay research and who are very familiar with Carolina bays' characteristics know that bays contain a variety of landcover, ranging from water to cultivated crops. They also understand that only a small proportion of the thousands of bays that dot the Atlantic Coastal Plain include pocosin-type vegetation. These same scholars also understand that it is the shape and location of the shallow geomorphic feature that makes it a bay, not the presence or absence of any type of vegetation ecosystem. But even those very familiar with bays sometimes confuse the issue. For example, in an internet paper entitled "Carolina bays fact sheet" released by the University of Georgia (www.uga.edu/srel/bays.html) the definition of bays was given as "isolated wetlands in natural shallow depressions that are largely fed by rain and shallow groundwater." In this definition, the wetlands are the bays, not the depressions. Statements such as this are at the heart of the problem.

What are some factors that contribute to the confusion? First, young scholars who are novices in Carolina bay research sometimes plunge into the subject without a thorough knowledge of the literature, accepting journalists' and the general public's interpretations and definitions as accurate, or perhaps scrutinizing only a narrow range of literature. Secondly, some scholars have established their own limited criteria for what a Carolina bay really is—most of this group consist of those who insist that vegetation is the primary factor. Thus, according to these scientists, the elliptical, shallow depressions that have been drained for agricultural or other uses and are devoid of vegetation are not really Carolina bays. At most, they may be called "ghost" or "relict" bays, contrary to the argument by many geographers and other earth scientists that they are bays regardless of the lack of vegetation.

In conclusion, it is very important to make an accurate distinction between Carolina bays and pocosins, especially in terms of ecological/environmental impact. A pocosin is a naturally wet feature that serves several ecological functions. It is a wildlife habitat, a home for distinctive plant life, and its wetland functions include flood and erosion control as well as a feature in which water can be cleansed by processing nutrients, suspended materials and other pollutants. A Carolina bay, conversely, if it is a dry or drained bay, has none of these functions and its uses by humans would probably have negligible impacts upon the environment. The same could not be claimed, however, for a Carolina bay that contains wetlands. The wetland portion would be in the same environmental category as the pocosin. These are valid reasons for insisting upon a distinctive definition for both pocosins and Carolina bays that would enable scholars and environmental planners to better manage the uses to which bays are subjected.

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An Adaptive Filter to Reduce SAR Speckles: A Case Study of Mapping Inundation Extent on the North Carolina Floodplain Using the JERS-1 SAR Data

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An adaptive filter was developed to reduce speckles and to preserve the boundaries (e.g., a flooded/nonflooded boundary) on a synthetic aperture radar (SAR) image, and hence to improve the accuracy on the inundation extent mapping using the SAR data. Based on the counts of pixels in each category within a moving kernel, the filter used different filtering approaches to reduce the speckles and retain the boundaries. As an example, the authors used the original, median-filtered, and adaptive-filtered Japanese Earth Resource Satellite – 1 (JERS-1) SAR data to map a flood extent on the North Carolina coastal floodplain, and to investigate the effectiveness of the adaptive filtering through a comparison study of the derived flood extents. Spatial correlation analysis and accuracy evaluation indicated that the adaptively filtered SAR data achieved higher accuracy on the inundation maps than either the median-filtered or the original SAR data.

Introduction

Floods are one of the major natural hazards that cost lives, cause damage to property, and disrupt social and economic activities. The ability to map the flood extent correctly can provide critical information for immediate flood relief activity, and pre- and post-flood mitigation. It is possible to use optical and radar remote sensing data to map the flood extent because the water and non-water surfaces, such as soil and vegetation, have distinctive signatures in the data. Because the optical sensor lacks the ability to penetrate vegetation canopies, its usage in densely forested areas can be limited. On the other hand, synthetic aperture radar (SAR) data are able to penetrate the canopies (Richards, 1987), and have been widely used in the mapping of flood extent (e.g., Imhoff et al. 1987, Hess et al. 1995, Melack and Wang 1998, Bourgeau et al. 2001, Wang 2003).

When using the SAR data for inundation mapping in forested environments one should be cautious with two facts. First, due to the enhanced double bounced trunk-ground interactions when a forested area is flooded, a stronger radar return has been observed as compared to forested area where the ground is nonflooded. Second, because of the

coherent processes of data processing used to create the SAR data (e.g., Ulaby et al. 1982), there are speckles or abnormal bright or dark spots on the SAR data and the speckles are a severe problem for interpretability of SAR data (Ulaby et al. 1982). The speckles or bright spots may be mistakenly interpreted as flooded forests. To reduce or remove the speckles, various spatial filters (e.g., Lee 1981, Lee et al. 1991, Lee et al. 1997, Jensen 2000) in addition to the commonly used median filter have been devised based on the mechanisms that create the speckles. Lee et al. (1994) provided a detailed review of the speckle filtering of SAR data. For example, Wang (2003) utilized a 7x7 median filter to reduce the speckle in studying the seasonal change of inundation on the North Carolina coastal floodplains using the Japanese Earth Resource Satellite – 1 (JERS-1) SAR data (<http://www.eorc.nasda.go.jp/JERS-1>). One problem with the median filter is that it can smear the flooded/nonflooded boundaries in open areas or forested environments. The smearing effect results because the filter always outputs the median value within a moving filtering kernel and ignores the distribution of the pixel values within that kernel, even though

the distribution may consist of important information about the speckles and boundaries. To overcome the median filter's shortcoming on smearing the boundaries, an adaptive filter that utilizes the counts of pixels in each category within a kernel has been developed. The filter uses different approaches according to the counts in order to effectively reduce the speckles and retain the boundaries at the same time. Thus, the objectives of this study were to: 1) develop the adaptive filter, 2) apply the filter to the JERS-1 SAR data in mapping a flood extent on the North Carolina coastal floodplain, 3) evaluate the filter's effectiveness of the speckle removal and boundary retention through a comparison study of the derived flooded extents from the original, median-filtered, and adaptive-filtered SAR data, and finally 4) investigate the accuracy of the inundation maps.

Analysis

An adaptive filter

The adaptive filter is a spatial filter that moves a pixel at a time from left to right one line at a time. The output is a new value for each filtered pixel produced by analyzing the counts of pixels of each category within the kernel in the hope to reduce the speckle and retain the boundary. Because there are three categories (open water, flooded forest, and non-flooded area) involved, the pixels within a kernel (e.g., 3x3, 5x5, 7x7, etc.) can be in a homogenous situation of one category, a boundary situation of two different categories, or a mixed situation of all three categories. The adaptive filter can detect which situation the kernel is in by analyzing the counts of pixels that belong to each category within the kernel, and then use different methods to output new values accordingly.

Based on the classification algorithm to be described, the pixels within a moving kernel are classified into one of the three categories (the actual pixel value on the input image is not changed). The number of pixels in each category is counted and ranked from the most to the least. The category having the most number of the pixels is the first populous category, the category that includes the second most pixels the second populous category, and so on. It should be noted that when the kernel moves cross

the image the pixel values and distribution change. Thus, the first, second, and third populous categories vary. Three situations and adaptive methods are considered when output a filtered pixel value:

- a) If the first populous category includes at least 60% of pixels within the kernel, then the kernel is at the homogeneous case of the first populous category. The center pixel (to be adaptively filtered) is assigned to the first populous category and its pixel value is output as the average value of all the pixels belonging to the first populous category. Therefore, a speckle is reduced if the center pixel does not belong to the first populous category or the pixel is an outlier of the first category.
- b) If the first populous category includes less than 60% of the pixels within the kernel, but the first and second populous categories combined include at least 70% of the pixels, the kernel is considered in the boundary situation of the first and second populous categories. To retain the boundary (first and then to de-speckle), the center pixel should be assigned as the first or second populous category depending on the relationships between the original value of the center pixel and the two categories' backscatter coefficient ranges. Using the classification algorithms (§2.3), one can divide the entire range of backscatter coefficient into three regions (Figure 1). The rules to separate the water/nonflooded area (W/NFA) and the nonflooded area/flooded forest (NFA/FF) are two dividing lines. There are three possible combinations of the first and second populous categories:

- 1) The first and second populous categories are water and nonflooded area (not necessarily in that order). In this situation, if the center pixel's original value is less than the W/NFA dividing value, the center pixel will be assigned as water and its output value will be the average value of all the pixels that belong to the water category. Otherwise, the center pixel will be assigned as nonflooded area and its output value will be the average value of all the pixels of the nonflooded area category.
- 2) The first or second populous category is nonflooded area or flooded forest. In this case,

if the center pixel's original value is less than the NFA/FF dividing value, the center pixel will be assigned as nonflooded area and its output value will be the average value of all the pixels of the nonflooded area category. Otherwise, the center pixel will be assigned as flooded forest and its output value will be the average value of all the pixels that belong to the flooded forest category.

3) The first and second populous categories are water and flooded forest (not necessarily in that order). In this situation, the distances from center pixel's original value to the W/NFA dividing value ($D_{O-W/NFA}$) and to the NFA/FF dividing value ($D_{O-NFA/FF}$) will be compared (Fig. 1). If $D_{O-W/NFA}$ is less than $D_{O-NFA/FF}$, the center pixel will be assigned as water and its output value will be the average of all pixels of the water category. Otherwise, the center pixel will be assigned as flooded forest and its output value will be the average of all pixels of the flooded forest category.

c) If neither a) nor b) is true, the kernel will be in an area where all three categories are present. Then, the center pixel will output its original value as the new value. In this case, the original value is preserved; this approach should retain an edge.

It should be noted that in implementation, for a 3x3 kernel, 60% and 70% of a total of 9 pixels are 5 and 6 pixels, respectively. For a 5x5 kernel, the 60%

and 70% of 25 pixels are 15 and 18 pixels, respectively, and so on so forth.

Study area and datasets

The study area outlined is on the floodplain of the Tar/Pamlico River, North Carolina, covering part of Pitt County on the west and Beaufort County on the east (Fig. 2). As the Tar River expands into the sound, the river is called the Pamlico River. The study area is about 128 km². Based on the statewide landuse and land cover layer created by the North Carolina Center for Geographic Information and Analysis, there are fifteen landuse and land cover types. Bottomland forests/hardwood swamps and cultivated areas are dominant.

Two sets of data were used: the JERS-1 SAR data and USGS color infrared digital orthorectified quarter quadrangles (DOQQs). The SAR is an L-band (24 cm wavelength) HH (horizontally transmitted and horizontally received) sensor on board the JERS-1 satellite launched into space by the National Agency of Space and Development of Japan (NASDA) in 1992. The SAR has a 35° off nadir incidence angle, and its image has a 75 km swath width with a nominal 18 x 18 m ground spatial resolution. The SAR collected global radar images until October 1998 when it ceased operation (<http://www.eorc.nasda.go.jp/JERS-1>). Through a sponsored program by the NASDA to East Carolina University, the JERS-1 SAR data are available to this study. The

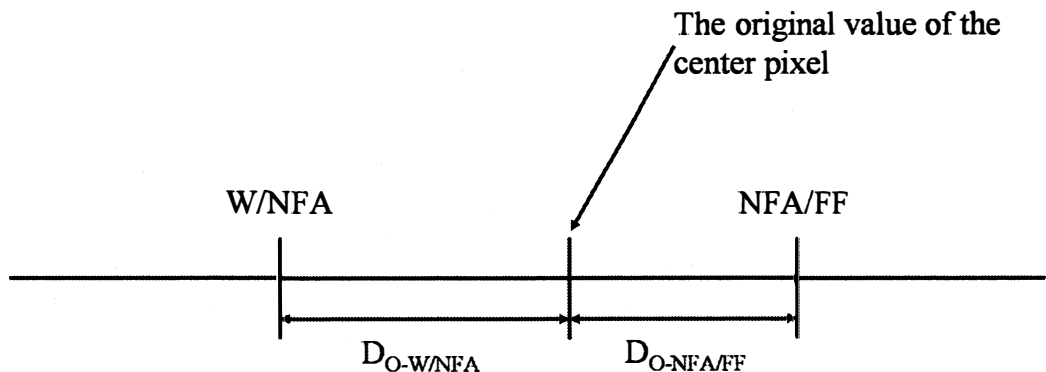


Figure 1. The distances from the original value of the center pixel to the water/nonflooded area (W/NFA) and nonflooded area/flooded forest (NFA/FF) dividing lines.

SAR data were acquired on 3 November 1994 and 10 June 1995, respectively. On the SAR images, the dark curve is the Tar River, which runs from the northwest corner to the southeast corner. The bright areas along the river banks are flooded forests, upland forests are in gray, and scattered patches of dark areas are flat surfaces, such as fields, bare soil, and pasture lands (Figure 2). The SAR images have been re-sampled to a 12.5 x 12.5 m resolution and absolutely calibrated by the NASDA. The conversion between a pixel intensity value (I) of the SAR image and backscatter coefficient (σ^0 , in Decibel or dB) is:

$$\sigma^0(dB) = 20.0 \times \log_{10} I - 85.34$$

The DOQQs created in 1998 are digital photographic data with a spatial resolution of 1 x 1 m. Due to its high resolution, water bodies, river channel, banks, upland forests, and some flooded forests can be easily identified. The DOQQ data in conjunction with limited ground observations are used to identify training and test sites for the water, nonflooded area, and flooded forest categories, so that the supervised classification algorithms for the SAR data can be used and their classification accuracy evaluated.

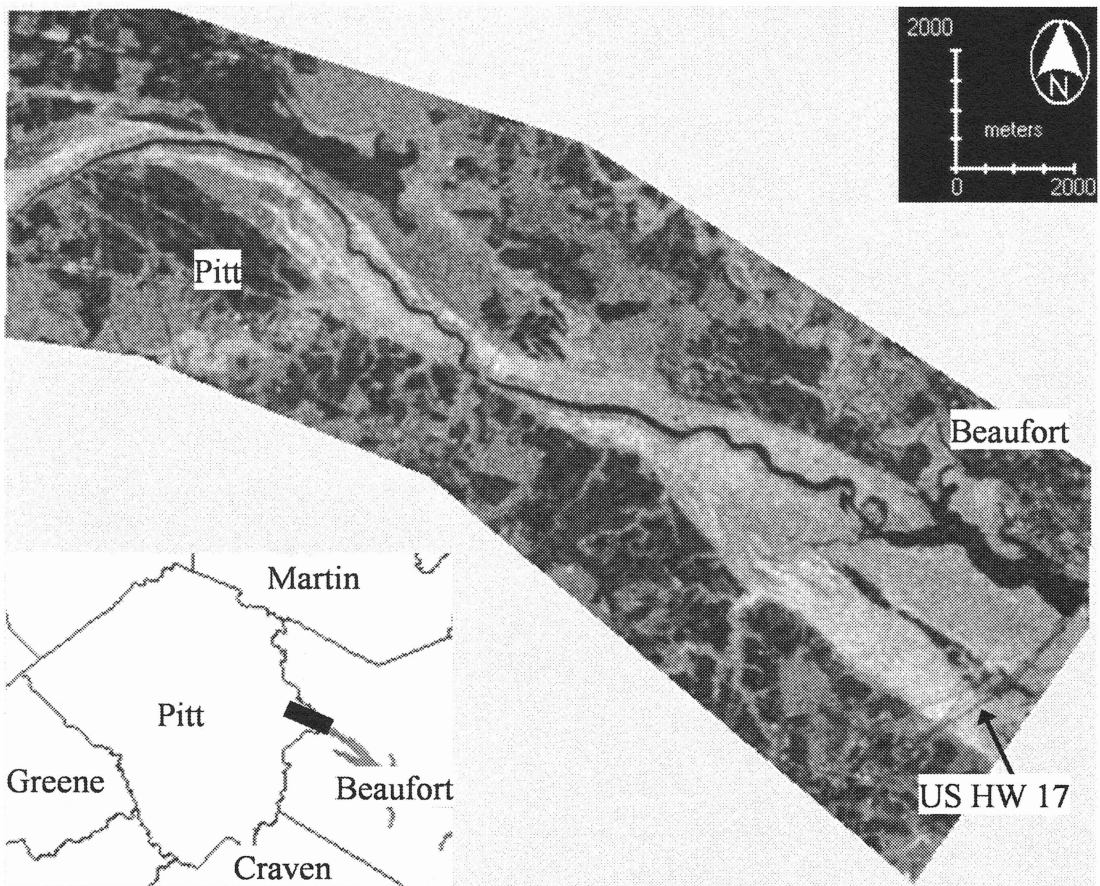


Figure 2. JERS-1 SAR image acquired on 3 November 1994 shows portion of the floodplain of the Tar/Pamlico River. The curved and dark signature is the river. The study area is about 128.0 km².

Analytical method

The analytical approaches enabled us to: 1) model inundation extents using the original, median-filtered, and adaptive-filtered SAR data, 2) compare the extents spatially, and 3) perform an accuracy assessment of the extents. To map the inundation extent, the SAR data were classified into three categories: open water, non-flooded area, and flooded forests based on the intensity of a pixels' backscatter coefficients. In general, the flat surfaces (such as an open water body) lead to a low backscatter coefficient. Flooded forest area has a high backscatter due to the double bounce interactions between a tree trunk and underneath water surface. The backscatter coefficient of non-flooded forest, crop fields, and pasture lands is in between.

To develop the classification algorithms, the SAR data were first filtered using a 5x5 median filter. Because of the temporal variation in inundation extents of the study area caused by the variation of river's discharge and flow condition, the training (as well as test) sites for the two dates of SAR data were identified separately. Then, using the identified 15 training sites for each of the 3 categories (a total of 45 sites for each date), we developed supervised classification rules on a pixel-by-pixel basis. On the 3 November 1994 SAR image, if a pixel's backscatter is

- ≤ -13.60 (dB), it is classified as open water,
 - > -13.60 dB but < -5.68 dB, it is classified as non-flooded area, and
 - ≥ -5.68 dB, it is classified as flooded forest.
- On 10 June 1995 SAR data, if a pixel's backscattering coefficient is
- ≤ -12.30 dB, it is classified as open water,
 - > -12.30 dB but < -5.24 dB, it is classified as non-flooded area, and
 - ≥ -5.24 dB, it is classified as flooded forest.

Next, the classification rules were applied to the original, median-filtered, and adaptive-filtered SAR data of 1994 and 1995 to create inundation maps. Then, the maps were compared non-spatially using descriptive statistics of each classified category, and spatially on a pixel-by-pixel basis. The spatial

comparison created a new layer based on the pixel-by-pixel agreement or disagreement of the two classified images. Table 1 shows all 9 possible outcomes of the agreement and disagreement of the comparison. For instance, if the same pixel (location) on both inundation maps was classified as water, a zero was recorded for that location on the output layer. The 0s, 4s, and 8s represent the agreement and the other values represent the disagreement. Thus, the ratio of the sum (of the 0s, 4s, and 8s) to the total number indicates the degree of agreement. It should be noted that three classified images are created and three comparisons are done at each date. Finally, the accuracy of the inundation maps is assessed using the selected test sites. Figure 3 is the flowchart of the analyses.

Results

Figure 4 shows three classified images or inundation maps using the SAR data on 3 November 1994. Non-flooded areas are represented by white, the flooded forest areas by grey, and open water areas and flat surfaces by black. The map derived from the original SAR data is characterized by many scattered dots and blocks, which is the result of the speckles in the data. The river channel can barely be recognized (Figure 4a). The map derived from the median-filtered SAR data shows some visual improvement having less scattered dots and blocks, and the river channel and surrounding flooded forest are some noticeable (Figure 4b c.f. 4a). The classified image after the adaptive-filtered SAR data has much less scattered dots and blocks, and the river channel and surrounding flooded forests are somewhat clearly delineated (Figure 4c). Similar observations for the inundation maps using the original, median-filtered, and adaptive-filtered SAR data on 10 June 1995 are evident. In summary, the adaptively filtered SAR data has the most visual improvement on the classified images, and may have reduced the speckles and at the same time retain the boundaries.

Table 2 summarizes the areas covered by each category on both dates and clearly demonstrates differences among the extent of each. For instance, on 3 November 1994, the water area covered 23.9%, 21.15%, and 33.2% of the study area as derived from original, median-filtered, and adaptive-filtered SAR

Table 1. On an output layer created by a spatial comparison of two inundation maps on one date, numbers 0 to 8 are used to recode the possible outcomes of the comparison on a pixel-by-pixel basis.

		Inundation Map A		
		Water	Flooded Forest	Nonflooded Area
Inundation Map B	Water	0	1	2
	Flooded Forest	3	4	5
	Nonflooded Area	6	7	8

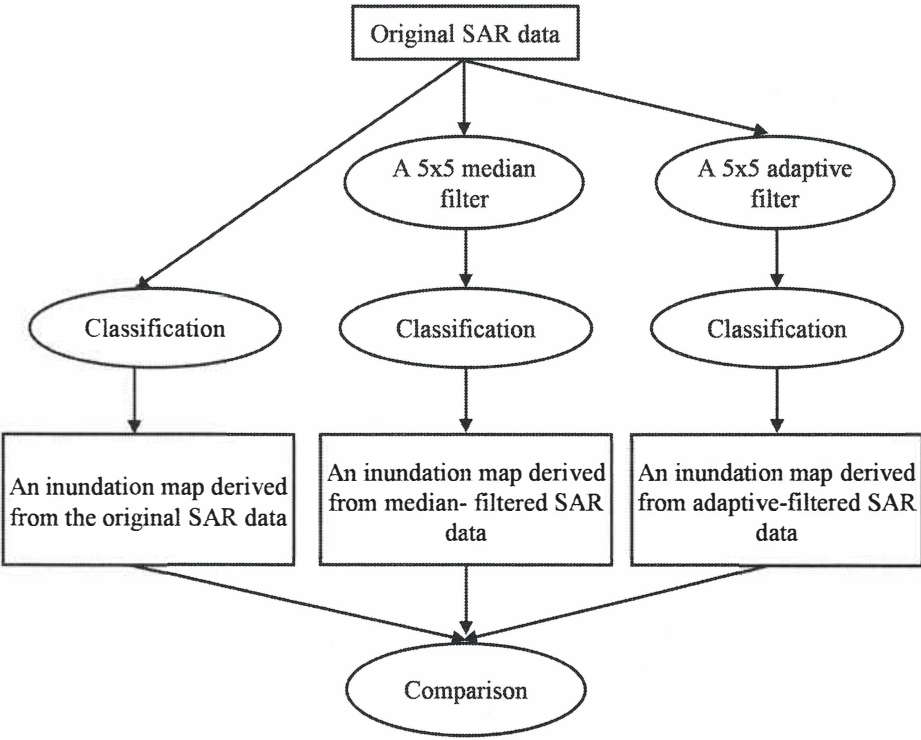


Figure 3. Flowchart of the analysis.

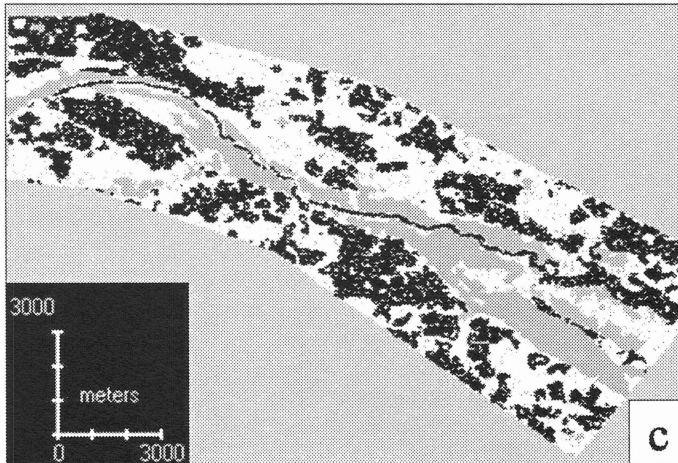
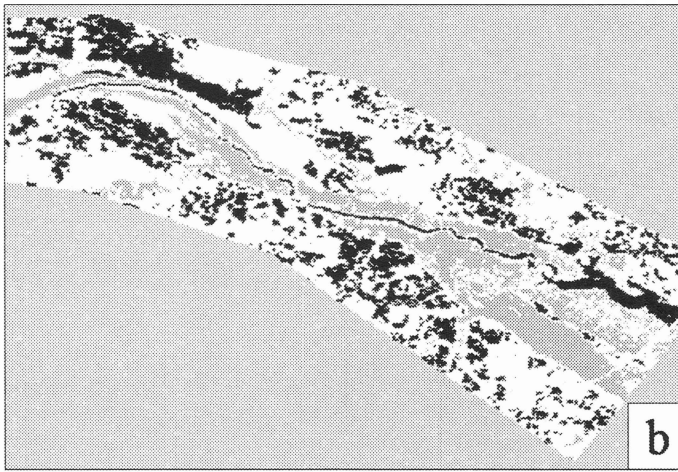
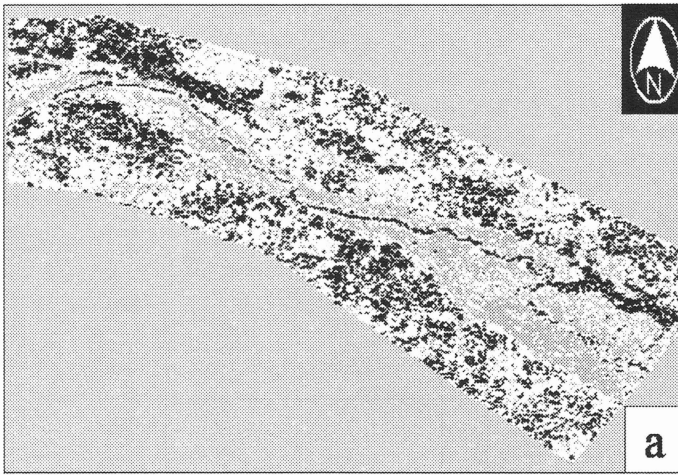


Figure 4. The inundation maps derived from the original (a), median-filtered (b), and adaptive-filtered (c) SAR data of 11/3/1994. Water is shown in black, flooded forest in gray and nonflooded area in white.

data. Because the same classification algorithms were used, the differences are the result of different filtering techniques.

Spatial comparison layers of the three inundation maps derived from 3 November 1994 and 10 June 1995 SAR data were then created. The degree of spatial agreements between the classified images derived from the original data and median-filtered or the original data and adaptive-filtered data is slightly lower than the degree of spatial agreement of the two classified images derived from the filtered data. Detailed percentages of the agreement or disagreement among the classified images on the two dates are summarized in Table 3. The spatial comparison of the classified images shows that the adaptive-filtered as well as median-filtered SAR data may reduce the speckles, and could also preserve the edges. Figure 5 shows, as an example, the spatial comparison of the inundation maps derived from the median-filtered and adaptive-filtered SAR data acquired on 3 November 1994 (the other spatial correlation layers are similar to this). The agreement and disagreement scattered widely; pixels classified as the same category by both classified images are in white, otherwise in black.

Finally, using 75 test sites (25 test sites for each category) visually identified on the USGS DOQQs, the classification accuracy was evaluated. Due to the temporal change of the inundation extents, test sites on 3 November 1994 and 10 June 1995 were selected independently. Table 4 summarizes the results and four findings are evident. First, the producer's accuracy and user's accuracy (Jensen 1996) derived from the adaptive-filtered or median-filtered SAR data are higher than that derived from the original SAR data for each category. Second, the accuracy derived from the adaptive-filtered or median-filtered SAR data increases or decreases for water or nonflooded category on both dates. Third, the adaptive-filtered SAR data has higher classification accuracy than the median-filtered SAR data do on both dates. Fourth, the adaptive-filtered SAR data has the highest overall classification accuracy. Thus, the adaptive-filter may be better than the median filter in reducing SAR speckles and retaining edges.

Conclusion

An adaptive-filtering method has been developed, which utilized the counts of the pixels of three categories within a moving kernel in order to

Table 2. Statistic summaries of each category from the inundation maps derived from the original, median filtered, and adaptive-filtered SAR data. The area is in km². The percentage of each category of the total study area is in brackets.

11/3/94	Categories	Original	Median-Filtered	Adaptive-Filtered
	Water	30.56 [23.9%]	26.99 [21.1%]	42.56 [33.2%]
	Nonflooded Area	70.37 [55.0%]	79.90 [62.4%]	59.65 [46.6%]
	Flooded Forest	27.07 [21.1%]	21.11 [16.5%]	25.79 [20.2%]
06/10/95	Categories	Original	Median-Filtered	Adaptive-Filtered
	Water	25.30 [19.8%]	18.70 [14.6%]	23.58 [18.4%]
	Nonflooded Area	65.79 [51.4%]	79.96 [62.5%]	70.63 [55.2%]
	Flooded Forest	36.88 [28.9%]	29.30 [22.9%]	33.76 [26.4%]

Table 3. Summary of the spatial agreement among classified images derived from the original, median filtered, and adaptive-filtered SAR data on 3 November 1994 and 10 June 1995.

		% in same (different) category
11/3/1994	Original vs. adaptive-filtered	72.36 (27.64)
	Original vs. median-filtered	72.56 (27.44)
	Median-filtered vs. adaptive-filtered	74.68 (25.32)
6/10/1995	Original vs. adaptive-filtered	66.50 (33.50)
	Original vs. median-filtered	65.98 (34.02)
	Median-filtered vs. adaptive-filtered	77.38 (22.62)

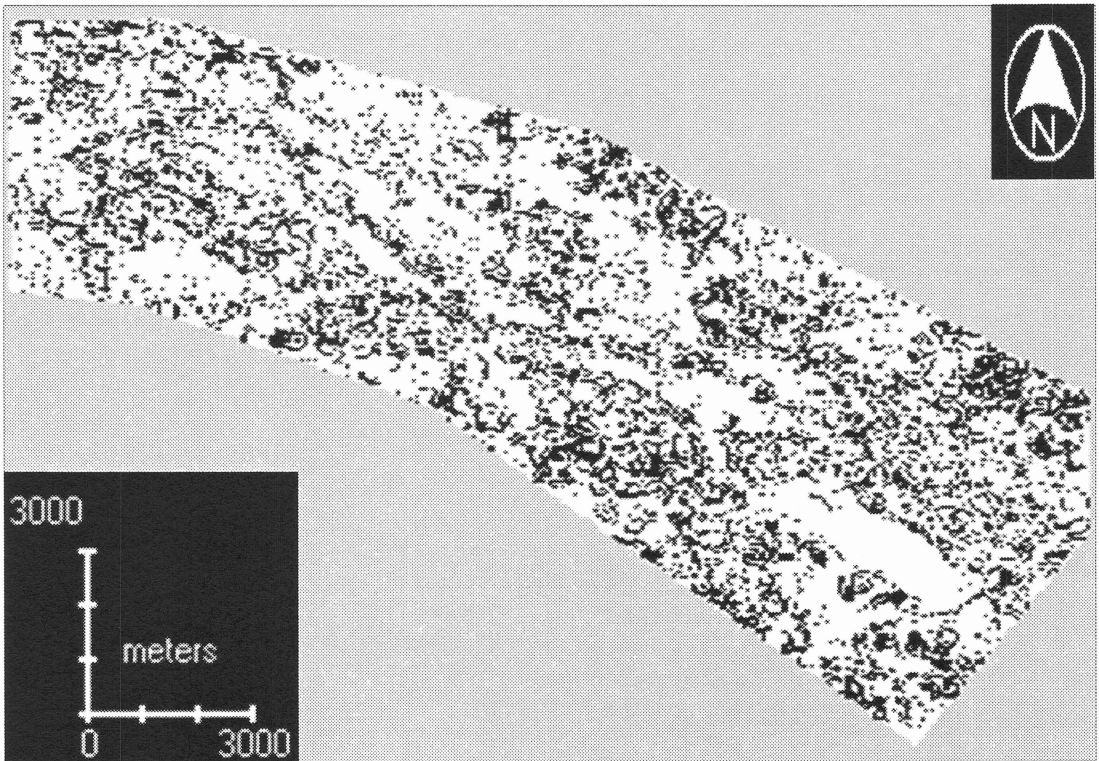


Figure 5. The spatial correlation between the inundation maps derived from the median-filtered and adaptive-filtered SAR data on 3 November 1994. Pixels classified as same category on both maps are in white, otherwise, in black.

Table 4. Error matrix and classification accuracy derived from the original, median-filtered and adaptive-filtered SAR data on both dates.

(a) 3 November 1994. Overall accuracy, 62.5% (original), 70.0% (median-filtered), 74.5% (adaptive-filtered).

		Producer's accuracy (%)	User's accuracy (%)
Original	Open Water	74.6	75.3
	Non-flooded Area	63.2	53.1
	Flooded Forest	53.5	67.4
Median-Filtered	Open Water	82.7	80.8
	Non-flooded Area	74.4	60.2
	Flooded Forest	56.6	78.6
Adaptive-filtered	Open Water	87.9	75.9
	Non-flooded Area	69.1	67.8
	Flooded Forest	71.5	81.9

(b) 10 June 1995. Overall accuracy, 60.7% (original), 72.3% (median-filtered) 78.2% (adaptive-filtered).

		Producer's accuracy (%)	User's accuracy (%)
Original	Open Water	72.6	70.4
	Non-flooded Area	59.1	53.6
	Flooded Forest	54.4	62.8
Median-Filtered	Open Water	81.8	84.8
	Non-flooded Area	75.3	62.7
	Flooded Forest	62.0	62.4
Adaptive-filtered	Open Water	86.7	74.3
	Non-flooded Area	71.2	65.0
	Flooded Forest	75.5	86.3

reduce SAR data speckles and to retain the boundaries. It has been applied to classify two dates of JERS-1 SAR data into water, nonflooded area, and flooded forest categories for a part of the Tar/Pamlico River floodplain of North Carolina. The SAR data were acquired on 3 November 1994 and 10 June 1995. Comparisons of the inundation maps derived from the original, median-filtered, and adaptive-filtered SAR data showed that the adaptive-filtering method reduced the speckles and preserved the boundaries better than the median filter. In addition, the adaptive-filtered SAR data had the highest overall classification accuracy among the median-filtered and non-filtered SAR data. Despite the success of the adaptive filter, there are cautions. First, the adaptive filter depends on pre-defined classification rules that are derived from the training sites on the SAR data after a 5x5 median filtering. The error in the pre-defined classification rules could introduce error in the adaptive filtering method. The adaptive filter based on the original data without pre-defined classification rules should be of advantages, but might difficult to developed due to the wide range of pixel values (backscattering coefficients) within a moving kernel. Second, the adaptive filter determines the filter window's situation only by counting the total number of pixels in each category whereas the spatial distribution within the filter window may provide useful information for adjusting the filtering algorithm. The information could improve the filter's ability to reduce speckles and preserve boundaries.

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An Evaluation of Fecal Coliform Bacteria Concentrations Up- and Downstream of the Irwin Creek and Sugar Creek Wastewater Treatment Plants in Mecklenburg County, North Carolina, 1998-2001

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Fecal coliform bacteria cause water quality problems for many urban areas across the United States. The objective of this study is to determine if the Irwin Creek and Sugar Creek wastewater treatment plants, located near Charlotte in Mecklenburg County, North Carolina, contribute significantly to the fecal coliform concentrations in the creeks. Fecal coliform densities in the wastewater effluent discharged from wastewater treatment plants were compared to the concentrations downstream of the facilities, and downstream bacterial levels were compared to the bacterial levels upstream of the facilities. Mann Whitney Sum Rank test suggests that the Sugar Creek and the Irwin Creek wastewater treatment plants are not contributing to elevated fecal coliform bacteria levels. Furthermore, linear regression analysis reveals that the stream flow does not have an effect on the fecal coliform concentrations at the sampling sites.

Introduction

Urban development can affect surface waters by increasing the amount of microorganisms from wastewater treatment plants (Fisher et al., 2000). According to the United States Geological Survey (2001), the main point source for bacterial pollutants is wastewater treatment plant outfall, the location where water is released into the receiving stream. States report that the effluent released from the wastewater treatment plants is the second major source of water quality impairment (Copeland, 1999).

The North Carolina water quality standard for fecal coliform states that fecal coliform concentrations should not exceed an average of 200 colonies/100mL from at least five consecutive samples analyzed within a 30 day period, nor surpass 400 colonies/100mL in more than 20 percent of the samples tested during certain a time period (North Carolina Department of Environment and Natural Resources, 2003). Little Sugar Creek and Irwin Creek were listed on the 2000 North Carolina 303(d) report for exceeding the fecal coliform bacteria standards (NCDENR, 2000). Pollution in these streams is primarily fecal coliform bacteria released with wastewater discharge (NCDENR, 1999).

The threat of bacterial contamination increases in areas where there is under-treated or untreated wastewater. High levels of fecal coliform bacteria and possibly other pathogenic microorganisms are present in untreated wastewater. The presence of these bacteria in streams indicates that the water has been contaminated with human or other warm-blooded animals. Elevated amounts of fecal coliform bacteria have been correlated with the presence of disease causing agents in the water, which could endanger the health of those individuals who are exposed to it (USGS, 2001).

Mecklenburg County's source of drinking water came from Sugar Creek during the late 1800s. The drinking water source was changed to Irwin Creek in 1904, because the water quality conditions in Sugar Creek were decreasing due to improper collection and disposal of waste. As a result of an extreme drought, Irwin Creek was unsuccessful in providing drinking water for the city of Charlotte. Although some Charlotte residents were on septic tanks in the early 1900s, the majority lacked adequate sewage disposal. Therefore, the residents dumped the raw sewage directly into the streams. Two wastewater treatment plants were built in 1927; one

next to Little Sugar Creek and the other along the Irwin Creek.

In addition to the dumping of raw sewage from the local residents and businesses, Little Sugar Creek and Irwin Creek were receiving improperly treated wastewater from the wastewater treatment plants. The bacteria amounts measured in the streams were considerably high thus making them unsuitable for human contact. The fecal coliform concentrations in Mecklenburg County's urban streams are much lower today than in the past, but these streams continue to have bacteria counts that exceed the North Carolina standard (Mecklenburg County Department of Environmental Protection, 2000).

Charlotte wastewater treatment plants are the largest dischargers in the city (North Carolina Department of Environment and Natural Resources, 1999). The effectiveness of any wastewater treatment plant in removing the fecal coliform bacteria is highly dependent on the quality of treatment that it provides (George et al., 2002). It is common for some tributaries in the Sugar Creek sub-basin to experience increased bacteria concentrations during non-storm periods, which suggests that point sources, such as wastewater treatment plants, are major contributors to the high fecal coliform bacteria concentrations (North Carolina Department of Environment and Natural Resources, 1999). Wastewater treatment plants are expected to prevent streams from receiving fecal contaminants, however, there continues to be increased concentrations of these bacteria.

There have been several studies conducted that compared the fecal coliform concentrations upstream and downstream of wastewater treatment plants to determine if wastewater treatment plants influence the fecal coliform concentrations entering surface waters. A study conducted by Vilanova et al. (2002) in Barcelona, Spain revealed that there was a 2-log reduction in the fecal coliform concentrations between the raw sewage and the upstream and downstream sites. Beck (1995) indicated that wastewater effluent not properly treated can influence the fecal coliform concentrations downstream of the treatment plant. Hoch et al. (1996) suggested that wastewater influx influenced

the downstream levels close to the outfall, and decreased with distance from the influx of the sewage treatment plant, which indicated rapid dilution of the discharged effluent.

The purpose of this study is to determine if the Irwin Creek Wastewater Treatment Plant and Sugar Creek Wastewater Treatment Plant contribute significantly to the fecal coliform bacteria concentrations in the receiving streams. This study provides an understanding of the association between wastewater treatment plants and fecal coliform levels by answering the following questions: (1) Is there a significant statistical difference in bacteria levels upstream and downstream of the wastewater treatment plants? (2) Is there a significant statistical difference between the downstream site and the effluent released into the streams? (3) Is there a significant correlation between the fecal coliform concentrations at the three sites and stream discharge?

Study Area

Mecklenburg County is located in the South Central Piedmont region of North Carolina. The county is separated by two river basins, the Catawba and the Yadkin (See Figure 1). Streams located in the western two-thirds of the county normally flow in a southwest direction towards the Catawba River. Irwin Creek (IC) and Little Sugar Creek (LSC) drain into Sugar Creek, which empties into the Catawba River five miles south of Fort Mill, South Carolina.

The study includes two sampling sites on each of the two streams and the Sugar Creek and Irwin Creek wastewater treatment plants (See Figure 2). Site MC32A is located along Little Sugar Creek at Archdale Drive, which is approximately 1.05 kilometers (0.65 miles) downstream from the Sugar Creek wastewater treatment plant. Site MC29 is positioned near Park Road about 1.05 kilometers (0.65 miles) upstream of the Sugar Creek wastewater treatment plant. The MC22A sampling site is located on Irwin Creek roughly 0.19 kilometers (0.12 miles) upstream from the Irwin Creek Wastewater Treatment Plant. Site MC23A is located near Arrowood Road nearly 10.73 kilometers (6.67 miles) downstream from the Irwin Creek wastewater treatment plant. This site is located on Sugar Creek. Irwin Creek

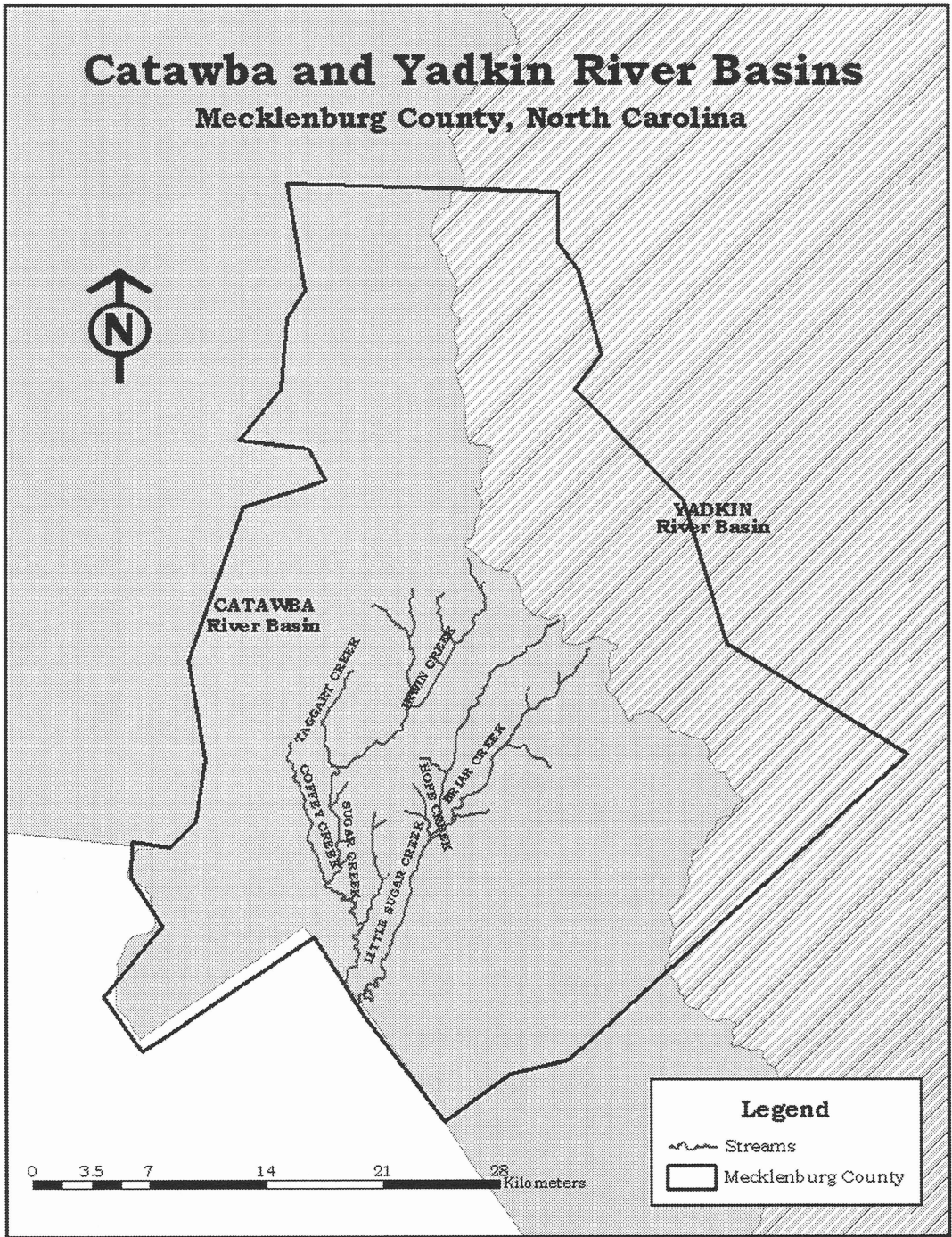


Figure 1. Mecklenburg County's River Basins

Fecal Coliform Study Area

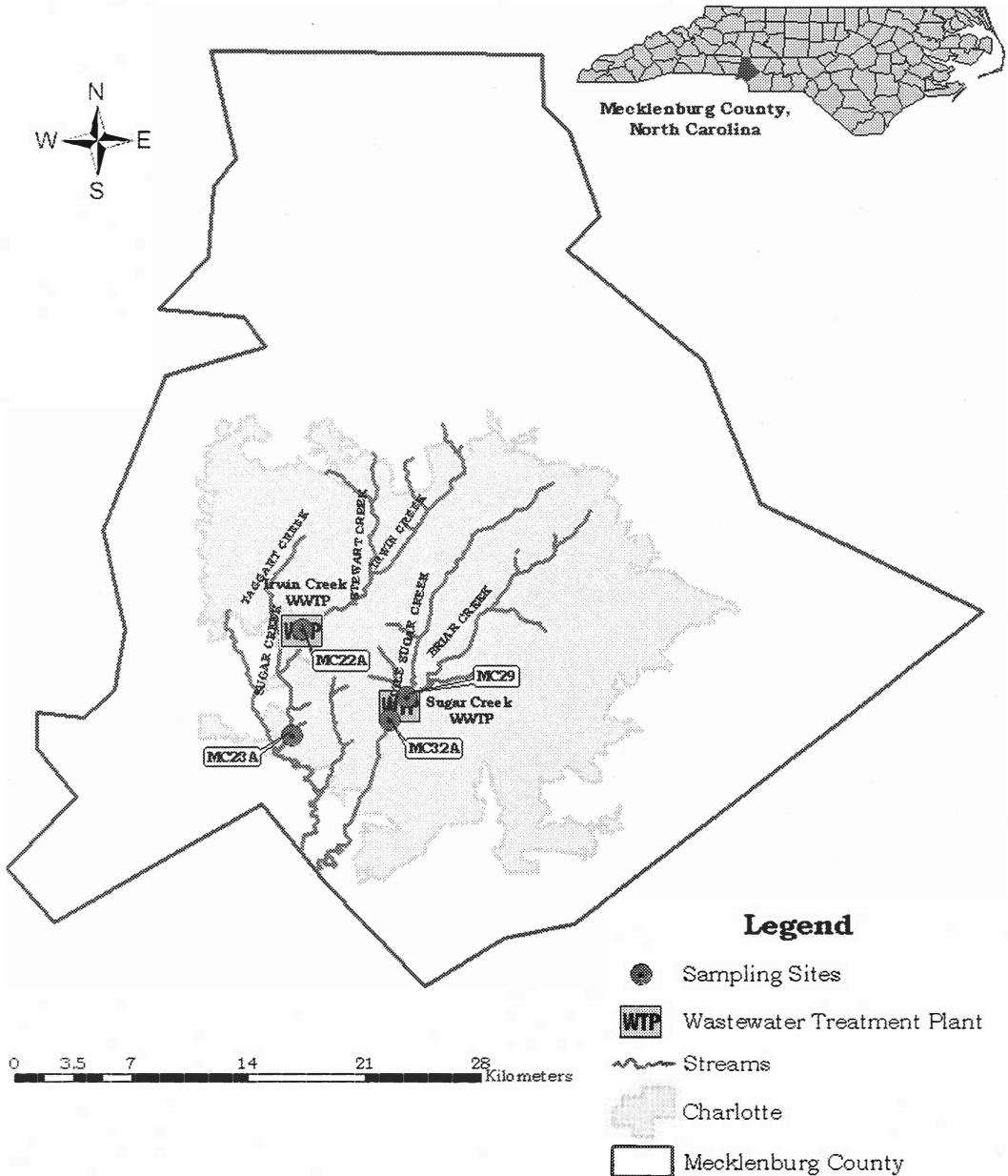


Figure 2. The locations of the stream sampling sites and the wastewater treatment plants

empties into Sugar Creek approximately 1.37 kilometers (0.85 miles) downstream from the Irwin Creek Wastewater Treatment Plant (See Table 1).

These streams drain most of the urbanized areas and are reported to have the worst water quality in Mecklenburg County (Ferrell, 2001). Little Sugar Creek is surrounded predominately by residential neighborhoods with a small amount of wood/brush and commercialized areas. Irwin Creek is surrounded mainly by wood/brush and commercialized areas with a small portion of residential neighborhoods (See Figures 3 and 4).

Methodology

The samples used in this study were collected and processed by the Mecklenburg County Department of Environmental Protection Environmental Laboratory (Mecklenburg County Department of Environmental Protection, 2000). Stream samples were collected randomly four to six times a year after at least 72 consecutive hours of dry weather as part of the phase one requirements for the city of Charlotte National Pollutant Discharge Elimination System Permit. Mecklenburg County Department of Environmental Protection assigned the site names and numbers and the prefix

MC signifies that the sites drain into the Catawba River basin.

The daily average stream flow rates were obtained from the United States Geological Survey gauges located at or near the sampling sites (See Figure 5). There are stream flow gauges at the Little Sugar Creek downstream site (Little Sugar Creek at Archdale Drive 02146507) and Irwin Creek upstream site (Irwin Creek near Charlotte, NC 02146300). There were no USGS stream flow gauges positioned at the LSC upstream site or the IC downstream site, therefore the closed gauges were used to obtain the stream flow. The LSC upstream flow rates were obtained from the gauge located along Little Sugar Creek at Medical Center Drive at Charlotte, NC (02146409), and the IC downstream rates were obtained from the gauge positioned on Sugar Creek at NC51 near Pineville, NC (02146381).

A unique Fecal Coliform Membrane Filtration Technique, which is a combination of several methods, was used to analyze the grab effluent samples for fecal coliform. The calculation method for the fecal coliform densities was the same as in the 9222B.6 Total Coliform Membrane Filtration Procedure from USEPA Standard Methods (Eaton and Greenberg, 1999).

Table 1. Sampling Site Locations and Distance from WWTP

Site Number	Site Name	Latitude	Longitude	Distance From WWTP
MC32A	Little Sugar Creek at Archdale Drive	35.1478N	80.8579W	1.049 km 0.6524mi
MC29	Little Sugar Creek at Park Road	35.1599N	80.849W	1.049 km 0.6524 mi
MC23A	Irwin Creek at Arrowood Drive	35.1391N	80.911W	10.725 km 6.6642mi
MC22A	Irwin Creek at WTPP	35.1964N	80.9056W	0.199 km 0.1242 mi

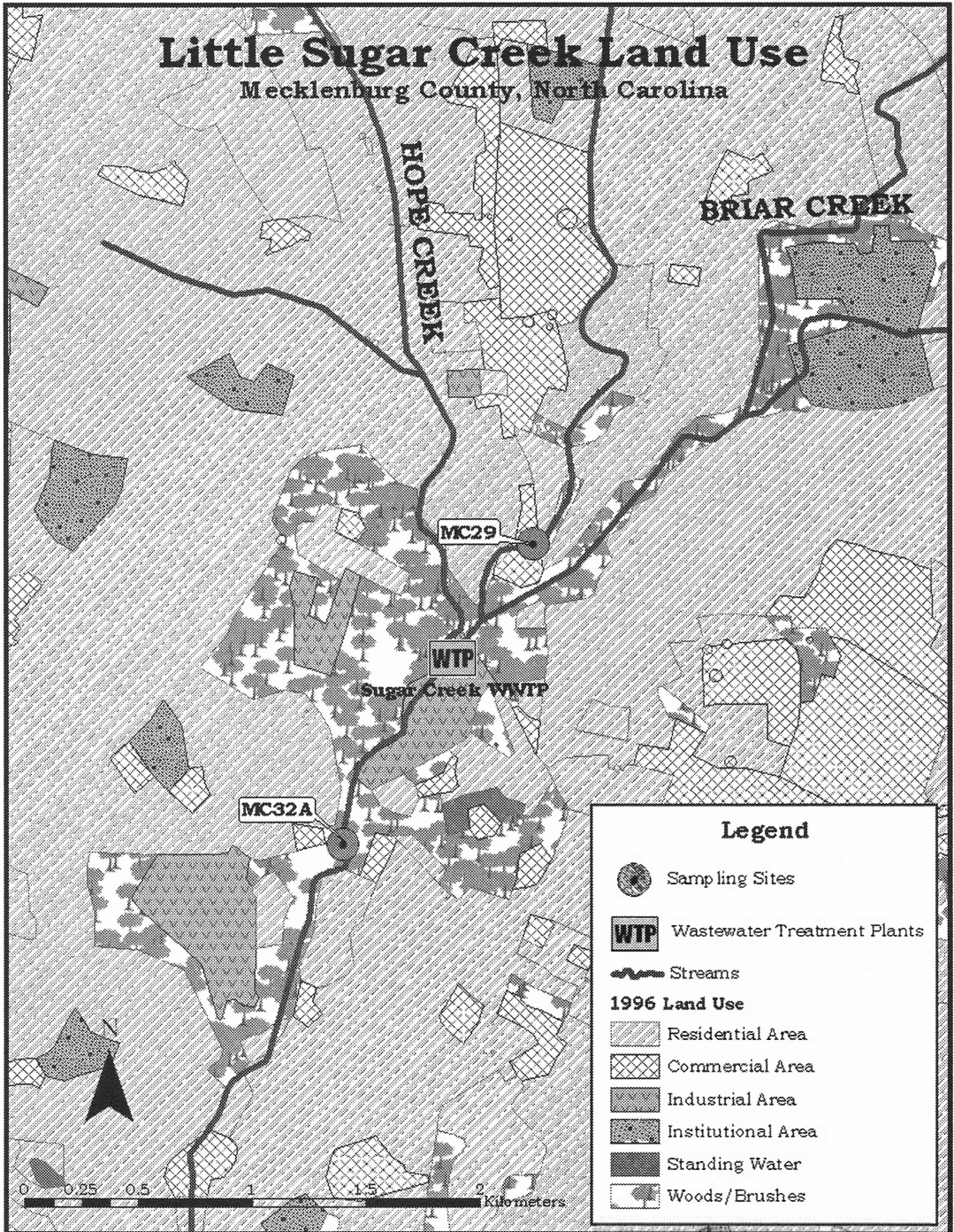


Figure 3. The land use surrounding Little Sugar Creek

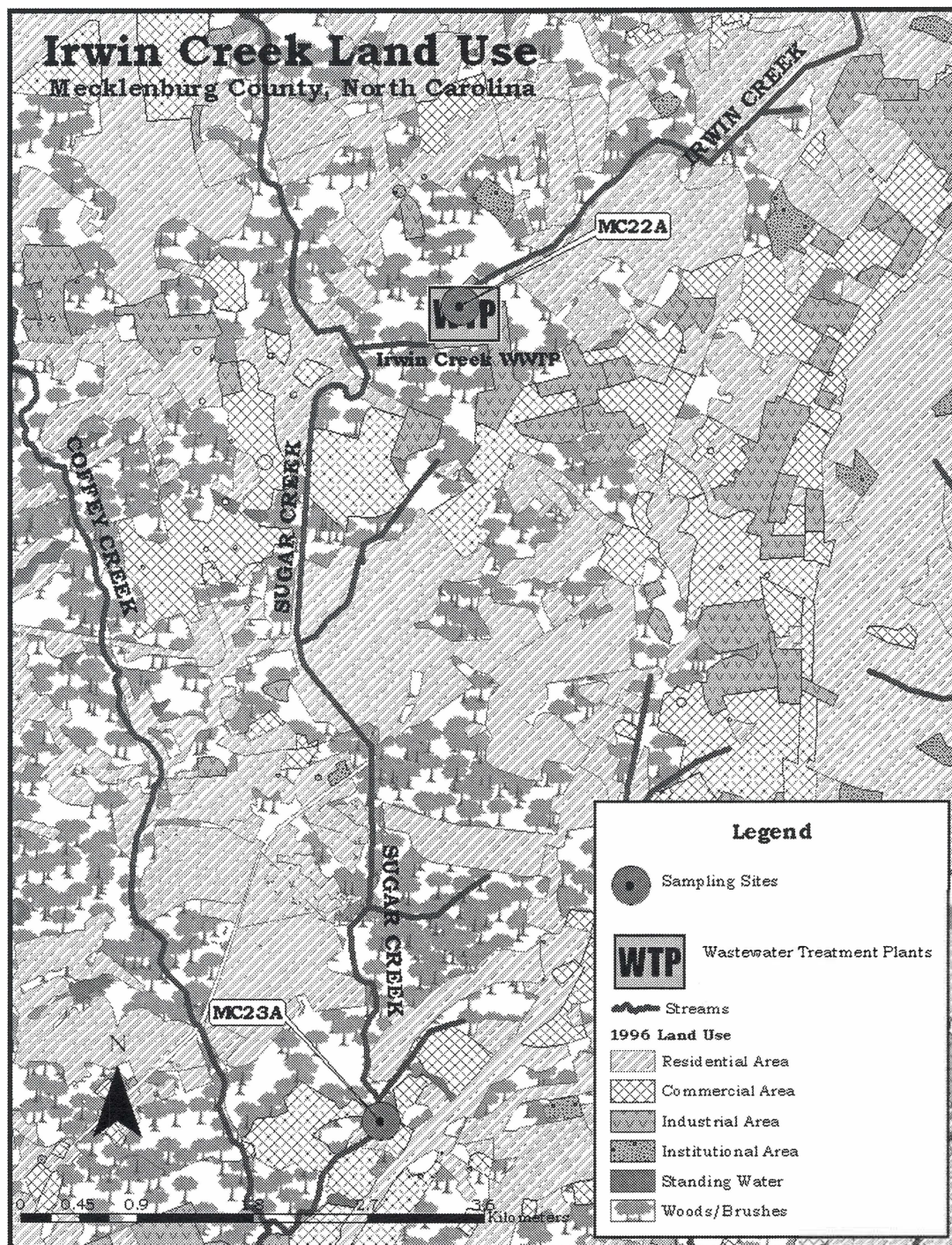


Figure 4. The land use surrounding Irwin Creek

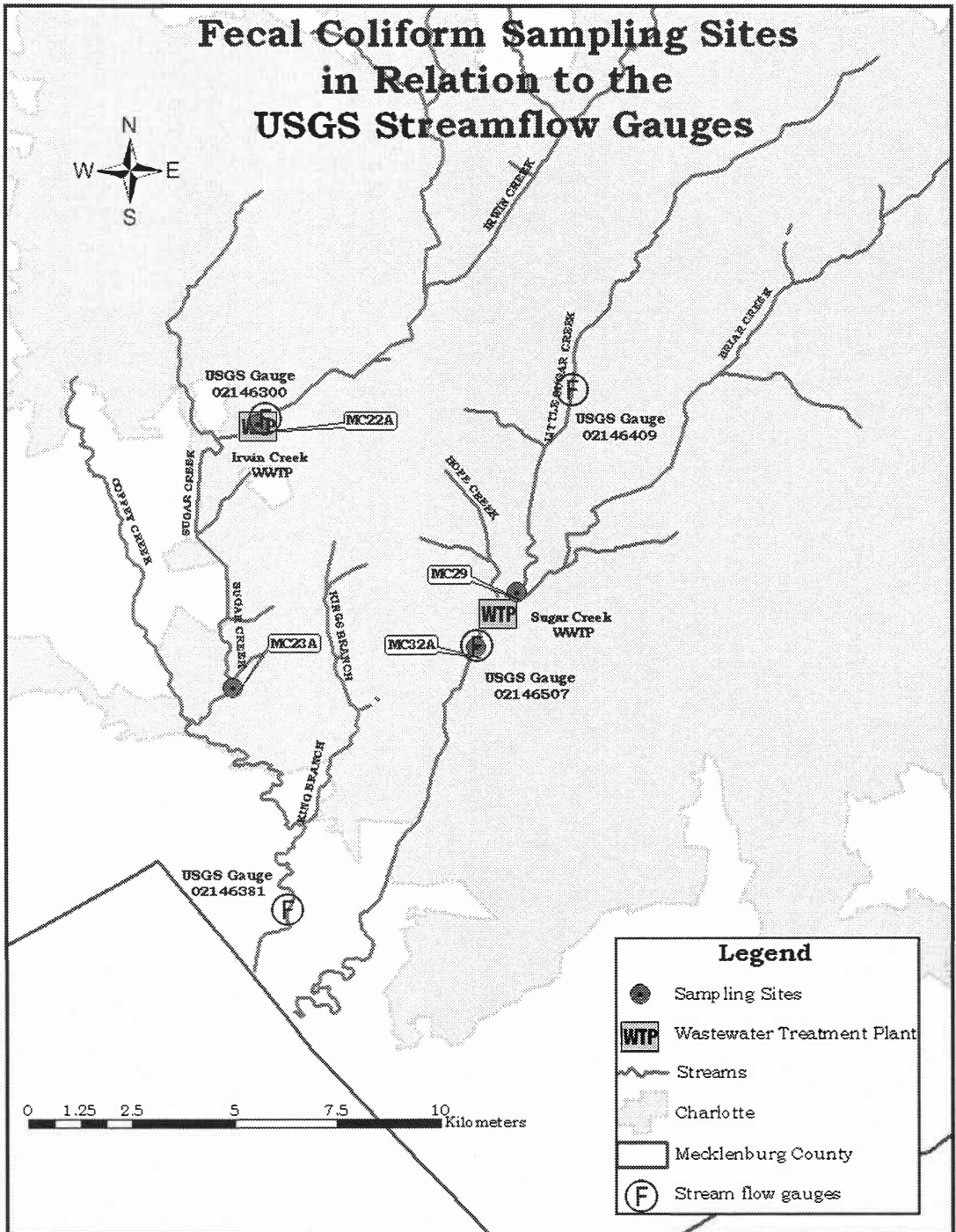


Figure 5. The Irwin Creek and Little Sugar Creek sampling sites in relation to the USGS stream flow gauges

A simple linear regression analysis was performed on the fecal coliform and stream flow data to determine the nature of the relationship between the stream flow and fecal coliform. The data were also analyzed using the Mann Whitney Sum Ranks test. This nonparametric statistical procedure was used to compare the medians of the sample groups. The median was used as the measure of central tendency because outliers do not affect the median. This test was used to evaluate the statistical difference between fecal coliform concentrations in the wastewater effluent at the upstream site and the downstream site.

The fecal coliform data from the sample sites were combined into one group and ordered from smallest to largest, then assigned a rank. If some of the observations were identical, an average rank was assigned. The ranked observations were then divided into the original groups. Next, the sum of the ranks corresponding to each of the samples was calculated. The "W" represented the smaller of the two sums. The "ns" signified the smaller number of samples and the "nL" indicated the larger number of samples. The mean sum of the ranks and the standard deviation of the test statistic were calculated before the test statistic. Once the test statistic was calculated, it was used to determine the

probability of the test. Below are the statistical equations for the Mann Whitney Sum Ranks Test:

The upstream samples were compared to the downstream samples collected over a four-year period from 1998 to 2001. The downstream ambient samples were also compared to the wastewater effluent fecal coliform bacteria samples over the same four-year collection period. The downstream samples were compared to the weekly effluent average because the travel time for the bacteria from the plant to the downstream site remains unknown. The weekly effluent average, which consisted of the fecal coliform discharged for the week, was calculated for the same week the downstream sample was collected. The level of significance was placed at 0.05 for a two-tailed test.

There were a few limitations with this investigation. Since some sites were sampled on a quarterly basis, there were four to six samples collected each year. There is only one Irwin Creek upstream ambient sample available for 1998 because the site did not exist before October of 1998. Also, there is no 2001 effluent data for the IC upstream site. Therefore, the upstream site for 1998 and the effluent data for 2001 were not completely represented during the four-year sample period. The total number of samples ranges between 14 and 22 samples per site. With a small number of samples, it could be difficult to be 95% confident. However, a small amount of data can verify if there is a statistical difference between the sample sites.

Test Statistic

$$Z_w = \frac{W - \mu_w}{\delta_w}$$

Mean Sum of the Ranks

$$\mu_w = \frac{ns(ns+nL+1)}{2}$$

Standard Deviation of W

$$\delta_w = \sqrt{\frac{nsnL(ns+nL+1)}{12}}$$

Z_w: the test statistic

W: the small sum of the two sums

μ_w: mean sum of the ranks

δ_w: standard deviation of the test statistic

ns: smaller number of samples

nL: larger number of samples

Results

There are 21 upstream (MC29) ambient samples and 22 downstream (MC32A) samples for Little Sugar Creek. There are 13 upstream (MC22A) ambient samples and 19 downstream (MC23A) samples for Irwin Creek. A total of 21 weekly mean effluent samples for the Sugar Creek Wastewater treatment plant and 14 weekly mean effluent samples were collected from the Irwin Creek Wastewater treatment plant (See Figures 6a and 6b). A summary of the descriptive statistics for Little Sugar Creek and Irwin Creek is provided in Tables 2 and 3.

The Little Sugar Creek fecal coliform concentrations varies between 50 colonies /100mL and 3000 colonies/100mL upstream and between 3

Little Sugar Creek Ambient and Sugar Creek Wastewater Effluent Fecal Coliform Concentrations

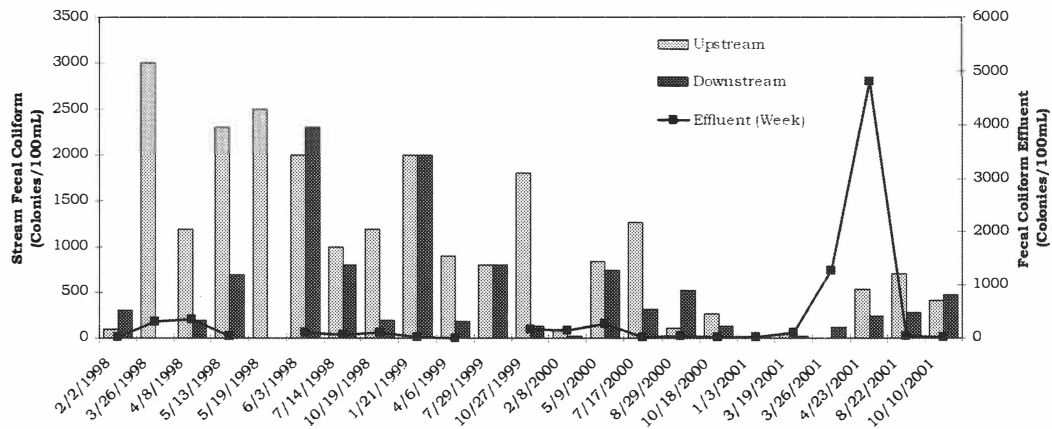


Figure 6a. Bar graph showing the data distribution for the upstream site, downstream site, and wastewater effluent for Little Sugar Creek

Irwin Creek Stream and Effluent Fecal Coliform Concentrations

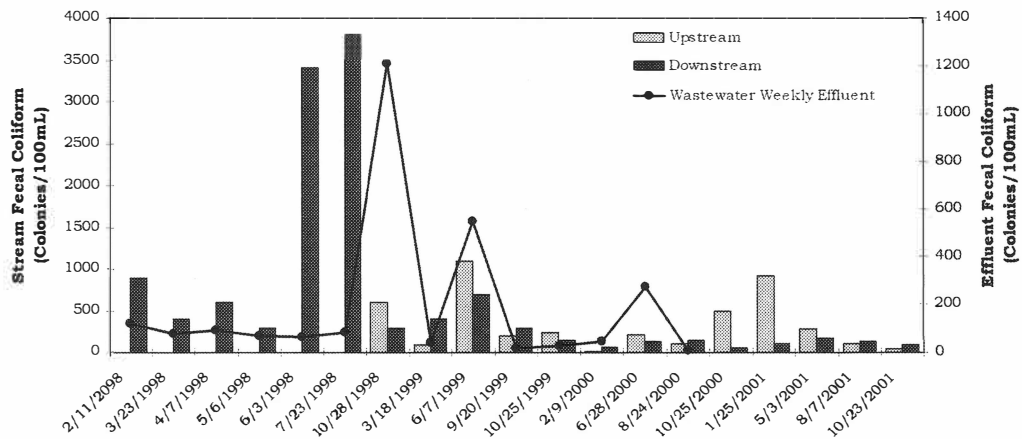


Figure 6b. Bar graph showing the data distribution for the upstream site, downstream site, and wastewater effluent for Irwin Creek

colonies/100mL and 2300 colonies/100mL downstream of the wastewater treatment facility. The Irwin Creek fecal coliform densities vary between 10 colonies/100mL and 1100 colonies/100mL upstream and 50 colonies/100mL and 3800 colonies/100mL downstream. The maximum concentration of fecal coliform (3000 colonies/100mL) measured from the Little Sugar Creek is

observed upstream from the wastewater treatment plant. However, Irwin Creek's downstream site has the single greatest incident of fecal coliform bacteria (3800 colonies/100mL). Likewise, the median fecal coliform bacteria are higher upstream (900 colonies/100 mL) than downstream (260 colonies/100mL) of Little Sugar Creek while the Irwin Creek median fecal coliform bacteria concentration is higher

downstream (300 colonies/100mL) than upstream (210 colonies/100mL).

The 200 colonies/100mL standard only applies to the effluent samples in this study because the stream samples were not collected consecutively within a 30-day period. Little Sugar Creek has samples that exceeded the North Carolina 400 colonies/100 mL standard for the study period in 76% of the samples collected at the upstream site and 36% at the downstream site. The stream samples analyzed from Irwin Creek exceeded the limitation in 31% upstream and 36% downstream. The wastewater effluent

surpassed the North Carolina limitation 24% at the Sugar Creek Wastewater Plant and 21% at the Irwin Creek Wastewater Treatment Plant.

The simple linear regression was performed to determine the strength of the correlation between the stream flow and coliform densities. The results from the test show that both upstream sites have higher correlations than the downstream sites, but the relationship between the two constituents is very weak (See Table 4). However, the graphs display that as the stream flow increases the fecal coliform concentrations decreases (See Figures 7a. and 7b. and 8a. and 8b.).

Table 2. Summary Statistics for Little Sugar Creek (colonies/100mL)

SiteLocations	Number of Samples	Minimum	Median	Mean	Maximum	Standard Deviation
Upstream (MC 29)	21	50	900	1099.05	3000	869.78
Downstream(MC 32A)	22	3	260	478.78	2300	599.98
Effluent (Week)	21	10.20	68.4	379.85	4813.8	1053.42

Table 3. Summary Statistics for Irwin Creek (colonies/100mL)

SiteLocations	Number of Samples	Minimum	Median	Mean	Maximum	Standard Deviation
Upstream(MC 22A)	13	10	210	339.23	1100	343.57
Downstream(MC 23A)	19	50	300	640.53	3800	1069.65
Effluent (Week)	14	9.20	73.8	191.95	1210.2	325.41

Table 4. Correlation Coefficients Between Fecal Coliform and Stream flow

Site Location	Correlation Coefficients
Upstream LSC (MC29)	0.113
Downstream LSC (MC32A)	0.035
Upstream IC (MC22A)	0.197
Downstream IC (MC23A)	0.091

Little Sugar Creek Upstream Site and Streamflow

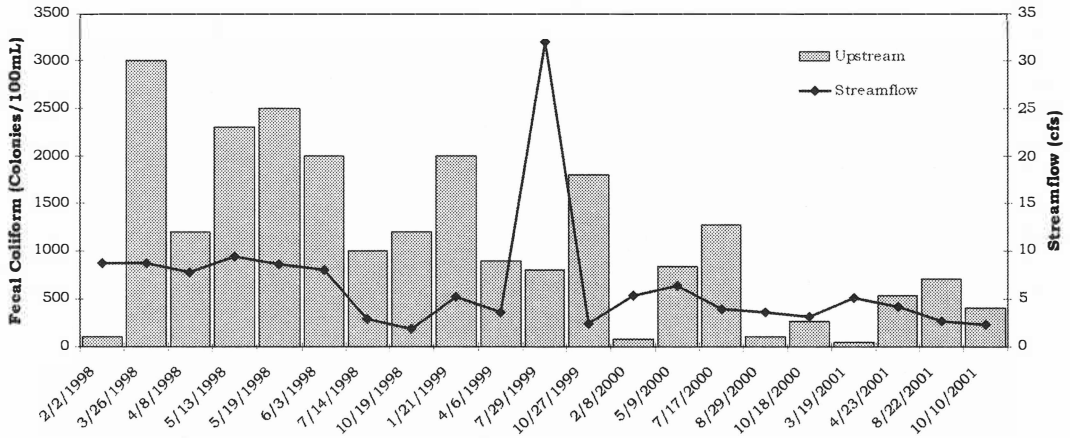


Figure 7a. The relationship between the stream flow rates at the Little Sugar Creek site

Irwin Creek Upstream Site and Streamflow

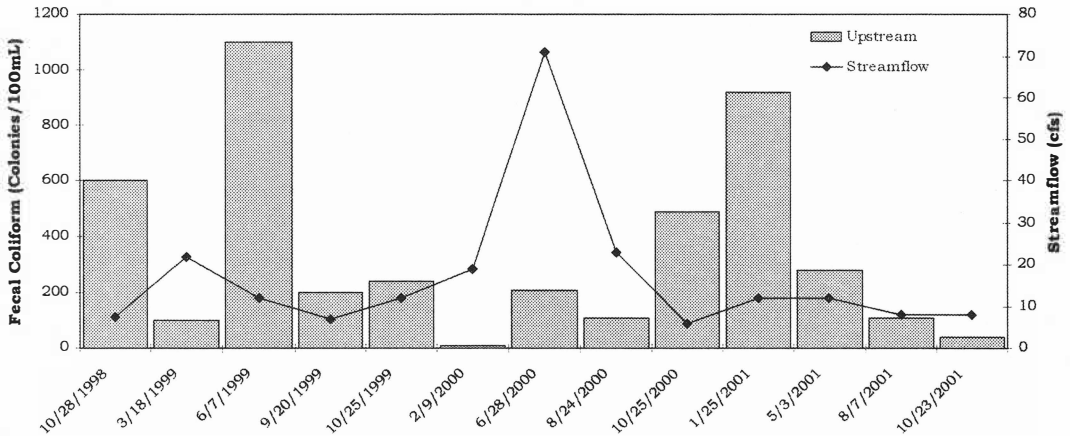


Figure 7b. The relationship between the stream flow rate and the Irwin Creek upstream site

The Mann Whitney Sum Ranks procedure was employed to determine if the fecal coliform bacteria concentration medians of the two locations are statistically equivalent. The results from the Mann Whitney Sum Ranks test revealed a significant statistical difference between median concentrations at the Little Sugar Creek upstream and downstream sites. Concentrations at the upstream site are

significantly higher than the downstream site. The sum of the ranks is associated 570.50 upstream and 375.50 downstream of LSC. The Wilcoxon "W" is 375.50 and the associated "z" score is -2.637. The "p" value for the statistical test is 0.008 for the two-tailed test. There is not a statistical difference between upstream and downstream sites located along Irwin Creek. The sum of the ranks is 199.00 upstream IC

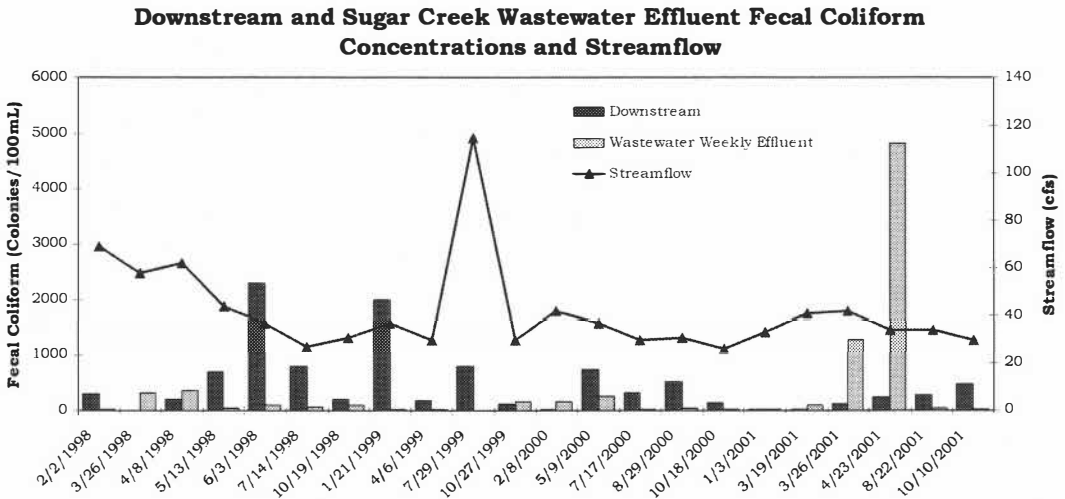


Figure 8a. The relationship between the discharge rate at the Little Sugar Creek downstream site and wastewater effluent

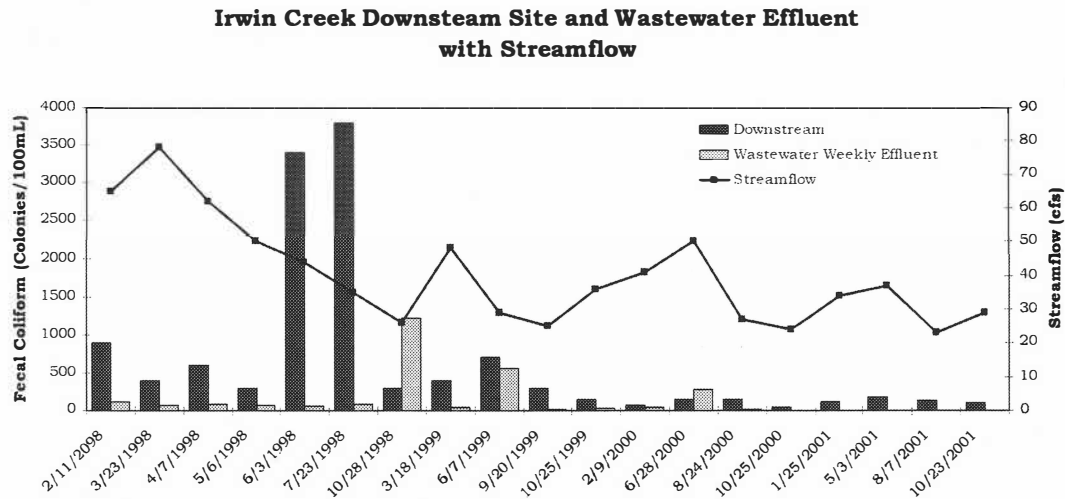


Figure 8b. The relationship between the discharge rate at Irwin Creek downstream site and wastewater effluent

and 329.00 downstream IC. The Wilcoxon “W” is 199.00 and the associated “z” score is -0.595 . The “p” value for the statistical test is 0.552.

The Sugar Creek wastewater effluent fecal coliform concentration ranges from 10.20 colonies/100mL to 4813.8 colonies/100mL. The Irwin Creek wastewater effluent levels vary between 9.20 colonies/100mL and 1210 colonies/100mL. The median coliform

concentration for the effluent is 68.4 colonies/100mL for Sugar Creek Wastewater treatment plant and 73.8 colonies/100mL for Irwin Creek.

The Mann Whitney Sum Ranks test indicated that there is a significant statistical difference between both downstream sites (MC32A and MC23A) and the effluent discharged into Little Sugar Creek and Irwin Creek. The sum of the ranks

is 584.00 downstream of LSC and 362.00 for the Sugar Creek effluent. The Wilcoxon "W" is 362.00 and the "z" score is -2.430. The "p" value for the statistical test is 0.015. The sum of the ranks is 403.50 downstream of IC and 157.50 for the Irwin Creek Wastewater Treatment Plant effluent. The Wilcoxon "W" is 157.5 and the "z" score is -2.934. The "p" value for the statistical test is 0.003. The sum of the ranks is 584.00 for site MC23A and 362.00 for the Irwin Creek effluent. The Wilcoxon "W" is 362.00 and the "z" score is -2.430. The "p" value for the statistical test is 0.015.

Discussion

There were differences in the fecal coliform concentrations measured from the two creeks. Little Sugar Creek had a higher median and experienced more fluctuation than Irwin Creek. Interestingly, the highest concentrations were observed at the upstream site on Little Sugar Creek, whereas Irwin Creek maximum concentrations were found downstream.

Stream discharge rates are known to have an effect on fecal coliform concentrations in streams. The stream flow and fecal coliform data reveal that the fecal coliform concentrations are high when the stream flow is low and suggest that the fecal coliform concentrations at downstream sites of both streams are effected by the increased stream flow rates. These results are very similar to those from the study conducted by Hoch et. al (1996). However, the regression analysis shows that there is no significant correlation between the two constituents, suggesting that the stream flow does not have a statistical effect the fecal coliform concentrations.

When testing to determine if the fecal coliform bacteria medians were equivalent, the outcomes of the Mann Whitney Sum Ranks test were different between the upstream and downstream sites at Little Sugar Creek and Irwin Creek. The significant difference between Little Sugar Creek upstream and downstream sites are similar to that found in a study conducted by Hoch et al. (1996) on the Danube River in Vienna, Austria. However, in their study, the downstream site had higher concentrations. They revealed there is a significant difference

between the fecal coliform concentrations at the upstream and downstream sites with the downstream site having higher concentrations close to the outfall, but decreased further downstream. While conducting a similar study in Canada, Beck (1995) concluded that the upstream site met the required standard for fecal coliform bacteria, but the downstream site did not, indicating the wastewater treatment plant effluents increased the fecal coliform concentrations. The Little Sugar Creek upstream site had higher levels of fecal coliform than the downstream site, which suggests that either the wastewater treatment plants are not increasing the amount of fecal coliform bacteria flowing downstream or is being diluted downstream. Unlike Little Sugar Creek, the insignificant difference between the Irwin Creek sites suggested that the wastewater treatment plant may have had a nominal effect on the water quality downstream from the plant. However the significant difference between the IC downstream site and wastewater effluent indicate that the other streams draining into the Sugar Creek may be influencing the fecal coliform concentrations at the IC downstream site.

Little Sugar Creek sampling sites are located around areas dominated with residential neighborhoods, whereas industrial and commercial areas influence the water quality of the Irwin Creek sites. The dissimilarity in land uses apparently impacted the fecal coliform bacteria concentrations measured at the different sampling sites. In a study conducted by Bales et al. (1999), fecal coliform bacteria densities in Mecklenburg County streams are higher at the sampling sites located near residential areas during low flow storm events. The storm water travels directly into the streams without receiving any treatment from the wastewater treatment plant. The authors did not explore the possible sources for the elevated concentrations in residential areas. Based on the descriptive statistics, their conclusion suggests that increased levels of fecal coliform bacteria are related to residential land use. Even though the ambient samples used in this study were collected at least 72 hours after the last rain event, there could have been some fecal coliform bacteria lingering in the streams.

These streams are located in areas with high population densities and impervious surfaces. Young et al. (1999) analyzed fecal coliform samples from different classes of land use and revealed that high population density and impervious surface cover increases the concentrations of fecal coliform entering streams located in urban areas. Also, those watersheds containing municipal sewage systems tend to have elevated fecal coliform bacteria levels over those watersheds with septic systems. According to an article appearing in the *Charlotte Observer* newspaper on November 7, 1996, the area surrounding Little Sugar Creek and Irwin Creek contains sewage pipes that tend to overflow or leak when the passageways are blocked, which increases the possibility of fecal coliform entering the streams.

Beck (1995) found that fecal coliform bacteria levels were directly influenced by the discharges from the wastewater treatment plant, because the treated effluent and downstream samples exceeded the set standards for recreational activities. The authors noted that the treatment plant in their study did not properly treat the effluent to minimal standards of <200 colonies/100mL set by Manitoba Environment. In this study, the downstream fecal coliform concentrations along both streams were higher than the levels discharged from the wastewater treatment plants. The Sugar Creek and Irwin Creek wastewater treatment plants had a small quantity of the effluent that surpassed the 200 colonies/100mL average with a 30 day standard set by the state of North Carolina. Those few discharges were insignificant in contributing to the streams' elevated fecal coliform concentrations. The results suggest that wastewater treatment plants were not contributing to the elevated fecal coliform bacteria concentrations.

This study does not address other possible sources of the contamination. However, according to the *Charlotte Observer* (July 19, 2000), misdirected pipelines and illegally connected sewer lines tied to storm drains are found several times a year in the Charlotte area and could be the point sources contributing to the increased fecal coliform bacteria levels. In 1999, a Mecklenburg County owned building located upstream from the upstream

sampling site (site MC29) had been illegally discharging raw sewage into Little Sugar Creek. These findings suggest that there may be other unknown illegal sewer lines connected to storm drains discharging raw sewage into Little Sugar Creek. Non-point sources such as fecal coliform bacteria in the feces of domestic and wild animals excreted in and near the streams, and illegal dumping of raw sewage are other are also possible contributors (Mecklenburg County Department of Environmental Protection 2000).

Conclusions

It is important to be knowledgeable of the factors that contribute to the degradation of our surface waters and how effective wastewater treatment plants are in preventing fecal coliform bacteria from entering into our waterways. According to prior studies conducted by the Mecklenburg Department of Environmental Protection (2000), fecal coliform bacteria have degraded the quality of water in Little Sugar Creek and Irwin Creek for decades. The purpose of this study is to determine if the Irwin Creek and Sugar Creek wastewater treatment plants contribute significantly to the fecal coliform bacteria concentrations in Irwin Creek and Little Sugar Creek. The fecal coliform samples used in this study are collected and processed by the Mecklenburg County Department of Environmental Protection between 1998 and 2001.

The findings from the Mann Whitney Sum Ranks test reveal that there is a significant statistical difference between median concentrations upstream and downstream from the Sugar Creek wastewater treatment plant, but not a statistical difference between upstream and downstream sites located along Irwin Creek. There is not a statistical difference between both downstream sites and the effluent from the wastewater treatment plants. Simple correlation coefficients revealed that there is not a significant relationship between stream flow and the fecal coliform concentrations. Therefore, it is concluded that the Sugar Creek and the Irwin Creek wastewater treatment plants do not contribute to elevated fecal coliform bacteria levels measured in the streams.

Acknowledgements

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Disability in North Carolina: Spatial Distributions and Access to Care

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Examination of the spatial patterns of disability rates by North Carolina county reveals regional patterns with eastern and mountain counties having higher levels of disabilities. Income and ethnic measures show the most frequent statistically significant associations with disability rates. Case studies of three counties – Mecklenburg, Chatham, and Halifax – show that residents in the counties with the greatest need for disability services have the poorest geographic access to them. These results have implications for those who make policies concerning the disabled. The paper demonstrates the benefits of collaboration between university students and a North Carolina state agency.

Introduction

Disability is a serious problem in the U.S. Approximately 20% of Americans (around 54 million people) experience an activity limitation due to a physical or mental impairment or health condition. The 1998 and 1999 North Carolina Behavioral Risk Factor Surveillance System indicated that 21% of non-institutionalized adults experience activity limitation as a result of a health condition or perceive that they have a disability (Division of Public Health, State Center for Health Statistics, 2001). To compound the situation, disability is associated with several other problems, including poverty, low educational attainment, and difficulty in obtaining social services. Despite the burden on society of disability, however, it is only recently that geographers have begun to study this problem (Gleeson 1999).

Recent work by geographers and others points toward the idea that disability is a social construction. A person is labeled as disabled when s/he fails to meet societal norms for such activities as employment, schooling, or self-care. Thus, for example, the inability to walk is a serious problem for most people in all times and places, but the inability to drive becomes especially serious in communities where residential

areas are distant from services and access to public transportation is limited.

Most people pursue their daily activities in the belief that everyone is physically and mentally fit. This notion, called *ableism*, “refers to ideas, practices, institutions, and social relations that presume able-bodiedness, and by so doing, construct persons with disabilities as marginalized, oppressed, and largely invisible ‘others’” (Chouinard 1997, p. 380). Being disabled leads to stigmatization and misunderstanding. The disabled are often subject to such psychologically damaging labels as “crippled” or “crazy.” The language used to express deviance marks the body and may have a great deal to do with how people see themselves in relation to others (Butler 1990).

This research was conducted as a service-learning project within the context of a university course on the geography of health. It results from collaboration between the North Carolina Office on Disability and Health (NCODH), three undergraduate students and their professor, and a GIS/computer cartography specialist at the university library. Following a request for information from NCODH, the students, in consultation with NCODH staff members,

developed a term project that met both the needs of the state agency and a class requirement to carry out a group research project.

NCODH wanted to examine the prevalence of people with various disabilities across North Carolina, as well as identify factors influencing the distribution of disability. The agency also wanted to know what types of services were offered by state agencies for people with disability, with a particular emphasis on three counties – Mecklenburg, Chatham, and Halifax – that have different population characteristics. These requests were translated for the purpose of this study into two aims with a spatial focus:

- (1) Examine the spatial patterns of people with various types of disability at the county level and what factors might be related to these patterns, and
- (2) Examine the accessibility of populations in Mecklenburg, Chatham, and Halifax counties to services that cater to the needs of the disabled.

Background

Like many health problems, disability is difficult to define. There are hundreds of different disabilities. Some are present at birth (e.g., hearing impairment); others are the result of occupational hazards (e.g., loss of limbs), aging (e.g., arthritis), or the psychological stresses of life (e.g., mental illness). Disability is often difficult to observe, and requires subjective assessment by both the affected individual and verification by members of the individual's peers. The limited training of physicians in certifying disabilities and the different definitions of disability used by federal (e.g., Social Security, Vocational Rehabilitation) agencies, state and local governments, and the military, lead to a bureaucratic maze that is difficult for people with disabilities to navigate. Furthermore, measuring disability is often beset with problems, including the lack of reliability and validity of instruments, most of which are poorly standardized and produce non-comparable estimates (Elwan 1999). It is important to note that definitional issues underlie some of the difficulties in statistical analyses of disability distributions.

Disability is linked with several other problems. Disabled people (and their families) are more likely than the rest of the population to live in poverty (Elwan 1999). It is difficult to determine whether poverty leads to disability or vice versa. Poor people may become disabled because they face unsafe working conditions or cannot afford to pay for medical care that might mitigate injuries or chronic illnesses. On the other hand, people may become poor because they are disabled, lose their jobs, and have to pay for health care. Many employers are unwilling to hire disabled people, fearing that they will be unproductive or have vocational needs that would disrupt workplace rhythms.

From the preceding discussion, we would expect degree of disability in North Carolina to be related to income level. Disability may also be related to rurality. Twenty-three percent of the non-metropolitan population has disabilities, compared to eighteen percent in metropolitan areas (National Center for the Dissemination of Disability Research 2002). Furthermore, rurality is associated with older populations, lower incomes, less education, and less availability of support services and transportation.

Consideration of rurality leads one to also think about the role of occupation in creating disabilities as many rural jobs such as farming, mining, and logging are among the most physically dangerous (Enders and Seekins 1999). About 2000 farm workers have a finger, arm, or leg amputated every year (North Carolina Dept. of Agriculture & Consumer Services 2001). Certain populations such as migrant farm workers may be especially vulnerable: a North Carolina survey reported that 44.5% of migrant farm worker households had a disabled individual (InterAmerica Research Association 1974).

A possible association is also expected between ethnicity and disability because of the links between ethnicity, poverty, and rurality. Disadvantaged minority groups such as African Americans and Hispanics have higher levels of poverty than European Americans and African Americans are overrepresented in rural areas.

In the US, without comprehensive maintenance programs and other schemes available, disabled people are usually considered to be the responsibility

of their families; publicly funded entitlements are rare, and rehabilitation services are not widely available. The problem of access to benefits for disabled people appears to be especially acute in North Carolina: "The Social Security Administration takes months – and often years – to approve claims it receives for disability benefits" (Krueger 2003).

Additionally, many poor people with disabilities lack appropriate resources to access health care. Insurance companies are often reluctant to pay for specialized care or nontraditional means of health care, such as stress management, chiropractic, and acupuncture. Surveys have shown that, nationwide, up to 46% of persons with disability use public transport regularly, compared with five to six percent of the overall population (Gleeson et al. 1996). Thus, if a needed health facility is not serviced by public transit, it will be inaccessible to many of the disabled. In addition, the disabled are at a disadvantaged in terms of access to or the ability to cope with needed transportation to care.

Measuring geographic access to care has a long tradition in health geography (Joseph and Philips 1984; Ricketts et al. 1994). Traditionally, these measures include the availability of health care personnel, distances traveled to care (Euclidean, road, time), and utilization rates in different geographic areas. Church and Marston (2003), however, argue that traditional methods of measuring accessibility are flawed when applied to people with disabilities because they do not account for the physical and mobility differences between people that might affect travel time, effort, and successful utilization of care.

Studies of disability by geographers can be traced to concerns, starting in the early 1970s, with mental illness and social dependency (e.g., Dear and Taylor 1982; Dear and Wolch 1987). Several scholars working with disability felt that "impairment" should cover a variety of health problems, including chronic illness, but should not be defined in the language of the biomedical model (Gleeson 1999; see also Butler and Bowlby 1997; Dyck 1995). In the last decade, one can discern a new "turn" to disability studies, beginning with Golledge's seminal (1993) article, and picked up by others (e.g., Dorn 1994; Parr 1997; Moss and Dyck

2003). This work provides a valuable theoretical background to this study, which is, in comparison, a more traditional geographic investigation of spatial distributions and geographic accessibility.

Methods

Units of Analysis

For aim (1), examination of spatial patterns of disability in North Carolina, the geographic units of analysis chosen were the 100 counties in the state. Numbers of people with various disabilities in each county are large enough to calculate stable rates for mapping and statistical analysis.

For aim (2), examination of accessibility to disability services, three counties were chosen that were stretched out along the rural-urban continuum and thus had very different characteristics such as population size and percent urban. Mecklenburg is a highly populated and largely urban county (96.24% in 2000), centered on Charlotte, the largest city in the state. Chatham, at the edge of the Research Triangle, is a county that follows a fairly typical pattern of evolving from a rural to a more urban county (19.27% urban in 2000). Many residents commute to work in Raleigh, Durham, and Chapel Hill. Halifax is a relatively remote county, with no metropolitan area nearby; however, it was 42.65% urban in 2000.

It is important for the analysis that follows to profile some salient characteristics of the study counties (Table 1). The relatively low commuting ratio for Chatham County indicates that a substantial proportion of residents work outside the county; many of them, presumably, in Raleigh, Durham, Chapel Hill, or Research Triangle Park. In contrast, the relatively high commuting ratio for Mecklenburg suggests that many people commute to Charlotte from outside the county. Differences in the ethnic composition of county populations are quite striking. Over half of Halifax's population is African American, while only about one-sixth of the residents of Chatham and one-fourth of the residents of Mecklenburg belong to this group. In contrast, almost ten percent of Chatham's population is Hispanic, reflecting the recent wave of immigration into the Triangle Area, whereas only one percent of the Halifax population is Hispanic. Three economic indicators, median housing value, median

household income, and percent below poverty, tell a consistent story. Mecklenburg County is clearly favored in all categories and Halifax the least favored by a large margin. Chatham County lies between the other two in economic indicators, closer to Mecklenburg than to Halifax.

The three counties also differ by age structure (Table 2). Mecklenburg has the largest proportion in the productive age group (16-64) and the smallest proportion of older adults. Chatham has the smallest proportion of children aged 5-15 and the largest proportion of older adults. Halifax has the largest proportion of children, the smallest proportion in the productive age group, and close to the largest proportion of older adults.

Data Collection

Aim (1). Keeping in mind the definitional difficulties noted above, disability in North Carolina was organized into six overlapping categories based on two items in the 2000 census long-form (sampled population). Item 16 was a two-part question that asked about the existence of the following long-lasting conditions: Blindness, deafness, or severe vision or hearing impairment (sensory disability), (2) a condition that substantially limits one or more basic physical activities, such as walking, climbing stairs, reading, lifting, or carrying (physical disability).

Item 17 was a four-part question that asked if the individual had a physical, mental, or emotional condition lasting six months or more that made it difficult to perform certain activities. The four activity categories were (1) learning, remembering, or concentrating (mental disability), (2) dressing, bathing, or getting around inside the house (self-care disability), (3) going outside the home alone to shop or visit a doctor's office (go-outside-home disability), and (4) working at a job or business (employment disability). Items (2) and (3) refer to an established category of analysis and service provision, the activities of daily living (see Lawton and Brody 1969 for a list and also <http://www/cdc.gov/nchs/datawh/nchsdefs/ADL.htm>). They indicate a level of care that can only be provided in a nursing home or with substantial assistance from family members or paid caregivers. Public or private resources to pay for such services are hard to obtain.

Data were collected for sensory, physical, mental, and self-care disability for children 5-15; for all six types of disability for the 16-64 age-group, and for all types except for employment for those over 65. Division into the three age groups was a control for age, a demographic variable that is clearly connected with degree of disability. Rates were calculated by dividing the total count of people with disabilities by type and age group divided by the

Table 1. Demographic, Ethnic, and Economic Characteristics for North Carolina, and Mecklenburg, Chatham, and Halifax counties.

	NC	Chatham	Halifax	Mecklenburg
Population, 2001 est.		51,645	56,703	716,407
Percent Urban, 2000		19.27%	42.65%	96.24%
Commuting Ratio, 2000		0.685	0.922	1.311
Percent White	72.1%	74.9%	42.6%	64.0%
Percent African American	21.6%	17.1%	52.6%	27.9%
Percent Hispanic	4.7%	9.6%	1.0%	6.5%
Persons with a Disability		8,426	15,784	104,224
Median Housing Value	\$108,300	\$42,851	\$26,459	\$141,800
Median Household Income	\$39,184	\$42,851	\$26,459	\$50,579
Percent Below Poverty	12.3%	9.7%	23.9%	9.2%

total population in that age group. Disabled rates by type and age group were mapped by county, using ArcView (Environmental Systems Research Institute, Inc. 2002).

To examine factors that might be related to the spatial distribution of various types of disability, data on a set of variables that the literature suggested might be associated with disability were collected for counties from the 2000 Census. These included three income measures (per capita income, median household income, and percent below poverty), percent urban, percent in primary activities (farming, fishing, and forestry), and two measures of ethnicity, percent African American, and percent Hispanic. Bivariate and multivariate regressions were performed using these variables and disability rates by disability type and age group (15 regressions in total).

Aim (2). Seven services (Department of Social Services, Independent Living Rehabilitation Program, Vocational Rehabilitation Services, Services

for the Deaf and Hard of Hearing, Division of Services for the Blind, Division of Aging, and Mental Health, Developmental Disabilities, and Substance Abuse) were selected as potential sources of care for the disabled. The locations of these facilities across North Carolina were geo-coded by zip-code centroid and placed on maps of the state. Then maps were made showing where these services were located either within the three study counties (Mecklenburg, Chatham, and Halifax) or in surrounding counties (the closest service of a particular type to the case study county centroid was chosen). These maps enabled the examination of access to care for disabled residents of the three counties.

Results

Table 2 shows disability rates for North Carolina and the three case study counties. As expected, rates are low for children aged 5-15, ranging from 14.0 percent to 17.4 percent, but increase to sometimes

Table 2. Percent of population and disability rates by age groups for North Carolina, and Mecklenburg, Chatham, and Halifax counties.

Age Group	Disability Type	North Carolina		Mecklenburg		Chatham		Halifax	
		% of Population	Disability Rate	% of Population	Disability Rate	% of Population	Disability Rate	% of Population	Disability Rate
5-15		15.2		15.4		14.0		17.4	
	Sensory		1.0		1.0		0.8		1.9
	Physical		1.0		0.8		0.4		2.4
	Mental		4.9		4.1		3.9		5.7
	Self-care		0.9		0.9		0.5		1.8
16-64		64.3		68.4		64.1		59.4	
	Sensory		2.5		1.7		2.3		3.8
	Physical		7.1		4.2		5.6		12.1
	Mental		3.7		2.5		2.6		6.9
	Self-care		1.9		1.3		1.4		3.4
	Go-out		6.8		5.8		5.1		11.2
	Employ.		13.3		11.0		11.4		19.2
65+		11.5		8.1		14.7		14.3	
	Sensory		15.4		12.6		13.9		19.4
	Physical		32.3		27.8		27.8		41.2
	Mental		13.2		11.6		10.7		17.3
	Self-care		11.3		9.7		8.9		16.0
	Go-out		22.7		20.3		17.8		30.8

alarming proportions for the productive and older age groups (e.g., 19.2 percent for employment disability in Halifax for those 16-64 and 41.2 percent for physical disability in the same county for those over 65). In North Carolina, almost one-third (32.3 percent) of older adults reported a physical disability, and almost a fourth (22.7 percent) said a disability inhibited their ability to go outside the home. There are clear differences in disability rates among the three selected counties. Mecklenburg rates are consistently lower than or equal to state rates. In contrast, rates for Halifax are always higher than North Carolina rates, often by fifty percent or more. In addition, Halifax rates are always higher than

those for the other two case study counties. Chatham's rates are always lower than state rates; they are sometimes higher and sometimes lower than Mecklenburg's rates. Overall, Halifax has a decidedly heavy disability burden.

It is impossible to describe in detail the spatial patterns of the fifteen age group-disability rates by North Carolina County. Very generally, dividing the state into the traditional Eastern (coastal plain and tidewater), Piedmont, and Mountain regions, it was found that (1) the Eastern region, especially the northeast and southeastern counties, had the highest disability rates, (2) Mountain counties had the next highest rates, and (3) the Piedmont region had the

Figure 1. Mental disability rates for age group 5-15 by county in North Carolina (percents)

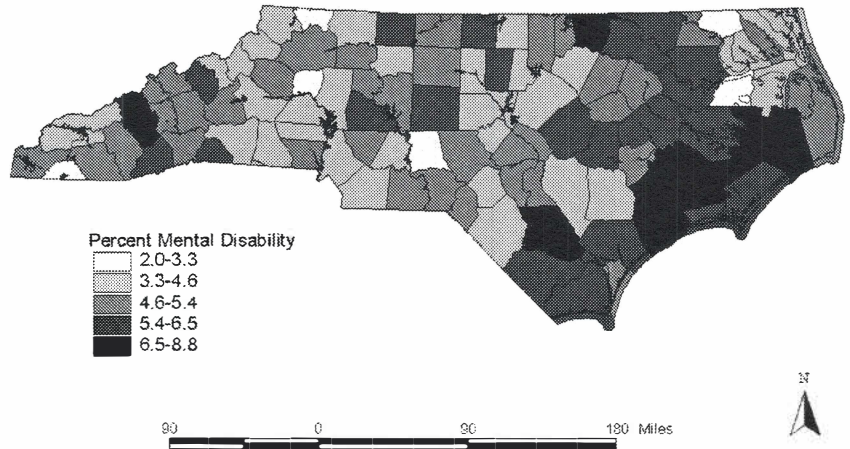
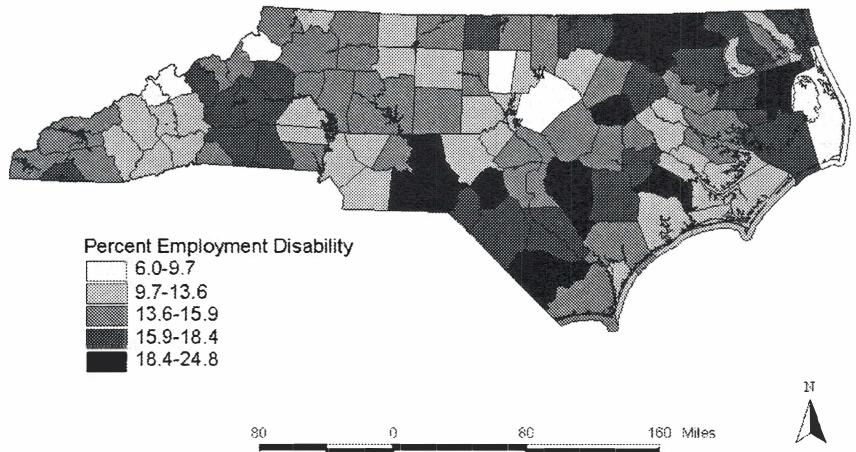


Figure 2. Employment disability rates for age group 16-64 by county in North Carolina (percents)



lowest rates. Figures 1 through 4, which show mental disability rates for children 5-15, employment disability rates for age group 16-64, and sensory and self-care disability rates for those 65 and older, respectively, were chosen as illustrations because they showed some of the stronger patterns, but they generally represent other disability map patterns as well.

Results of regressing the seven predictor variables on disability rates by North Carolina counties are shown in Table 3. For children 5-15, R-squared values were very low and only two independent variables were significantly associated with disability rates. Percent in primary activities was, contrary to expectation, negatively associated

with sensory disability ($t = -2.10$, $p = 0.038$). For self-care, percent African-American was positively associated with disability ($t = 2.53$, $p = 0.0129$), in the expected direction.

For the 16-64 age group, all R-squares were 0.44 or more and all were significant at the 0.0001 level. Two economic independent variables, per capita income and median household income, were involved in models for all six disability rates. For mental, going outside, and employment disabilities, percent African-American showed a positive association. The models for older adults also had fairly high R-squared values and, again, all were significant at the 0.0001 level. Income variables dominated as independent variables

Figure 3. Sensory disability rates for age group 65+ by county in North Carolina (percents)

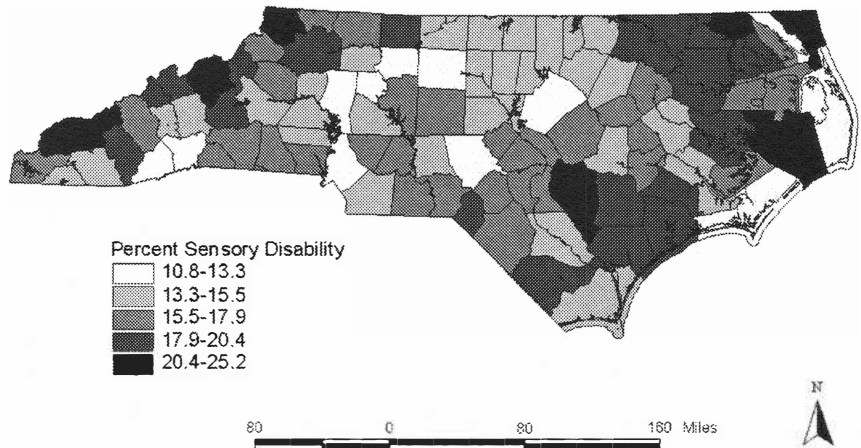


Figure 4. Self-care disability rates for age group 65+ by county in North Carolina (percents)

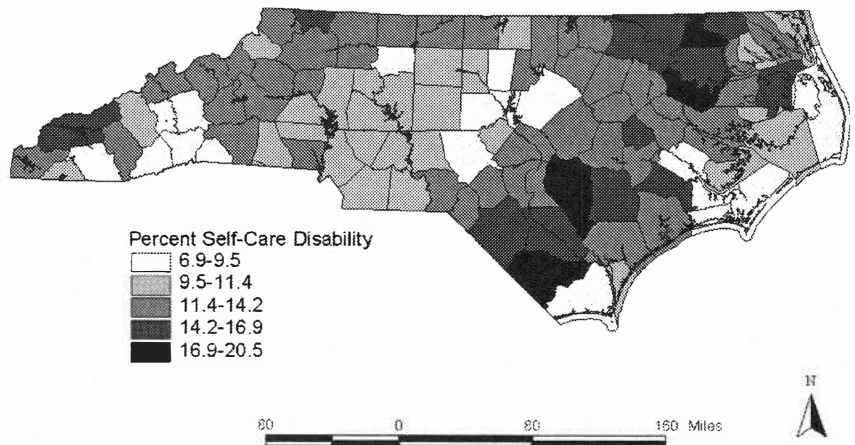


Table 3. Results of regressions of predictor variables on disability rates by age group for 100 North Carolina counties.
**significant at the 0.05 level; **significant at the 0.01 level.*

Age Group	Disability Type	Per Capita Income	Median Household Income	% Below Poverty	% Urban	% Primary Activities	% African American	% Hispanic	Adj. R sq.	P
5-15	Sensory					-2.10*			.03	.0380
	Physical								.13	.0055
	Mental								.04	.1459
	Self-care						2.53*		.05	.0129
16-64	Sensory	-8.87**							.44	.0001
	Physical		-13.32**						.64	.0001
	Mental		-11.09**				2.27*		.62	.0001
	Self-care	-9.97**							.50	.0001
	Go-out	-9.73**					8.04**		.72	.0001
	Employ.	-8.32**					3.13**		.53	.0001
65+	Sensory	-5.10**		2.12*			-3.57**		.47	.0001
	Physical	-10.66**							.53	.0001
	Mental	-7.76**						2.76**	.38	.0001
	Self-care	-4.01**		3.47**					.51	.0001
	Go-out	-7.25**							.34	.0001

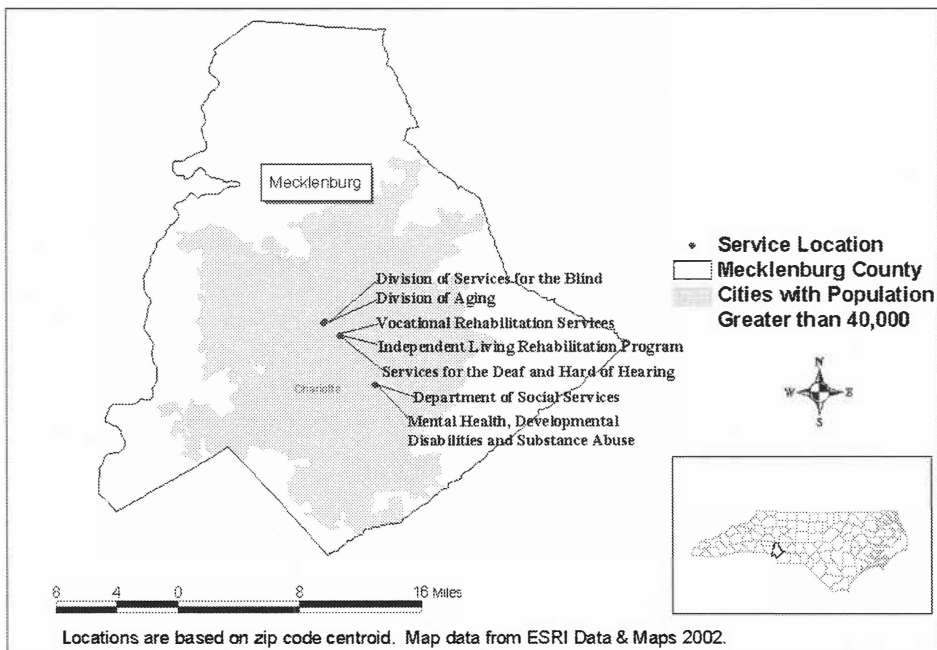


Figure 5. Locations of disability services in Mecklenburg County, NC

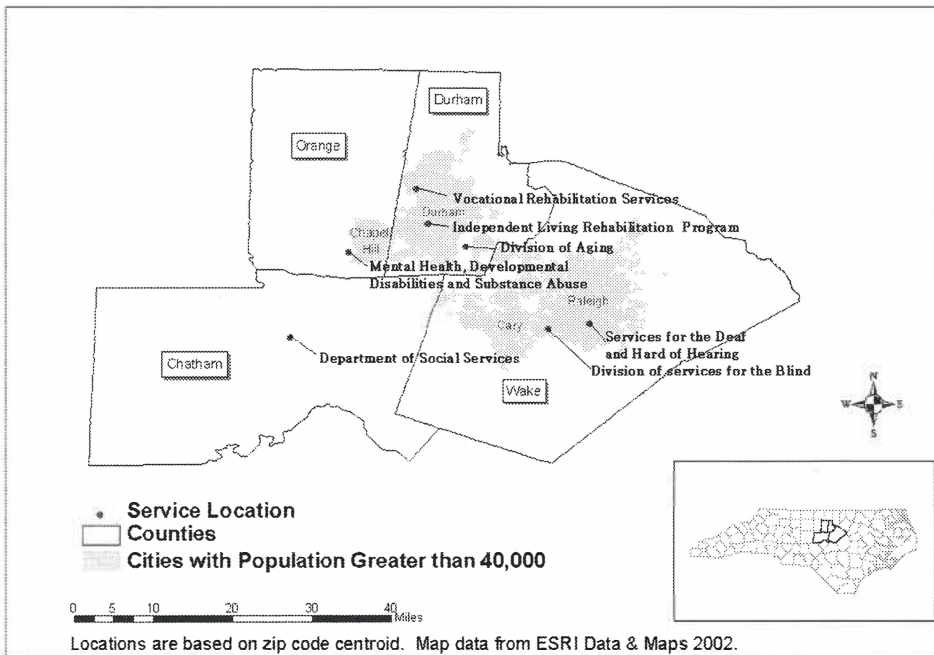


Figure 6. Locations of disability services near Chatham County, NC

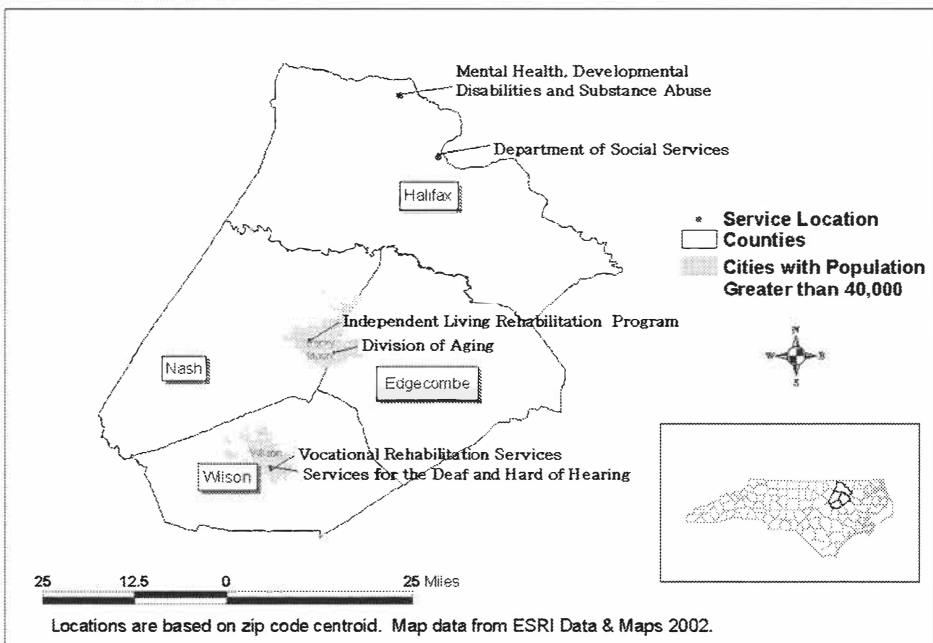


Figure 7. Locations of disability services near Halifax County, NC

associated with disability. For sensory disability, contrary to expectation, percent African-American showed a negative association ($t = -3.57$, $p = 0.0000$), and for mental disability, percent Hispanic showed a positive association ($t = 2.76$, $p = 0.0000$), in line with expectations.

Figures 5 through 7 display disability services in or near the three case study counties. The maps show urban population concentrations of 40,000 or more in order to illustrate the access to care issue more graphically. All seven services are found in Mecklenburg County, located within Charlotte, the state's largest city. Only one of the services is located within Chatham County; for the rest, residents must travel up to 30 miles to one of the major cities in the Research Triangle, Raleigh, Durham, or Chapel Hill. Halifax County has two services; the rest are located in Rocky Mount or Wilson which are, again, up to 30 miles away for some residents. Although it is not known which facilities are accessible by public transportation, one can speculate that many services, especially those farther away from residents, are only accessible by car. It is also interesting to note that Mecklenburg services are most concentrated in the same facilities, whereas those for Chatham County are the most geographically dispersed.

Discussion

Maps of disabilities (Figures 1 through 4) consistently showed the highest rates for the eastern part of the state, the lowest rates for the Piedmont, and rates in between for the mountains. Thus there are regional differences in disability. The disability maps also pinpoint specific counties with relatively high specific disability rates, which is important information for service providers in those counties. Map patterns suggest that negative correlations exist between income and disability and that positive correlations exist between percent African American and disability because disability rates tend to be higher in counties where incomes are lower and percent African American higher. The maps also appear to support the hypothesis that rurality is related to level of disability as counties in both the eastern and mountain regions tend to be more rural.

The connection between higher disability rates and lower incomes discussed in the literature was

the most significant result from the regression models (Table 3). For the 16-64 and 65+ age groups, one of the three income variables (usually per capita income) was always positively associated with disability. It is difficult to ascertain cause and effect in the disability-income relationship, however. People with lower incomes have less access to care and thus less opportunity to alleviate a disability; in turn, those with disabilities have less access to the educational and employment opportunities that generate income. Contrary to expectations and also examination of disability rate maps, degree of rurality (measured by percent urban) was not significantly associated with disability. Perhaps the county level of analysis masks within county differences in rurality. Also contrary to expectation, percent in primary activity was not an important independent variable; in fact the only model in which it was significant, sensory disability for children 5-15, it was negative. Again, the county level of analysis may be inappropriate for examination of the role of this variable. Alternatively, accidents from primary activities may not be as important relative to disabilities created by other activities as was thought.

Ethnicity did play a role, as expected, in some models. Percent African-American was important for self-care for children; mental, going outside, and employment for adults 16-64; and sensory for older adults. Many African Americans are both poor and have disabilities. Being African American could be linked to poverty or more severe poverty compared to being non African American or it could be an independent marker of disability risk because of racial discrimination in such areas as housing, employment, medical care, or social services (see LaVeist 1993). Percent Hispanic was positively associated with mental disability for those 65 and older, a noteworthy result for those providing services to this rapidly increasing minority group.

Comparing the disability rates (Table 2) to the maps of access of residents to disability services (Figures 5 through 7) is a clear illustration of the Inverse Care Law, which states that: "The availability of good medical care tends to vary inversely with the need for it in the population served" (Hart 1971, p. 405). Those who have the highest disability rates

appear to have the poorest geographic access to care. This statement needs to be qualified because it is not known where individuals live in relation to facilities. Information about the travel of a sample of individuals to disability care would be needed to confirm the claim. Part of the explanation for the statement could be that state and county services tend to be better in communities such as Charlotte in Mecklenburg County because they possess large enough tax bases or charity organization to support them.

A major component of the access problem is transportation to care. For example, public transportation is more likely to be available in Mecklenburg County, which is the center of a metropolitan area with Charlotte at its center, than it is in Chatham or Halifax. People in the latter two counties must travel substantial distances, either in their own or someone else's car, to reach a care facility. A factor that might play a role here is commuting patterns: contrast Chatham County's outward flows to the Research Triangle with the flows into Mecklenburg County from its surrounding hinterland.

Access to services can of course be a factor in determining rates because some disabilities can be avoided or eliminated by proper care. However, other factors, such as poverty and ethnicity, are also at work in the least well-served counties. Recall that Halifax County has strikingly higher proportions of African Americans and people in poverty, as well as lower median housing values, median household incomes, and proportion in the productive age group than the other two counties. It is well known to geographers that more urban and richer populations often receive better services of many kinds. Some would respond that this is the way that economic and political forces work and little can be done about it. Others would say that more resources, including services and opportunities to overcome poverty, should be delivered to those who need them the most, in order to eliminate the kinds of imbalances revealed by this study.

This study, we feel, represents a unique collaboration between a North Carolina state agency whose concern is the welfare of a substantial portion of the population and a state university where the primary goal is to provide students with the best

education possible through course work and an introduction to research methods. It demonstrates that a service-based learning project can be of applied to the "real-world" interests of a state agency such as NCODH that does not have the resources to carry out the necessary research (NCODH received a copy of the class project report and will receive a copy of the published paper). At the same time, the students who carry out the projects learn to deal with all of the problems that arise when practical research is conducted.

Conclusions

Analysis of the spatial patterns of disability and access to care services in North Carolina presents a good illustration of the problems the disabled face. Maps of disability rates and of where people live in relation to care clearly demonstrate the inequalities that exist across space. Areas where disability rates are higher often have lower incomes and sometimes have higher proportions of African Americans and Hispanics. It was also found from an analysis of disability service locations in three case study counties that counties with the highest need tended to have the poorest geographic access to services.

This study adds to the relatively small body of geographic literature on the disabled. The analyses, which were carried out at the county and state levels, can be used by health care policy makers to re-allocate funds, add needed facilities, or re-locate existing services. Further geographic work needs to be done at the level of individuals and the places and spaces they inhabit as they cope with the burden of disabilities.

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Antiques Tourism and the Selling of Heritage in Eastern North Carolina

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Antiques tourism is a form of heritage tourism, wherein people travel in pursuit of antiques, or stop to shop for antiques during a trip for another purpose. It is an increasingly popular development strategy for cities and towns across North Carolina and throughout the United States. There have been few attempts to inventory or understand antiques tourism from an academic perspective, thus creating a need for site-specific empirical studies. This study describes the place of the antiques tourism trade in three eastern North Carolina communities —Selma, New Bern, and Wilson. Surveys, personal interviews, and general observation reveal significant differences in the ways in which entrepreneurs define what is “authentic” antiques-based development. There is variation in the scale and spatial form of antiques districts, the level of town involvement in promoting the antiques trade, the marketing strategies of owners and operators, the use of the Internet in promoting and selling antiques, and the types of antiques and customers.

Introduction

Heritage tourism is a growing market sector in North Carolina and the United States. Heritage tourism takes many forms, including museums, memory trails, war memorials, historic downtown districts, community festivals, and state and national parks. An increasingly important form of heritage-based development is antiques tourism. Although the collecting of antiques and historical artifacts is not a recent emergence, its popularity has been augmented as of late by the *Antiques Roadshow*, a television program where ordinary citizens bring family heirlooms and flea market buys to appraisers to learn the history and market value of their items. This show and others have encouraged people to travel to antique shops, malls, and auctions in search of treasures. Jim Tucker, director of the North Carolina-based Antiques and Collectibles Associations, has observed an increase in the number of antiques retailers in the country despite a recent lull in the economy and competition from e-commerce (Jares 2003).

A comprehensive count of the number of antiques establishments in the United States is difficult to obtain. Yet, a recent search of a national business directory revealed that there are at least 40,283 establishments in the United States with a Standard

Industrial Classification of “Antiques-Dealer” (SIC of 5932-02). According to this data, North Carolina has the tenth largest number of these establishments with 1,156 (Table 1). Even more impressive than the sheer number of malls and shops is the extent to which cities and towns have devoted entire districts to antiques tourism. An interesting example of such development is Havana, Florida, which markets itself as “North Florida’s Art and Antiques Capital.” Havana’s antiques district began in the mid 1980s, filling an economic void left behind when cigar production moved to Central America several decades earlier. With more than 30 shops, the city represents itself as a “haven for shoppers and art lovers who are tired of malls and big chain stores.” The relationship between large retailers and antique stores has taken on an interesting dimension in Colleyville, Texas, where entrepreneurs are converting a vacant Kmart building into an antiques mall with Tuscan-style décor (Jares 2003). Historic Depot Town in Ypsilanti, Michigan offers numerous antiques and collectible shops as well as a Farmers’ Market, and several museums. Antiques are an increasingly visible part of the tourist landscape in Kentucky, where approximately 40 of the 281 attractions listed on state-approved interstate signs are antiques shops or

Table 1. Antique Dealer Establishments By State, Sorted by Number (Source: *American Business Disc* 2003)

State	Antique Dealers	State	Antique Dealers	State	Antique Dealers	State	Antique Dealers
CA	4,014	MI	1,102	AL	620	MS	353
TX	3,569	NJ	1,037	CO	615	NH	341
NY	2,769	MO	994	OK	613	NM	278
FL	2,162	WA	939	LA	594	NE	264
PA	1,948	TN	882	SC	579	WV	213
IL	1,371	WI	874	IA	552	MT	205
OH	1,273	IN	743	KY	520	VT	202
GA	1,221	CT	729	AR	490	ID	194
VA	1,158	OR	725	KS	467	RI	183
NC	1,156	MD	714	AZ	435	UT	161
MA	1,134	MN	661	ME	427	Total	40,283

antiques districts. In 2002, antiques and souvenir shopping contributed \$220 million in direct spending to Kentucky's economy (Baxter 2003).

Despite the popularity and economic importance of the antiques industry, it is a grossly under-analyzed topic in the geographic and tourism literatures. Like heritage tourism in general, the selling and buying of antiques can take a variety of different, sometimes conflicting appearances and meanings within communities. Even what is considered an antique is open to multiple constructions and interpretations. Documenting this variation is an essential step in assessing the sustainability and importance of antiques as a platform for economic development.

This paper explores the place of antiques tourism in three eastern North Carolina communities— Selma, New Bern, and Wilson (Figure 1). We used information collected from surveys, personal interviews, and archival resources to document and analyze the diversity of the antiques trade in form, function, and scale; and differences

in entrepreneurial approaches to tourism and the business of antiques. The lack of uniformity in the antiques business in these communities illustrates the extent to which heritage and authenticity are inherently dissonant and contested concepts.

Antiques as Heritage

Antiques tourism is a form of heritage tourism wherein people travel in pursuit of antiques, collectables, memorabilia, old wares, curios, or second-hand items; or stop to shop for these items during a trip for another purpose (Michael 2002). Heritage tourism, as defined in this paper, refers to travel for the purpose of experiencing places, activities, and objects that offer a way of connecting with the past—whether it is for the purpose of nostalgia, creating a distinctive place or self identity, researching family roots, spiritual or religious enlightenment, or the general understanding of historical events and people (Olsen and Timothy 2002). Antiques tourism falls within the realm of heritage tourism since many antiques are marketed

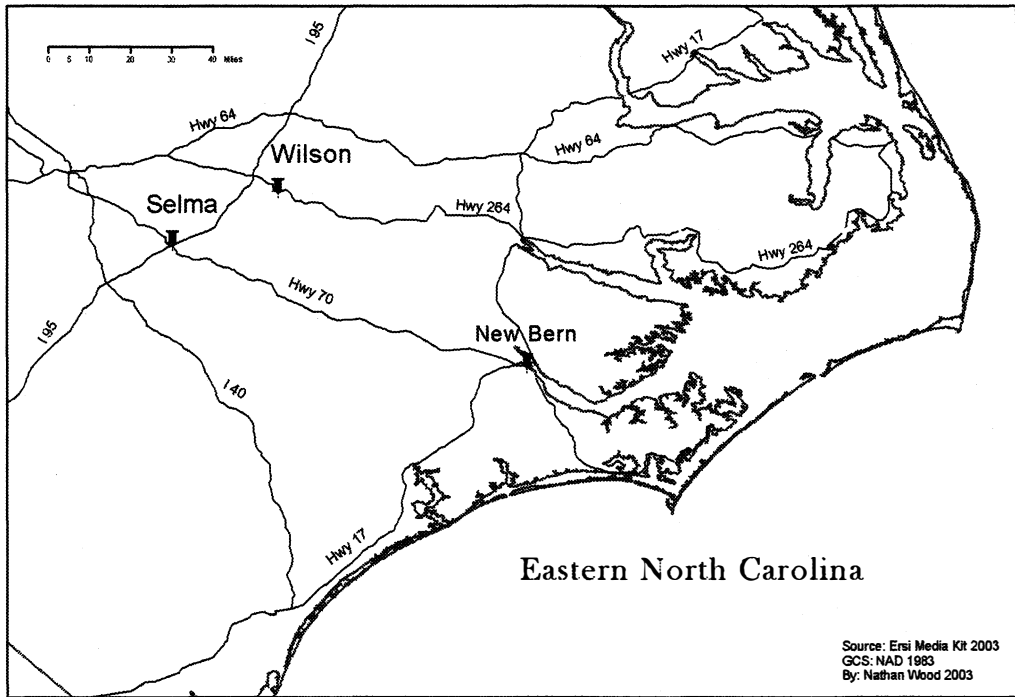


Figure 1. Location of Selma, New Bern, and Wilson.

as historically significant objects or artifacts, and the buying of these goods allows people to use ideas about the past to fulfill their present needs and desires (Graham et al 2000).

Despite the widely held belief that the United States suffers from “historical amnesia,” there appears to be growing public interest in heritage. Rosenzweig and Thelen (1998, 3) suggested that Americans frequently engage in “popular history making,” in which they “take an active in role in using and understanding the past.” They found that while studying history in school bored many individuals, these same people were eager to use the past on their own terms and in ways that contributed to the construction of their identities. Of the almost 1,500 people they interviewed, two-fifths had a hobby or collection related to the past. Some scholars have suggested that the growing popularity of heritage is related to the fact that the world is becoming more globally oriented. Distanced from

their historical and geographical roots, people increasingly reach out for things to link them to those who came before. Shortridge (1996, 10) used the term neo-localism to describe the “deliberate seeking out of regional lore and local attachment by residents (new and old) as a delayed reaction to the destruction in modern America of traditional bonds to community and family.” Implicit in this yearning for place in neo-localism is a desire to return to an earlier time. The concept of neo-localism runs the risk of overly romanticizing the division between local and global. At the very least, however, as Aplin (2002, 16) observed: “We need connections with both place and time to locate our present lives geographically and historically; heritage helps in both the temporal and spatial sense.”

While neo-localism is a useful concept for understanding why people value old things and consume history, it does not capture all the reasons behind why people yearn for the past and desire to

bring it into the space and time of the present. Almost thirty years ago, noted geographer David Lowenthal (1975) discussed the growing popularity of nostalgia among all levels of society, noting the expansion of antique buying to the middle class. In an attempt to explain the social importance of antiques and other tangible forms of heritage, Lowenthal (1985) suggested that there are several benefits to engaging the past. First, the past is used to make the present familiar, providing a framework for comprehending contemporary features and patterns. Second, the past allows us justify or validate current practices and attitudes by referring to tradition. Third, the past is integral to our sense of identity, whether on the basis of family, region, race/ethnicity, or nation. Fourth, the past is a means of escaping the present, creating a distinction between now and then. The past becomes "a foreign and exotic place where people did things differently" (Lowenthal 1996, x). Conceivably, antiques tourism fills these needs and many others. Indeed, Goulding (2000) found that people consumed heritage for a variety of existential, aesthetic, and social reasons.

Antiques as Economic Development

At the same time that heritage has important socio-cultural functions, it is also a resource that is increasingly being used to promote economic development in both urban and rural areas, particularly tourism development (Graham 2002). According to the Travel Industry Association of America, tourists who engage in historical activities "spend more, do more, and stay longer than other types of U.S. travelers" (Hargrove 2002, 10). Antique shops and stores are important sites in the production and consumption of heritage because of their role in transforming historical objects into saleable commodities. Yet, geographers have virtually ignored the antiques tourism sector. Site-specific empirical studies such as the one reported here are needed to inventory and understand this growing industry. This is particularly the case in North Carolina, where the Department of Heritage does not officially recognize antiques tourism and state officials have not attempted to document or evaluate its importance statistically or otherwise. This is odd given that shopping is the

number one activity of tourists visiting the state (North Carolina Department of Commerce 2003). There are early indications that the economic pay off from antiques tourism could be significant. In one of the only economic impact studies of antiquing as a tourism recreation activity, Grado and his colleagues (1997) found that the industry brought southwestern Pennsylvania \$3.36 million annually.

The antiques industry not only promotes local economic growth with the presence of shops, but also supports artisans who prepare the antiques for market. Michael (2002, 121) suggested that the antiques industry is not simply the recycling of used goods but represents a "complex mixture of retailing, wholesaling, and physical production...It generates employment across a diverse range of skilled occupations and . . . preserves skills that are often not required for contemporary manufactures." This point is particularly relevant to antiques in North Carolina, since the state is known for its skilled furniture artisans.

Michael (2002, 123) suggested that the antiques industry generates tourism arrivals in at least two ways. First, it serves as a primary trip generator, drawing people whose predominant reason for traveling is to search for antiques, thus making antiques shops or districts "a destination like any other tourism product." Second, antiques tourism is a secondary trip generator, providing "an ancillary activity at a location that induces the visitor to extend the length of their stay." Although Michael's work took place in Australia, his general findings appear to be consistent with antiques development in the United States. For example, among the three North Carolina communities examined, we observed that antiques had a largely secondary influence on the attraction of travelers to Selma while Wilson would be considered a primary generator of tourism arrivals. New Bern had an even mix of primary and secondary antiques tourists.

Antiques tourism is not single, monolithic industry but a diverse collection of establishments and entrepreneurs. Tunbridge and Ashworth (1996) have suggested that heritage is inherently "dissonant," meaning that it is characterized by a lack of consistency or agreement in the way people produce and consume the past in the present. Similarly, Graham (2002) noted "heritage has multiple uses and interpretations

which immensely complicate any assessment of its role." Heritage tourism does not simply exist in some universal, objective way. It is a "selective re-creation and re-interpretation of the past based upon contemporary values and ideas" (Olsen and Timothy 2002). This is not to suggest that heritage is somehow "bogus history." The past is always remembered and represented in reference to the present. The production of all heritage—including antiques tourism—can take any number of different forms and meanings since the needs and demands of the present vary socially and geographically from place to place. In analyzing antiques development, we felt that a comparative approach would yield the greatest insight and allow us to document the dissonance and diversity intrinsic to this emerging form of tourist development.

The Nature of Selling Antiques

According to Barthel (1996, 345), historical sites and artifacts are heavily sought because the paying public desires an "unmediated" encounter with the past, "to get in touch with history in a very real, literal sense." While the antiques industry puts us in close, physical contact with historical objects, it is not an unmediated experience but one shaped by selection, contextualization, and interpretation (Barthel 1996). As Barthel (1996) also pointed out, representation of the past is mediated by the attitudes, motivations, and actions of powerful individuals who manipulate the exchange of cultural meanings. In the case of the antiques industry, dealers and storeowners frame how the public values and interacts with historical items. Like museums, antiques shops are not simply repositories of artifacts but "carefully managed realms of classification" that play a critical role in determining what counts as an historical treasure and who has the power to assign value to one object over another (Handler and Gable 1997, 3). Although there are many actors involved in the production and consumption of antiques, we feel that any critical analysis of antiques-based tourism must examine the role of antiques entrepreneurs.

Authenticity is a popular theme within heritage tourism studies since attractions are often marketed with emphasis on the genuineness or legitimacy of

the historical experience or product they offer to the public (Chambers 2000, 97-99). Authenticity takes on even greater importance with the selling of antiques since the dollar value of an object is often directly related to its age, documented history, and rareness. However, authenticity is not an inherent quality or condition but rather a socially constructed concept that "varies with different people, at different times, and in different places" (Dylser 1999, 604). Handler and Gable (1997, 223) pointed out that notions of authenticity are based on "an ever-changing historical sensibility that is a product of the present, not the past." Objects, such as antiques and artifacts, become historically significant when identified by authorities, who are not only guided by knowledge of the past but also the desire to project a marketable, believable image to the public (Bruner 1994; Handler and Gable 1997).

Although the 100-year rule appears to be a strict and reliable yardstick for deciding what is an "authentic" antique, our conversations with dealers reveal that authenticity is frequently based upon other criteria and that the term "antique" is open to multiple, and sometimes competing interpretations. While some shop owners include a broad range of goods under the label of antiques, including collectible and vintage items, other dealers pride themselves on the "purity" of their shops. Clearly, because of the dissonant and potentially contested nature of the antiques industry, entrepreneurs target different markets and use different strategies to sell heritage. In the sections that follow, we document the varied ways in which entrepreneurs in eastern North Carolina have envisioned and carried out the selling of antiques.

Methods

This study sought to find out why antique shops are flourishing, where this development is taking place, and what relationship antiques has with tourism in general and heritage tourism in particular. Three North Carolina towns—Selma, New Bern, and Wilson—were chosen for this study because it was believed that they each represented a different style of antiques tourism. The research began with a search for literature on antiques, both regionally

and specifically in the towns chosen for the survey. It was quickly discovered that there were only a few academic studies about antiques tourism. What little that has been written is for a general magazine audience. The research then led to visits to each town to observe the layout of the antiques districts and the style of the businesses.

Because of the influential role that entrepreneurs play in constructing the heritage experience of antiques tourists, we focused on the perceptions, motivations, and business approaches of antiques proprietors. This was done through a preliminary paper survey of five to seven entrepreneurs in each of the three towns. These respondents represent approximately 45 percent of all antiques establishments in each town. This survey collected general information about each business and the entrepreneur's observations of the antiques industry in their local area. The survey was followed by in-depth personal interviews with two different proprietors in each town. Our results are drawn from these interviews as well as our own observations. It is important to note that this is a preliminary study better suited for creating hypotheses for future, more rigorous studies rather than drawing firm conclusions. At this point, given the lack of any

substantive geographic research on antiques—quantitative or qualitative in nature—our goal was to conduct a largely exploratory survey of three antiques tourism clusters. In the next several pages, we provide historical background on these communities and compare/contrast the spatial form of their antiques districts, the level of town involvement in promoting antiques, the style of marketing, use of Internet technology, and the type of tourists served (Table 2).

Historical Background

The small (3.23 square mile) town of Selma is in Johnston County, which is easily accessible from Interstate 95. Smithfield, famous for being the home of Hollywood legend Ava Gardner, is nearby. Selma was chartered in 1873 and was a booming railroad town. Even early on, Selma was a town with an interest in culture and the arts. The downtown area was home to two opera houses, remarkable for a place so small. Selma was also the birthplace of the medicine Vicks Vapo-Rub, which was created in a small downtown pharmacy. The town was noted for having two different rail lines cross in the middle of downtown. These rail lines sent cotton and tobacco from rural North Carolina to the mills where they were

Table 2. Overall Comparison of Three Antiques Towns

	Selma	New Bern	Wilson
Size	3.25 sq. miles	26.98 sq. miles	23.44 sq. miles
District	Revitalized historic uptown	Historic downtown	Hwy. 301
Type of Visit	Passing Through	Overnight Tourist	Business
Type of Visitor	Casual Shopper	Casual Shopper	Dealer
Town Involvement	Heavy	Moderate	Light
Marketing	Dealer's Association Billboards	Visitor's Guide Pamphlets	Billboards Newspaper
Internet	Town and Dealer Advertising and Sales	Town Advertising	Town and Dealer Advertising and Sales
Trip Generator	Secondary	Primary/Secondary	Primary

processed. With the advent of the automobile and the declining importance of the railroad for shipping, Selma began to decline. The once thriving downtown was falling apart, and citizens were searching for a way to bring Selma back to life. In 1997, the town manager, Bruce Radford, came up with the idea of making Selma an antiques center (Hajian 1999).

Selma's antiques development was facilitated by the fact that it was located close to a major interstate and had an historic downtown. Radford pointed to the importance of downtown when he said: "People don't expect to shop for antiques in buildings that are made of brass and glass. They want an older feeling. Our buildings were tailor-made for antiques" (Quoted in Westbrook 2000, 18). Radford offered one year's free rent to anyone who would move into one of the downtown buildings and open an antiques store. The town council approved the idea and started courting proprietors. "I chose Selma because of the concentration of antiques shops and because of town support for this concept," said Tonia Harris, the owner of Visual Pleasures Antiques. However, many of the new investors wanted to buy their buildings instead of just leasing them, because of the amount of the expense of repairing damage inside buildings. One shop owner described the purchase of her building in a state magazine: "At closing, you know how they give you keys? I couldn't get keys. The building didn't have any doors!" (Quoted in Westbrook 2000, 19). Massive renovations were eventually completed, and today Selma has a thriving uptown antiques district.

New Bern, the second oldest town in North Carolina (after Bath), was settled by German and Swiss immigrants in 1710 and named after the town of Bern in Switzerland. Situated between the Neuse and Trent Rivers, New Bern became the site of Tryon Palace, North Carolina's colonial capital, in 1766. The palace was named for Governor William Tryon, and famous for having hosted George Washington for a night's stay during his tour of the new United States. This long history is still very visible in the downtown area. New Bern has the oldest working clock tower in the state. It is also the place where Pepsi was created in a downtown corner pharmacy. New Bern's already active heritage

industry has provided a strong infrastructure for the development of its antiques district. The district is in the downtown blocks, one street over from the waterfront and within walking distance of historic homes and the bed and breakfast area.

Wilson is famous for being the home of North Carolina's heralded Brightleaf tobacco. However, with the decline of the tobacco industry, Wilson has had to explore alternative income sources, including antiques development. Wilson was settled in the mid-18th century by small farmers, and has enjoyed fairly healthy growth. The town was already home to the noted Boone's Antiques, which was started in 1951. A dealer-oriented antiques district has grown around the area of the original Boone's establishment along Highway 301. Today, Wilson markets itself as the "City of Antiques" and is host to several large antiques stores and auction houses. Boone's is still in operation, now housed in a multi-building complex.

Antique Districts

The Uptown Selma antiques district is a revitalized historic downtown area with a cluster of shops. Most of the antiques stores are centered on a four-block area (Figure 2). There are over 10 antiques stores in the town as well as boutiques that specialize in items like handmade soaps and quilts. There is a parking area at the immediate edge of the antiques district, and parking is also available along the street within the Uptown blocks. Visitors are encouraged to park their cars for the day and explore the town on foot. Selma is a day-trip oriented antiques town, with several supporting restaurants and cafes, but no in-town bed and breakfasts or hotels. There are many places to stay overnight in neighboring Smithfield, and many visitors choose to visit Selma after shopping at Smithfield's outlet mall. There are other heritage attractions in Selma. One is the newly restored Union Depot Train Station, which was restored to working order in 2002. Another is the Atkinson's Grist Mill, which is just outside of town. The historic Rudy Theatre offers two shows daily, reminiscent of Selma's opera-house legacy. Selma also hosts a Railroad Days festival each fall to celebrate the town's railroad history and attract additional customers for the antiques shops. The opening of new antiques stores appears to

be progressing steadily as more of the historic buildings are refurbished.

New Bern's antique district, which consists of approximately 12 shops, is also located in the core area of the downtown historic district (Figure 3). Also located in the heart of the historic district is the Chelsea, the pharmacy where Pepsi was created. Today visitors can sit at the counter in a re-creation of Caleb Bradham's store and taste "Brad's Drink" which was created as a hometown version of Coca-Cola. The antiques district is within walking distance of the historic homes district, where many of New Bern's famous bed and breakfasts are located. A common weekend trip is to stay in a bed and breakfast, visit Tryon Palace one day, and then explore the antiques district the next day. Scattered among New Bern's antiques stores are specialty shops, boutiques, and eateries. Because the antiques district is close to the

new waterfront convention center, many people who visit the antiques district are business tourists. As one entrepreneur observed: "When people come to downtown New Bern and stay at the Sheraton or go to the convention, they gravitate down here on Middle Street [the antiques district]."

Wilson's antique district consists of approximately 11 antiques stores with several other establishments specializing in reproduction and refinishing. The district in Wilson is quite different from the ones in Selma and New Bern in that it is not located in the town's historic downtown area. The stores are very large and dealer-oriented. In other words, while the stores are open to the public, they tend to sell to other antique establishments. In fact, some antique dealers in Selma and New Bern buy their stock in Wilson. In addition to antiques stores, Wilson is home to several large auction



Figure 2. The revitalized historic downtown antiques district in Selma surrounds the intersection of Anderson and North Raiford Streets. (Photograph by authors)

houses, including Langston Antiques. The antique district in Wilson is along Highway 301, near Interstate 95 (Figure 4). Stores have their own parking lots, and are too far apart to walk from one store to the next. Wilson has the largest square footage of antiques space of any of the three towns and entrepreneurs have the reputation for carrying expensive, high-end items. There are several hotels and restaurants near the antiques district, including the well-known Parker's Barbeque, but visiting these establishments requires driving as well.

Town Involvement

Selma, New Bern, and Wilson demonstrate significant differences in the level of town involvement. In Selma, the antiques district is being used by local leaders to revitalize a crumbling historic downtown. The town pays for all of the

outside advertising, including billboards and directional signs. Selma has invested a significant amount of money in its antiques district and has been successful in creating a themed historic downtown area with the antique stores. Most of the antiques dealers in Selma belong to the Uptown Selma Antiques Dealers Association, which exists primarily for advertising and promotional purposes. This organization pays for group advertising for the dealers in over 30 publications along the eastern seaboard. The president of the Antiques Dealers Association observed that: "Without town support, the dealers could not be prosperous." Selma is growing at such a rapid rate that downtown business merchants are organizing a second association. This association will include the restaurant and boutique owners as well as the antique dealers.



Figure 3. The antiques district in New Bern is located in the historic downtown area, one block from the waterfront. (Photograph by authors)

In New Bern, there is no association established specifically for the antiques dealers, but the downtown businesses all belong to the New Bern Preservation Foundation and Downtown Merchants Association. The Preservation Foundation and the Merchants Association do not advertise outside the town, but they do host events such as *Alive after Five* and the Antiques Show and Sale. *Alive after Five* is an event where all the downtown businesses, most of which close at five o'clock p.m., stay open until nine o'clock. There are musicians, food vendors, and other outside activities in the downtown area, and people are invited to bring their families and come down to the waterfront and historic downtown area for the evening. The Antiques Show and Sale is held at the Riverfront Convention Center for the purpose of raising money for the Preservation Foundation. Many of the antiques dealers participate in this event by either selling at a booth or volunteering for appraisals or talks on specific types of antiques, such as pottery. The city does not pay for billboard advertising, but the New Bern Visitor's Bureau maintains a website that provides tourist information.

Wilson advertises itself as the "City of Antiques" on billboards along all the major highways that run into or near the town. The Chamber of Commerce and the Visitor's Bureau pay for this advertising. A Wilson antiques store manager stated: "The town is supportive emotionally but not financially . . . people like to go out of town to buy things . . . people from

Raleigh come here." Most of the buyers who shop in Wilson are from out of town, so advertising through billboards and pamphlets does bring in business. At the same time, however, most of the antiques stores in Wilson advertise individually in antiques magazines of their own choosing since dealers are their primary customers.

Marketing

The Uptown Selma Antiques Dealers Association does most of the marketing for the antique district in Selma. They have adopted two slogans—"Antiques Mecca" and "Selma: A Charming Place to be"—for billboards and flyers used by the city. Billboards, the main advertising medium, are placed along Interstate 95 near the Selma exits. One of these exists is connected with the large Carolina Outlet Shopping Center in Smithfield, which is popular among travelers headed north and south on the interstate. Selma's billboard marketing strategy aims to catch people who are stopping in Smithfield and bring them over to Selma. The newest addition to Selma's interstate marketing plan is directional signage. These signs direct people to the Uptown Selma Antiques District after they exit Interstate 95.

Billboards are important for marketing Selma and its antiques district, but they are not the only strategy. Selma has an easy-to-navigate website that showcases the town and provides a printable map of the antiques district. The Antique Dealer's

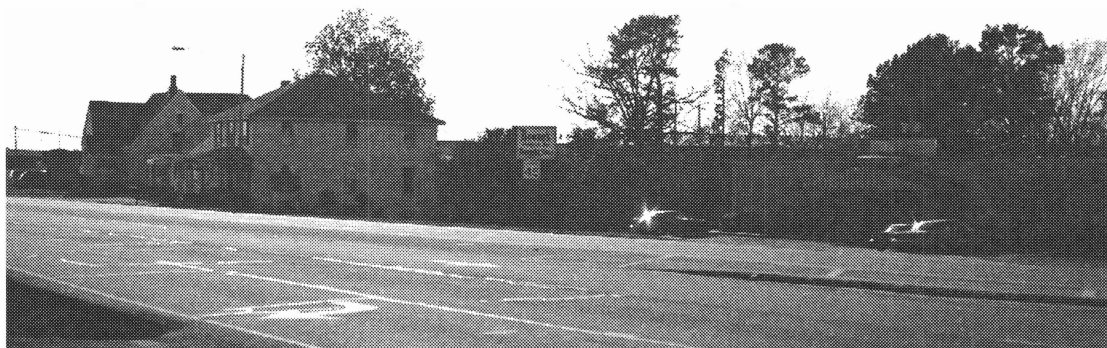


Figure 4. The Wilson antiques district lines the sides of Highway 301, anchored by Boone's Antiques and other large-scale establishments.

Association also purchases advertising space in 30 newspapers. This form of advertisement invites people to include Selma in their travel plans before they leave home. The Uptown Selma Antiques Dealers Association claims to advertise in magazines that go from New England to Florida, and also in the central part of the United States. Some of the shops also do independent marketing in newspapers or magazines. One shop owner holds clinics and classes on antiques in her shop to attract tourists. "I hold appraisal clinics that are free to the public, like little mini antiques roadshows....I usually [advertise] when I have an appraisal clinic coming up."

New Bern's advertising strategy is quite different from Selma's. Instead of emphasizing billboards, it relies mostly on print advertising aimed at people attracted to Tryon Palace and other historic sites in the area. The visitor's guide and the Visitor's Bureau website both feature the New Bern antiques district. The *New Bern Magazine* is a small, complimentary publication found in the town's stores, restaurants, and hotels. It presents articles about the current events and activities in town as well as advertisements for individual establishments, including many of the antique stores. Most of the stores here do their own advertising. Many stores advertise in the *New Bern Magazine*, regional newspapers, and on the local radio station. However, the most common advertising seen in New Bern is in the form of posters and handouts that are found throughout downtown. For example, when the New Bern Preservation Foundation held its annual antique show and sale, many downtown businesses advertised the event with posters in their windows and flyers distributed to customers.

The Visitor's Bureau in Wilson handles group advertising via billboards along the area. The bright yellow billboards proclaim that Wilson is the "City of Antiques, Barbeque, and So Much More," thus illustrating the commitment of town authorities to the antique district. The antique district is currently the biggest marketable area in Wilson. The Visitor's Bureau also produces the Visitor's Guide, which features several pages listing the antique dealers found in town. This pamphlet is available upon request from the Visitor's Bureau. However, most of the direct marketing of the

antiques stores is done individually. Each store handles this a bit differently, but most advertise in regional newspapers and many advertise in national or international antiques publications. Trade paper advertising is the medium of choice for large auctions. Advertising in antiques publications such as the *Maine Antiques Digest* allows the stores to reach the antiques consumer directly. Many of the stores, and especially the auction houses, have established customers. These dealers repeatedly travel to Wilson to buy antiques in Wilson. Many of the stores use a mailing list to inform loyal customers about upcoming events.

Use of the Internet

Although the evoking of heritage can be conceptualized as a reaction to globalization, it is worth noting that trade in antiques is a global business has been enhanced rather than threatened by new Internet technology (Michael 2002). Selma, New Bern, and Wilson all use the Internet to promote their antiques districts. Selma's site, www.visitselmanc.com, taps into a niche market and is used for promoting the town, its antiques district, and heritage festivals. The site features photos of the historic area, a calendar of events, a map of the antiques district, and links to the individual shop websites. Most of the stores have individual websites. Some are used only for advertisement, but many are used to sell antiques as well. In general, surveyed shop owners said they are pleased with their use of the Internet.

New Bern's website, www.visitnewbern.com, taps into a general heritage tourism market by providing information and links to the historic sites in the area, including Tryon Palace. This site is solely for tourism promotion in New Bern, and while it includes the antique district, it does not focus on it. Also, many of the shop owners in New Bern are retirees who operate their stores as a hobby, and they generally do not use the Internet. Therefore, the town website provides no links to specific shop sites.

In Wilson, the antiques district is just one part of a broad tourism strategy that includes a variety of attractions. Wilson's town website, www.wilson-nc.com, promotes all forms of tourism in the town. A significant section of this website is devoted to the antiques district, and includes the address,

telephone number, and website (if available) of every antique store in town. Many of the stores in Wilson have individual websites. All the stores with websites use them for promotion and advertising, and many sell through their sites as well. Wilson proprietors also commonly use larger websites such as Ebay for selling their antiques. Storeowners stressed the importance of the Internet in today's antique market, and stated that they had nothing but positive experiences and increased sales by using the Internet. One storeowner pointed out that the Internet has had a huge impact on the antiques industry. She said: "in your shop you may not have someone who will walk in your door and pay you \$2,500 for a platter. It may sit in your shop for two years, but on the Internet, you can find that buyer tomorrow . . . That's the real difference."

Types of Antiques and Customers

The antique shoppers who visit Selma are usually only there for the day and most are just passing through Selma on their way to another destination. Shoppers commonly spend some time shopping at the outlet centers in Smithfield. However, many people do spend an entire day in Selma. Many of them are on their way to or from Florida. They stop in Selma because it is on their way and many are loyal customers who visit every year, according to one antique entrepreneur we interviewed. While young people do enjoy shopping in Selma, most shoppers are over forty, and many are retirees.

The shops in Selma carry a variety of antiques, but some proprietors specialize in something specific, such as country primitives or a certain type of furniture. Most stores have the ability to ship purchases worldwide, and many will hold purchases for customers who are traveling and wish to pick up their purchases on their way home. According to one storeowner in Selma, an antique's authenticity or historical marketability is not simply a product of its sheer age but the extent to which it can be connected to a prominent family or an interesting story. This same entrepreneur places story cards on pieces for sale in her shop. Many of the stores in Selma offer Wish Lists, a form that customers fill out if they are looking for something specific. The proprietor will then make an

effort to find the piece for customers and notify them to arrange a sale. If the customer has changed his or her mind, the proprietor will put the piece in the shop and sell it to someone else. Most proprietors in Selma buy antiques nationally and internationally, so they are usually able to find what the customer is looking for. According to one shop owner in Selma, she interacts with dealers in France, England, and Chicago.

The visitors to New Bern's antique district are usually tourists who are in New Bern for reasons other than antiques shopping. Many come for the historic sites, an event at the convention center, or a getaway weekend at the bed and breakfasts. Some even arrive by boat and stay in New Bern's marina for a while, and visit the antique stores while they are docked in town. Since most of the shoppers are travelers, and shipping is available (though not encouraged), most of the shops in New Bern sell "small." "Small" are antiques that are small enough to be put into a bag or a suitcase. Therefore, although furniture is available for purchase in New Bern, it is not as common. Most shops are eclectic, and only a few owners specialize. Most of the antiques for sale in New Bern are bought by proprietors at regional auctions or sales.

Many of the stores in New Bern are very small-scale enterprises. Quite a few entrepreneurs moved to the New Bern area after retirement and opened a store because they love antiques. As one shop owner explained: "We retired here, and I always wanted to have a folk art antique shop . . . we've done it for a hobby." This is usually the reason for the shops being small and the advertising being limited.

Like the dealers, the shoppers in Wilson are serious about antiques. Many shoppers are actually dealers from somewhere in the southeastern United States, and they come to Wilson specifically to buy antiques. According to one major antiques dealer in Wilson, visitors usually spend the night and visit multiple antiques houses during their stay. The proprietors of a few of the stores in New Bern and Selma occasionally buy the antiques they sell in Wilson. Some visitors to Wilson are even international buyers, traveling from Asia and Europe to buy antiques.

There are some small stores in Wilson, but they are the exception rather than the rule. Most of the stores and auction houses in Wilson are large-scale business

operations. Stancil's Antiques focuses on high-end "smalls" like silver and English porcelain. The specialty at large auction houses like Langston Antiques is usually furniture. Wilson has been an antiques area for a long time, and this has allowed some of the antiques stores to move into their second or third generation of ownership. Almost all are family-owned and operated, but many have multiple full- or part-time employees. The proprietors in Wilson buy antiques all over the world and ship internationally as well. This also encourages business on a large scale.

Conclusion

Antiques tourism is an increasingly important yet under-analyzed component in the booming heritage industry. This neglect is due, in part, to the varied nature of antiques-based development. No doubt there is a growing national fascination with collecting antiques, collectibles, and other historical artifacts. At the same time, however, antiques tourism is not carried out in an uniform or consistent way across the landscape. It plays out locally in shops, malls, and auctions run by individual entrepreneurs who target different markets and use different strategies. As our anecdotal evidence from Selma, New Bern, and Wilson suggests, antiques districts are diverse collections of establishments and entrepreneurs that defy broad generalizations. Future studies should focus on documenting and explaining this variation in more comprehensive and rigorous terms. It will be particularly fruitful to produce a national map of major antiques tourism clusters, places where antiques-based heritage development takes on great cultural and economic importance.

Variation in the geography of antiques districts results not only from the place-specific development needs of communities but also the dissonant and contested nature of heritage and authenticity. Rather than communicating a universal vision of how the past should be produced and consumed, the antiques industry in Eastern North Carolina—from the large corporate-like auction houses in Wilson to the small, retiree-owned shops in New Bern—demonstrates that heritage is multi-sold and multi-interpreted (Graham et al. 2000). While the inherently loose nature of authenticity has allowed for the rapid establishment of

antiques establishments of varying sizes and styles, there is some concern that a lack of standardization may eventually hurt the sustainability of the industry. Dissonance or discord over what represents an authentic or legitimate antique occurs not only among entrepreneurs but also among customers, who may feel cheated if an item is later independently appraised for less than the purchase price. Future studies will need to provide a more complete unpacking of how authenticity is conceptualized, commodified, and consumed in the antiques trade. This will require conducting in-depth interviews and participant observation with antique dealers and shoppers. History is made in antique stores—like museums—when objects are put in the context of the past, given meaning through stories and narratives, and framed in relation to the needs of the present (Handler and Gable 1997). In this respect, antiques tourism involves not only the trading commodities but also the selling of ideas about heritage and how the past is a resource for the present.

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End Notes

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Transnational Communities in Eastern North Carolina: Results from a Survey of Latino Families in Greene County

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Over the past twenty years, changing processes of globalization and economic integration have sparked an increase in Latino transnational migration to the United States. According to the most recent U.S. Census, Latinos are now the nation's largest minority group, comprising 12.5% of the total U.S. population (U.S. Census 2001). The majority of Latinos qualify as recent immigrants, with more than 70% having been born outside the U.S. (Boorstein 1997; Suárez-Orozco 1995). One noteworthy feature of recent Latino migration has been the emergence of new destination areas, outside of the traditional gateway states of California, Texas and Florida. Among the most significant of these new growth areas has been the Southeastern United States. Census figures show that the Hispanic populations of the states in the Southeast grew an average of more than 200% between 1990 and 2000.¹ As indicated in Table 1, no state in the country experienced a more dramatic increase during this time than North Carolina, which saw its Hispanic population grow 394% (Chatham County nd; Hyde and Leiter 2000; Johnson-Webb 2000; U.S. Census 2000a; Vargas 2000).

This accelerated immigration and settlement of Latino families is profoundly reshaping the demographic, economic, cultural and social landscape of North Carolina (Cravey 1997 and 2000; ECU Regional Development Institute 1999; Johnson-Webb 2000; Johnson-Webb and Johnson 1996; Leiter et al. 2001; Skaggs et al. nd). Yet there is little understanding of the processes of migration at work or the reality of Latinos in specific locales within the state. Our contention is that the Latino migration experience involves a complex set of relationships that link spaces and com-

munities across borders, in a fluid dynamic that we here call *transnationalism* (Glick Schiller et al. 1992; Glick Schiller and Basch 1995). We use this term to capture the ways in which Latinos maintain familial, cultural and economic ties to their 'home' and 'host' counties simultaneously, and thereby build and maintain networks and relationships that straddle nation-state boundaries (Cravey 2003).

In what follows, we present initial results from the first phase of a study focused on better understanding Latino transnational migration in Greene County, a tier-1 agricultural county in eastern North Carolina that has experienced dramatic growth in its Latino population during the past decade (Figure 1). The overarching goal of the study is to specify the patterns, processes and impacts of Latino transnational migration and community building in Greene County as a means of understanding some of the broader migration trends impacting the rural South. Following a brief introduction to transnational theoretical paradigms, the remainder of this report will provide preliminary study results focusing on Greene County Latino family employment and migration histories, as well as connections to home place and integration into the non-Latino local community. This represents an initial step in comprehending the intricate and multi-faceted processes of transnational community building that are flourishing in rural North Carolina.

New Directions in Migration Theory: Transnational Spaces and Communities

Traditional approaches to migration have tended to portray it as a process in which uprooted

Table 1. States With the Highest Hispanic Population Growth, 1990-2000

	Hispanic Population			
	1990	2000	Pop. Change	% Change
1. North Carolina	76,726	378 963	302,237	394
2. Arkansas	19,876	86 866	66,990	337
3. Georgia	108,922	435 227	326,305	300
4. Tennessee	32,741	123 838	91,097	278
5. Nevada	124,419	393 970	269,551	217
6. South Carolina	30,551	95 076	64,525	211
7. Alabama	24,629	75 830	51,201	208
8. Kentucky	21,984	59 939	37,955	173
9. Minnesota	53,884	143 382	89,498	166
10. Nebraska	36,969	94 425	57,456	155

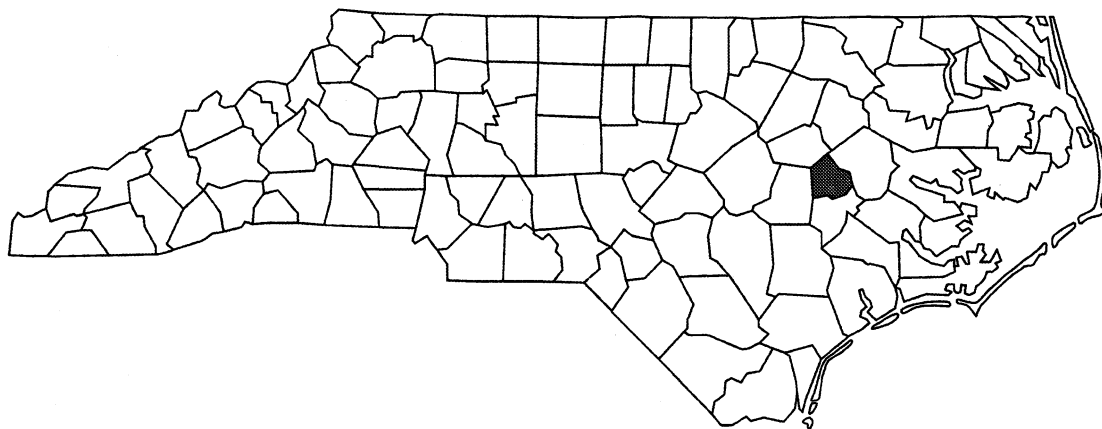


Figure 1. Greene County

settlers break ties to their homeland while seeking to assimilate into a new society (Kivisto 2001; Portes et al. 1999). In a world increasingly subject to global forces, however, there is a need to develop more dynamic and fluid conceptualizations of international migration. This is evident in recent shifts in migration theory that explicitly reject the traditional "bipolar" or "binary" logic of origin and destination

(Anderson 2000; Kearney 1995; Rouse 1992). These shifts reflect a broader critique of population geography, and have served as a catalyst to introduce new theoretical and methodological approaches to the study of international migration (Findlay and Graham 1991; Gutting 1996; Halfacree and Boyle 1993; McHugh 2000; White and Jackson 1995).

Scholars observe that migrants do not rupture

permanently with their countries of origin. Instead, they develop complex familial, economic and cultural networks that transcend spatial and political boundaries to bridge their home and host locations. These circumstances have led to a growing body of research that draws on the notion of 'transnationalism' as a theoretical construct for understanding human migration (Bailey et al. 2002; Rouse 1991; Faist 2000; Glick Schiller 1997; Glick Schiller et al. 1992; Glick Schiller and Basch 1995; Goldring 1998; Smith and Guarnizo 1998; Portes 1996; Portes et al. 1999). Transnationalism embodies the multifaceted linkages, interactions, and relations between people and institutions spanning across increasingly fluid political boundaries of nation states (Vertovec 1999). Through these linkages and processes emerge "transnational communities" (Bresser 1998; Portes 1996) that, according to Conway and Cohen (1998:27), "are characterized by the incorporation of migration (and remittances) cultures into the very adaptive fabric of the social system, such that people live between two worlds: North America and 'home' communities in Mexico, Latin America and the Caribbean."

Geographers have much to contribute to our understanding of these processes, by focusing attention on the role of space and place in the construction of transnational communities. Migrants, from this perspective, are active in the construction of "transnational spaces," which embody not only physical territories but also the larger opportunity structures, networks, ties, social practices and meanings that bind and connect distinct places (Bailey et al. 2002). According to Mitchell (1997:110), geography is ideally suited to examine these complex relationships, and she calls upon us to undertake "transnational spatial ethnographies." Such studies can contribute to the burgeoning literature on transnationalism, by highlighting the ways in which mobility becomes integrated into migrants' sense of space, place, home and community.

Latino Migration in Rural North Carolina

The data presented in Figures 2-4 and in Table 2 suggest that the dynamics of Latino transnational migration in North Carolina are complex and changing. For example, a comparison between Figure

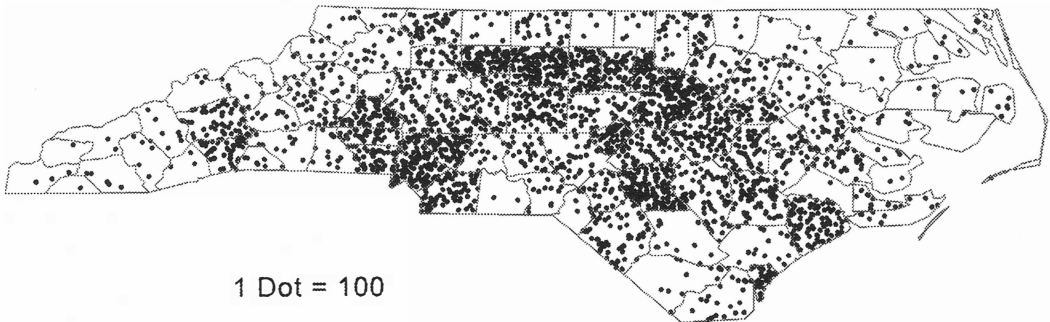
2 and previous maps published in this journal by Johnson-Webb and Johnson (1996, p. 23) indicate that recent Hispanic settlement is much more widely distributed across all parts of the state. Thus, although census figures show that the largest Hispanic communities continue to be located in metropolitan counties such as Mecklenburg (Charlotte), Wake (Raleigh), and Forsyth (Winston-Salem), there is also a significant concentration in the South-Central Piedmont region and smaller concentrations in both Western Carolina and the eastern Coastal Plain. In a number of rural counties (Duplin, Lee, Montgomery, Sampson), Latinos now comprise more than 10% of the total population (see Figure 3). This is striking given that in 1995, only two counties in the state had Latino populations exceeding 5% (Johnson-Webb and Johnson 1996). It is not surprising, then, that counties experiencing the largest increases in Hispanic population are predominantly located in rural areas across the state (see Figure 4). Indeed, a number of rural counties (among them Hoke, Randolph and Tyrrell) saw their Hispanic populations grow more than 1000% between 1990 and 2000.

In part, the growth of the Latino population in rural North Carolina can be attributed to the state's large agricultural sector, which, along with considerable recent growth in manufacturing and agro-industries, has generated employment opportunities for Latinos. To date, however, there has been scant research into the nature and extent of migration into rural areas of North Carolina. To address this, the Department of Geography at East Carolina University has initiated a research project aimed at documenting the transnational experiences of Latino families in Greene County, a predominantly agrarian community located in the eastern Coastal Plain. During the past decade, Greene County experienced a dramatic 894% increase in its Hispanic population, placing it 12th among North Carolina Counties (U.S. Census 1990 and 2000b). Hispanics now make up 8.0% of the county's population, the 6th highest proportion in the state (U.S. Census 2000b). Latinos also comprise 12% of public school children, and the kindergarten class, a sensitive indicator of growth in the Hispanic population, is now over 20% Hispanic (Greene County Public

Table 2. North Carolina counties ranked by: Hispanic Population in 2000; Percent change in Hispanic Population, 1990-2000; and Hispanic Population as a percent of total population

	Hispanic Pop. ('00)		% Change '90-'00	Hispanic Pop. ('00)		% Hispanic
1 Mecklenburg	44,871	1 Cabarrus	1,271	6,620	1 Duplin	15.1
2 Wake	33,985	2 Tyrrell	1,264	150	2 Lee	11.7
3 Cumberland	20,919	3 Alamance	1,100	8,835	3 Sampson	10.8
4 Forsyth	19,577	4 Randolph	1,078	8,646	4 Montgomery	10.4
5 Durham	17,039	5 Union	1,031	7,637	5 Chatham	9.6
6 Guilford	15,985	6 Hoke	1,008	2,415	6 Greene	8.0
7 Onslow	10,896	7 McDowell	965	1,214	7 Johnston	7.7
8 Johnston	9,440	8 Yancey	876	478	8 Durham	7.6
9 Alamance	8,835	9 Davie	837	1,209	9 Onslow	7.2
10 Randolph	8,646	10 Forsyth	831	19,577	10 Hoke	7.2
11 Catawba	7,886	11 Burke	824	3,180	11 Cumberland	6.9
12 Union	7,637	12 Greene	794	1,511	12 Alamance	6.8
13 Duplin	7,426	13 Sampson	791	6,477	13 Randolph	6.6
14 Cabarrus	6,620	14 Catawba	756	7,886	14 Surry	6.5
15 Sampson	6,477	15 Robeson	751	5,994	15 Yadkin	6.5
N.C. Total	378,963		394	378,963		4.7%

Hispanic Population in 2000 by County

**Figure 2.**

Schools 2003). Greene County now ranks among the top five counties in North Carolina with respect to Hispanic births as a proportion of total births, reaching 13.6% in 1997 (Johnson et al. 1999).

Initially, predominately male migrant workers were drawn to work in the fields of Greene County,

which encompasses the most tobacco dependent region in the state. More recently, however, the nature of this migratory flow has shifted toward more "permanent" migration and settlement of families including women and children. Indeed, there are strong indicators of lasting Latino community

Change in Hispanic Population, 1900 - 2000

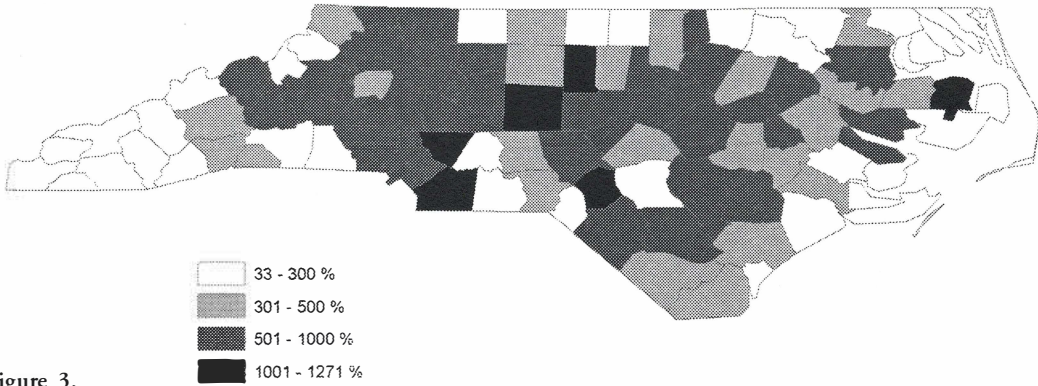


Figure 3.

Hispanic Population as a Percent of Total Population, 2000

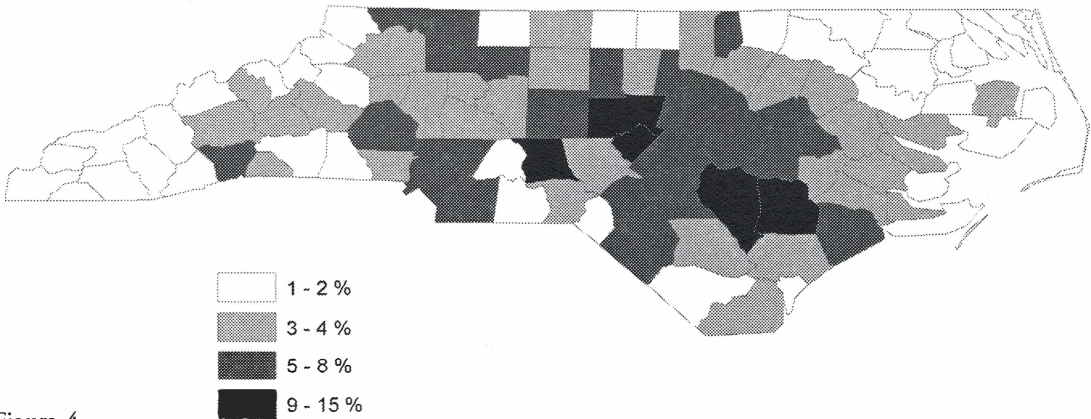


Figure 4.

building in Greene County, such as the proliferation of small Latino-managed *tiendas* (stores) in nearly every major neighborhood in the county. Services offered range from fast food to bus tickets, Western Union money transfers and Mexican cowboy boots. Several informal Latino businesses now offer construction, landscaping and auto repair services to clients outside the Latino community itself, and local

salsa bands find enough gigs to make a reasonable second income for band members. The county now has a small, but vigorous adult soccer league, which is largely comprised of Latinos, and Greene Central High School, a bastion of baseball, recently added a varsity soccer program. Snow Hill, the county seat, plays host to a Latino Festival weekend in the late summer months, which serves not only to provide a

meeting venue for Latinos from surrounding counties, but also one in which Latinos and non-Latinos can meet outside the work environment. Eastern North Carolina, in other words, is rapidly becoming a transnational community. The growing Latino presence is fundamentally altering the economic, cultural and social landscape of the region.

Methodology

In 2002, three geographers affiliated with ECU's Rural Development Initiative (Rebecca Torres, Jeff Popke and Holly Hapke), in collaboration with the Greene County Public School System (GCPS) and the ECU Rural Education Institute (REI), received funding from the Z. Smith Reynolds Foundation in support of "Los Puentes: Dual Language Immersion Multicultural Education and Research Program." This project combines approaches to "two way" or "dual language" immersion and multicultural education with a program of supportive academic research. Within this context, the ECU Geographers initiated an empirical study of the area's demographics that sought also to identify the needs of parents and children in the community. Specifically, this research is focused on better understanding the patterns, processes and impacts of Latino migration to eastern North Carolina and the socio-economic realities of Latino residents.

The first step of the research has been to conduct an extensive socio-economic survey of Latino families with children enrolled in Greene County Public Schools. "Families," for the purposes of this study, are defined as any households with children enrolled in GCPS—whether they are under the care of parents, relatives or other guardians. In spring 2003, initial survey forms were designed, covering a wide range of topics, from socioeconomic status and living conditions, to remittance behavior and use of social services. The survey forms were pilot tested with mothers enrolled in the local Family Literacy program and revised accordingly based on feedback. Given the literacy barriers that exist, the decision was made to conduct telephone interviews with parents or guardians in lieu of sending home written survey forms with children.

Interviews were conducted throughout the summer and fall of 2003. A total of 139 surveys were completed, representing a 39% sample of all 358 Latino households with children enrolled in GCPS. Including all household members, 697 people were represented in the study sample households (an average of 5 people per household). Households were contacted and asked to participate on a voluntary basis. While most of the questions were focused on obtaining household-level information there were also queries specific to the respondents' personal experiences. In most cases, those agreeing to participate were women. This is due, in part, to their lower participation in the labor market making them more likely to be home and available to answer questions. Also, because the survey was viewed as being linked with the school system and involving issues related to children, males tended to defer to female members of the households. As a result, although women account for less than half (46%) of adult household members in the study, they comprised 78% of all survey respondents. The resulting gender bias must be considered in the analysis of the specific questions related to the respondent (as opposed to the household).

Presented below are selected preliminary results focused on those variables that indicate some measure of transnationalism among Latinos living in Greene County. We view this survey as the first phase of a long-range examination of Latino transnational processes in North Carolina. The next phase, which we hope to commence in the spring of 2004, will comprise a series of in-depth interviews, focus groups and family histories designed to add more personal narratives to the data presented here. In the long run, it is our hope that the research initiated here will contribute to a better theoretical understanding of the dynamics of transnational migration in the rural Southern U.S., while also making a strong, practical contribution to enhanced policy formulation and service delivery by the Greene County school system, government institutions and their state-level counterparts.

Preliminary Results: A First Look at Latino Families in Greene County, NC

I. Latino Household Structure, Employment and Poverty Indicators

One of the primary survey objectives was to collect socio-economic background data on Latino households that would serve as a baseline for future investigations. These data are useful in situating Latino families within the eastern North Carolina socio-economic framework. In terms of household structure, of the 697 Latinos living in households surveyed, 322 (or 46%) are adults of at least 18 years of age. Of these, 54% are men and 46% are women. In general, Greene County Latino households tend to follow a nuclear family structure, with few extended family members resident. Indeed, survey respondents, their spouses and children account for 91% of all household residents, with the remaining 9% divided among siblings (4%), grandparents (2%), parents (1%), and cousins (1%).

As with findings reported in other studies, a preliminary analysis of the data revealed that Latino households are over-represented in low-skilled employment and live on the margin of poverty. This, in part, reflects the relatively low levels of education demonstrated by adult household members surveyed, averaging only 7 years of schooling completed (6th – 7th grade equivalency). An analysis of household employment patterns revealed that, in the 139 households surveyed, there were a total of 200 adults employed (not including 63 who identified themselves as “homemakers”). Figure 5 provides a summary of the principal occupations represented in the sample. Agriculture was the predominant form of employment with approximately 38% of the employed household members working as farm laborers. This reflects the fact that agriculture continues to provide the economic foundation of Greene County, particularly tobacco, cotton, hog and poultry production. Other important employment categories included construction (23%) and non-farm low-skilled labor (21%). The balance

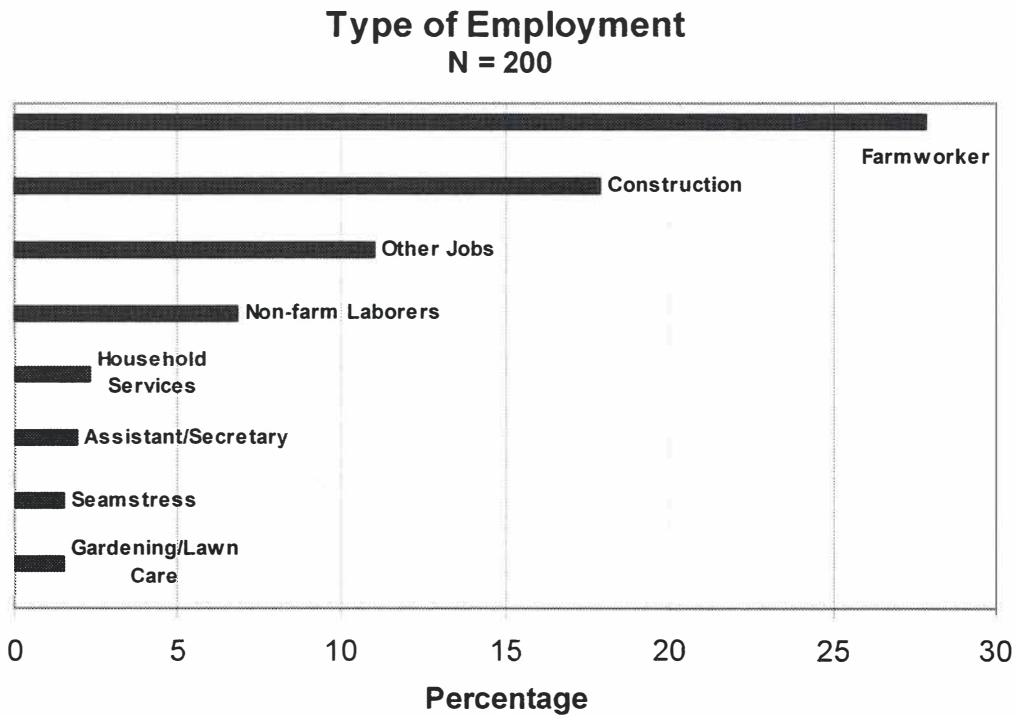


Figure 5.

of employment was sprinkled among a diverse group of labor categories, including administration, secretarial, domestic, gardening and restaurant work, among others.

An analysis of average household monthly income suggests that most Latino families live on very low wages. Respondents reported an average monthly salary of approximately \$600 per employed worker. Three quarters of all of the households surveyed live on average household earnings of less than \$2000 a month (see Figure 6). This places a significant number of respondent households at or below poverty thresholds as determined by the U.S. Department of Health and Human Services.²

Other data also suggest relatively high levels of poverty among Greene County Latino families. For example, 90% percent of all households qualify for free or reduced lunches for their school-aged children, a common poverty indicator used by school systems. One-third of the families rent their housing, while 55% own their home and 8% live in accommodations provided by their employers. Nearly 90% of the families live in "single wide" mobile homes, among the poorest housing available

in a county that is notorious for its high number of dilapidated, fully depreciated trailers. Twenty percent of the families own a computer and only 10% have Internet access in their homes, highlighting the so-called 'digital divide' in access to technology among different ethnic and racial communities in the U.S.

II. Transnational Routes to Eastern North Carolina

One of the principal objectives of the survey was to improve understanding of the patterns and processes surrounding Latino transnational migration to rural eastern North Carolina. The survey included a series of questions designed to acquire migration histories of informants and other household members. Specific questions included birthplace, prior residence, place of arrival in U.S., duration in the U.S. and NC, and factors influencing decision to settle, among others. Presented below is a brief discussion and graphic representation of selected study results related to the migration history of the sample population.

Greene County Latino families are overwhelmingly Mexican by origin. Of the 319 adult household members accounted for in the survey,

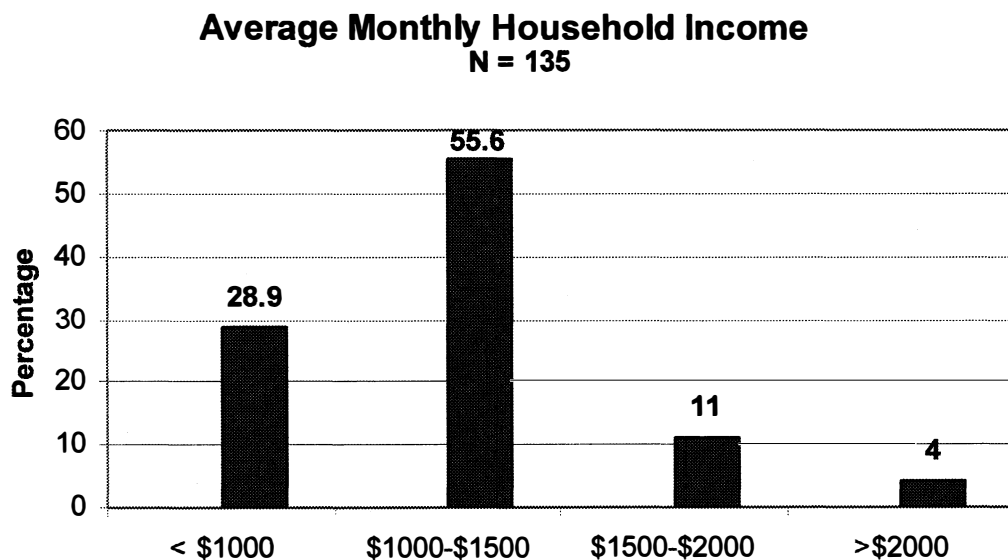


Figure 6.

nearly all were Mexican (95%), excepting 4 from Honduras and 11 born in the U.S. (Table 3). While 19 different Mexican states were represented in the sample, there are certain patterns to the source regions. In particular, we found that 56% of Mexican-born Latinos come from one of three states—Michoacán, Guanajuato or Tamaulipas (see Figure 7). The next four most common birth states (Hidalgo, San Luis Potosí, Guerrero and Veracruz) account for an additional 29% of household residents. In some sense, these findings are not surprising as both Michoacán and Guanajuato are traditional regions of out-migration, ranking 2nd and 3rd respectively as sending states of immigrants to the U.S. (INEGI, 2000).

Interestingly, 53% of respondents indicated that their first city of arrival upon entering the United States was in North Carolina. Although this may partly reflect female respondents arriving to join spouses who had come earlier, it also suggests the existence of fairly well-established direct transnational routes between Mexico and the state of North Carolina. A relatively small number of respondents, for example, found their way to Greene County after first arriving in traditional gateway states such as Texas (the second most common response, at 23%) or Florida (12%), and only one

respondent came by way of California. It is also noteworthy that all of the 75 respondents who followed a direct path from Mexico to North Carolina came initially to smaller cities and towns, rather than to larger 'gateway cities' within the state (Table 4). Not a single Greene County respondent, for example, first arrived in Charlotte, the Triangle, or the Triad region. Instead, respondents came directly to eastern NC cities and towns such as Snow Hill, Farmville and Wilson. This suggests that the transnational routes of the rural East may be somewhat isolated and distinct from those that comprise the large Latino communities of North Carolina's larger urban areas.

Survey respondents, for the most part, arrived in the U.S. with other family members, including partners (with or without children) and, to a lesser extent, siblings, parents and other extended family members. Only 15% of respondents arrived alone. This reflects, in part, the sample bias towards female respondents who are less likely to migrate alone than are males. But it also suggests that family ties play an important role facilitating migration and settlement in North Carolina. Approximately 56% of respondents were initially housed by family members upon arriving to the U.S. Another 24%

Table 3. State of Birth

Mexico		303 (97.1%)			
Michoacan	83	Guerrero	19	Tabasco	6
Guanajuato	48	Veracruz	15	Zacatecas	5
Tamaulipas	39	Distrito Federal	2	Jalisco	4
Hidalgo	23	Durango	9	Aguascalientes	3
San Luis Potosi	20	Sinaloa	8	Morelos	3
United States		5 (1.6%)		Honduras	
Texas	5			San Pedro Zula	2
Florida	3			Lempiras	1
North Carolina	3			Lloro	1

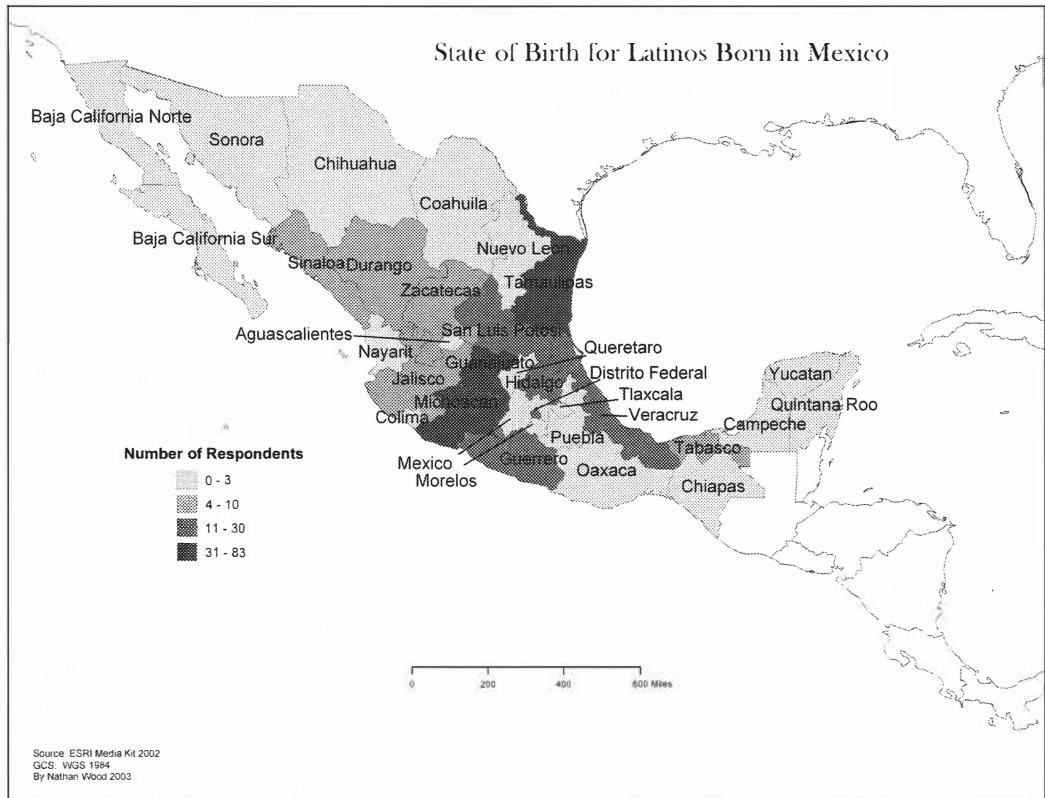


Figure 7.

first stayed in housing provided by their employers, a common practice for agricultural workers.

Several factors influenced household members in making the decision to migrate to the U.S. Figure 8 reviews the principal factors that played a role in their decision to migrate to the U.S.. Among the frequently stated reasons for coming to the U.S. were employment (86%), education (73%) and relatives (46%). When asked for the most important reasons for settling specifically in Greene County, once again employment was the most frequent response (81%), followed by family ties (68%) and the quality of schools (58%). These are consistent with the overall reasons why Latinos migrate to the U.S. Relatives and personal linkages also play an important role in drawing families to settle in Greene County. Seventy-six percent of all respondents heard about Greene

County from either family members or friends. Other issues influencing household decisions to settle specifically in Greene County included cheap housing (50%) and low crime rate (38%) – both arguably associated with the rural nature of the county. Figure 9 reviews the principal factors that influenced families' decision to settle in Greene County.

III. Transnational Connections Between Eastern North Carolina and Mexico

Greene County Latino families appear to be a relatively permanent and stable population, in contrast to the stereotypical image of the male migrant farmer worker. Of those surveyed, 59% indicated that they intended to remain permanently in the United States, with a further 29% indicating they were 'unsure' about their long-term plans. Only

Table 4. First City of Arrival in the United States (For Respondents Arriving First in North Carolina)

<u>City of Initial Arrival</u>	<u>Frequency</u>	<u>% of Total</u>
Snow Hill	26	35.6
Farmville	8	11.0
Wilson	6	8.2
Greenville	4	5.5
La Grange	4	5.5
Walstonburg	3	4.1
Goldsboro	3	4.1
Elm City	2	2.7
Smithfield	2	2.7
Winterville	2	2.7
Hookerton	2	2.7
Oriental	2	2.7
New Bern	2	2.7
Macclesfield	1	1.4
Grimesland	1	1.4
Bailey	1	1.4
Stantonsburg	1	1.4
Pamlico	1	1.4
Morehead City	1	1.4
Cove City	1	1.4
Total	73	100.0

12% of Latino respondents indicated that they did not intend to stay in the U.S. This sense of stability is related to the fact that most Latinos surveyed were not recent arrivals to Greene County, but have resided there for some time. For example, only 16% of all Latino children enrolled in GCPS during 2003 met "migrant" status, which is defined as children who are foreign born and have lived in the county for less than 3 years (Greene County Public Schools, 2003). As Figure 10 indicates, most respondents arrived in the U.S. in the early or mid-1990s, with relatively smaller numbers arriving in the past four years. Overall, respondents have lived an average of 6 years in Greene County, 8 years in North Carolina and 9 years in the United States.

Although these figures suggest some degree of 'permanence' within the Greene County Latino community, there are also indications that households remain well connected to their home countries. Analysis of survey data shows that Greene County

Latino families have continued to maintain strong ties to their home places, and are indeed constructing a transnational community linking eastern North Carolina to their homeland and its traditions, customs and culture. For example, over half of survey respondents indicated that they hope to return to their home country in the future, while an additional 30% indicated that they missed their homeland (Figure 11). Although very few respondents regretted their decision to migrate to the U.S., it seems that Latinos continue to feel attachments that cut across the boundaries of nation-states and cultures.

Language, perhaps more than any other single factor, sustains and conveys culture. While the average length of stay in the U.S. for respondents was 9 years, Spanish continues to be the language most frequently spoken at home for 80% of the families. Nineteen percent of families indicated that both Spanish and English were spoken equally at home while only 1% spoke solely English in the household. While language

Factors Influencing Decision to Migrate to the U.S.

N = 139

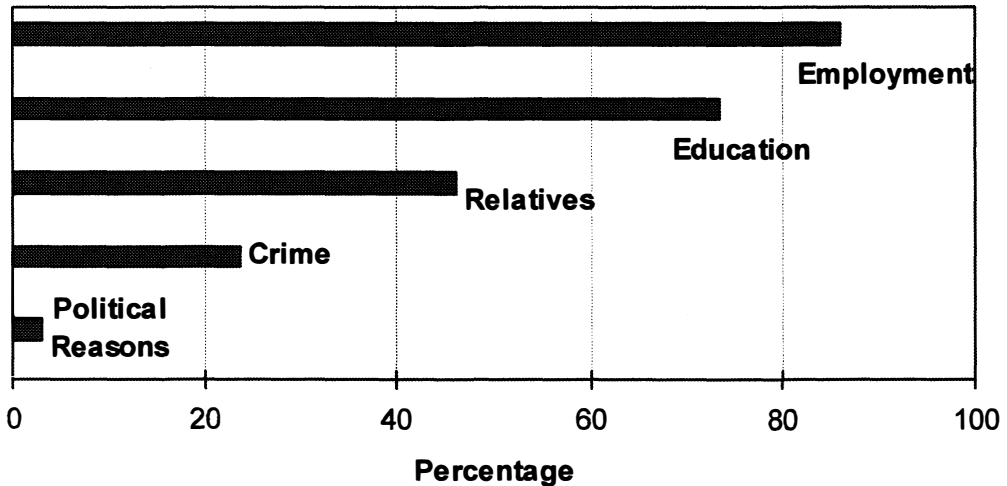


Figure 8.

is typically lost with first and second generation immigrant children, it would appear that Spanish continues to be passed on to the children of Greene County immigrants. Indeed, 25% of respondents indicated that Spanish remained the strongest language for their children. Nevertheless, through school and outside social contacts, children also acquire English. Twenty-two percent of households indicated that their children spoke English with greater fluency than Spanish, and over half stated that their children spoke English with equal fluency.

One of the most important indicators of transnational linkages to home place is the remittances sent regularly to families back home. Approximately one third of the Greene County Latino families stated that they send remittance back to their place of origin. This is significant as remittances by families with children are typically much lower than those made by single, unaccompanied persons. Remittances are regular, if somewhat infrequent (see Figure 12), with most sending monthly (14%) or "every few months" (18%). The dollar amount of remittances from Greene

County Latino families is relatively small. Ninety-one percent of those who reported sending remittance sent amounts of \$300 or less. Remittances were used overwhelmingly by family members back home for subsistence level maintenance, the purchase of items such as food and consumable goods (96% of cases), and to a lesser extent to build or improve a home (10%) or for farming (3%) (see Figure 13). While relatively small, these remittances are a strong indicator of ties to the homeland. They are also an important source of foreign exchange for home countries. Mexico, the highest recipient of remittances from the U.S., is dependent upon this income as a social safety net for many of its most economically vulnerable households (O'Neil 2003).

IV. Integration of Latinos Into the Greene County Community

While Latino families have established transnational ties with their homeland, they are also exhibiting a certain degree of integration into the mainstream non-Latino Greene County

community. Preliminary data suggest that, although Latino families remain somewhat isolated by barriers of language, class and legal status, they are nevertheless more integrated into the mainstream than is typical of unaccompanied, often male, migrant workers. In part, these findings can be attributed to the fact that our survey focused on families with school-age children. The presence of children builds ties to the school system, which in turn supplies families with information regarding local services, activities and social events. Children also increase opportunities for families to interact with non-Latinos through school activities and local social events such as birthday parties. It is also likely that the local community is more accepting of families with women and children than they are of groups of single male workers who have little opportunity to interact with local community members outside their work (Griffith, 2003).

It is noteworthy in this respect that 68% of children in households surveyed were born in the United States (56% percent of them in North Carolina), making them U.S. citizens and indicating some measure of family stability over the long-term. This high level of citizenship among Latino children contrasts sharply with that of adult survey respondents, only 19% of whom indicated that they were citizens. Clearly, the lack of citizenship among Latino adults is an important barrier to integration. This is evident, for example, in the finding that Latinos seldom participate in the political process; only 4% had household members who have voted in U.S. national or local elections.

Citizenship is not the only barrier to the integration of Latino adults in Greene Country.

**Factors Influencing Decision to Settle in
Greene County**
N = 139

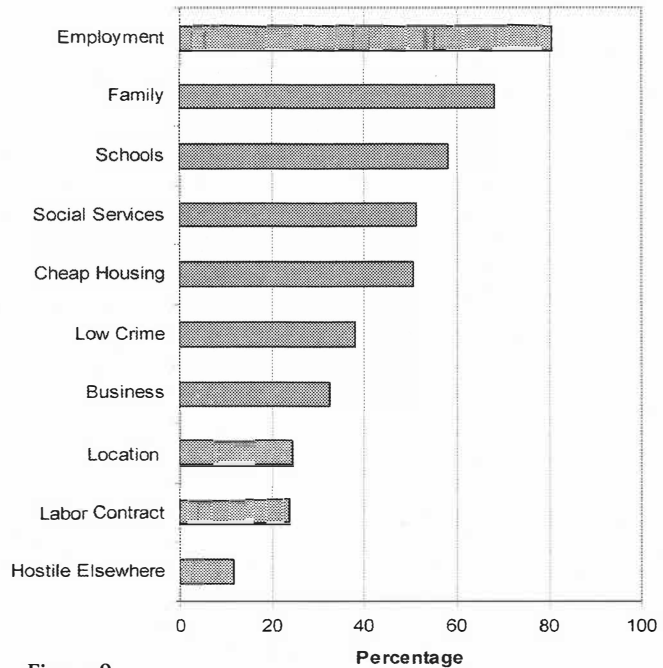


Figure 9.

Another is the low level of English language proficiency exhibited by respondents – 72% indicating that they spoke “no” or “little” English.³ In answers to an open-ended question regarding the stresses associated with being an immigrant in the U.S., several respondents raised the language issue. They expressed frustration at their inability to help children with schoolwork, limited job opportunities due to lack of English and a feeling of isolation stemming from the inability to communicate with others.

The low level of involvement of Latino families in local civic activities may be attributed, in part, to language barriers that inhibit Latinos from participating (see Figure 14). The highest degree of participation was in church-related activities and group functions (15%). This logically follows from the fact that 82% of Greene County Latino families reported that they attended church regularly. This

Year Participant Came to the US N = 133

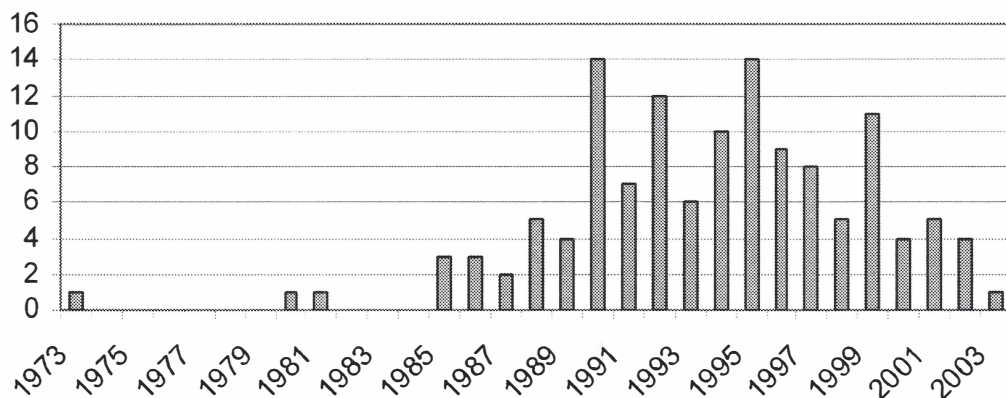


Figure 10.

Participants Feelings About Home N = 139

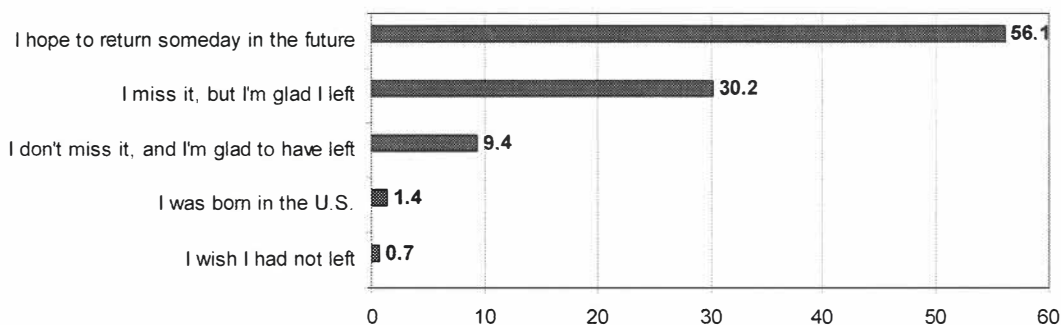


Figure 11.

is one activity where language is not a barrier, as 98% of church-going families attend services held in Spanish. After church-related activities, the highest rate of family participation was found in local sporting teams (12%), typically through their children. Other than these two areas, participation in civic organizations is very low.

In contrast to their low participation in civic activities, Latino families exhibited relatively high levels of participation in local social events; particularly those involving their children (see Figure

15). School activities ranked highest on the list, followed by family activities such as trips to the beach, local fairs and parks. Families also maintain links with Latino community social events, with nearly 50% participating in the Snow Hill Latino Festival and a third attending Latino dance or music events and *Cinco de Mayo* festivities.

Another sign of growing integration into the local mainstream is that nearly 50% of the families surveyed revealed that they had non-Latinos whom they considered close friends. This suggests that

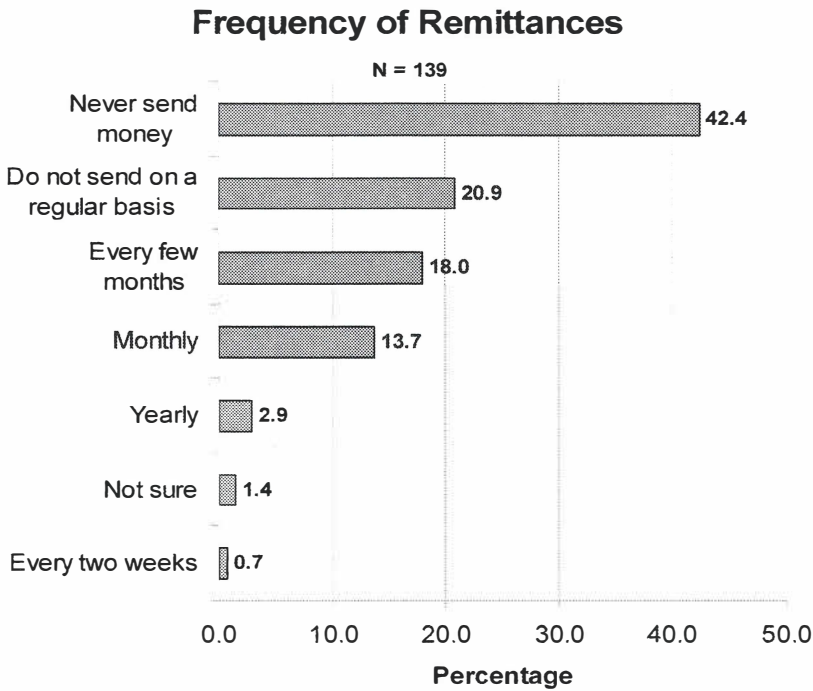


Figure 12.

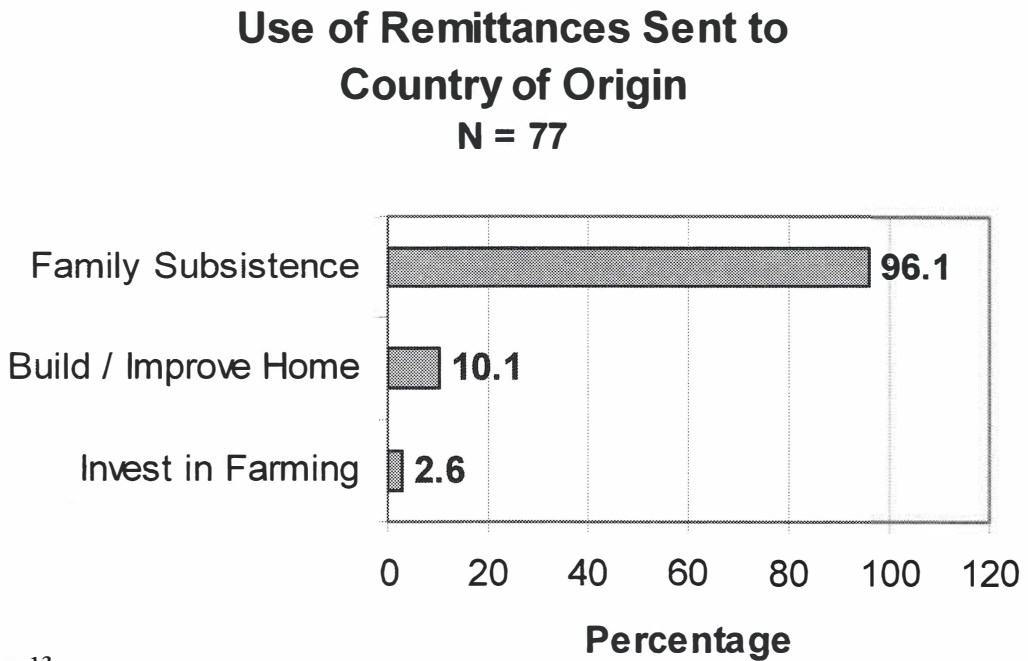


Figure 13.

meaningful relationships are gradually being built outside the Latino community. Despite this, approximately 20% of Latino families reported that people 'have been mean or unkind' to them. In several cases respondents reported feeling "discriminated against." Other frequently mentioned sources of stress included legal status and fear of deportation; the inability to speak English; the lack of freedom and resources to visit family back home (especially post-9/11); the scarcity of jobs for immigrants and an inability to pay the bills. Nevertheless, most respondents suggested they were relatively content living in Greene County, frequently describing it as "*tranquilo*"—peaceful and laid-back. Many families mentioned being pleased with the school system, the local health clinic and services available to children and families. Overall, Greene County is considered by Latinos to be a good place to live.

Conclusions

While we are hesitant to draw definitive conclusions from research that is still in its preliminary stages, the data presented here do suggest a number of interesting trends that might warrant further investigation. First, it seems clear that Latino migration is having a greater impact upon rural areas of North Carolina than has been the case in the past. Although the state's larger metropolitan areas continue to be home to the largest numbers of Latino families, smaller cities and towns have witnessed a much more dramatic demographic transformation, and thus perhaps also a more salient social and cultural impact than some of the more long-standing destination areas. Second, and despite the increased diversity in migration patterns, Latinos continue to be concentrated predominantly in low-wage

Participation in Civic & Social Activities

N = 139

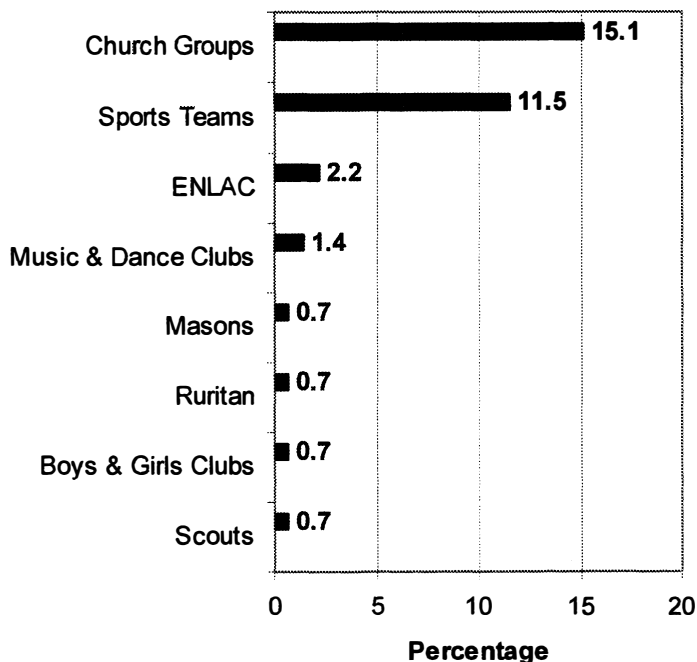


Figure 14.

occupations, and to suffer from higher than average rates of poverty. This low socio-economic status clearly has complex underlying causes, the investigation of which should be of priority for researchers and service providers alike. Third, there is significant evidence that Latinos in North Carolina have constructed, and are maintaining, transnational connections that span across political boundaries. There is evidence, for example, that there are direct migration routes between Mexico and eastern North Carolina, routes that are strengthened by extended family networks and the economic impacts of remittances sent back home. Less clear is the extent to which the transnational communities of eastern North Carolina are integrated into other such networks elsewhere in the state, or whether they exist in relative autonomy from, for example, the large Latino communities in the state's metropolitan areas. Fourth and finally, there is evidence that Latinos in

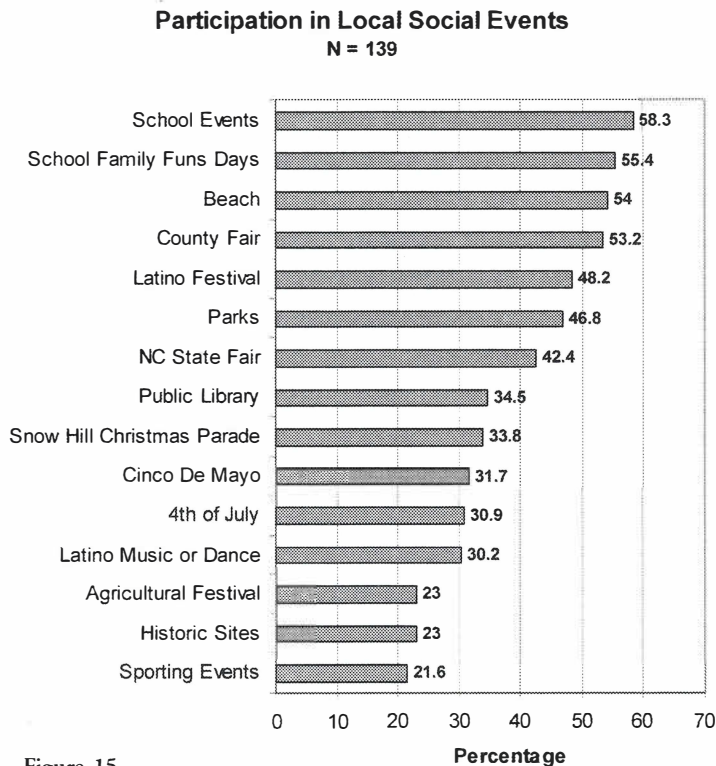


Figure 15.

Greene County are building local transnational communities that draw upon the social and cultural resources of both their home and host countries simultaneously. By all appearances, these are not transient communities. Latino families and their children are building long-term futures in places like Greene County and, despite barriers of language and occasional prejudice, are integrating into the local social milieu. At the same time, it is clear that Latinos maintain important and meaningful connections to their home culture. The ways in which Latinos manage these 'hybrid' social identities is a potentially interesting focus for further research.

Endnotes

¹ As defined here, the Southeast includes Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee and Virginia.

² According to the Health and Human Services Poverty Thresholds for 2003, the poverty level for a family of 5 is annual household earnings below \$21,540 (Federal Register, 2003)

³ In part this may reflect the gender bias of the survey sample as women exhibited lower levels of outside labor participation and therefore had fewer opportunities to develop English language skills on the job.

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Book Review

North Carolina: People and Environments, 2nd Edition

Ole Gade, Arthur B. Rex, and James E. Young, with L. Baker Perry. Parkway Publishers, Inc., Boone, NC, 2002. 602 pp., photos, maps, 3 appendices, 4 indices, tables, figures, boxes, bibliography. \$64.50 hardcover (ISBN 1-887905-63-4), \$44.50 paper (ISBN 1-887905-64-2).

Reviewed by W. Frank Ainsley, University of North Carolina at Wilmington

For many years, geographers have needed a good, readable, college-level textbook to use in classes on the regional geography of North Carolina. The authors of *North Carolina: People and Environments* have made a valiant effort towards fulfilling that challenge. This massive text (602 pages) is more than twice the size and weight of the first edition (284 pages). This massive volume is encyclopedic in scope. Thousands of up-to-date facts, including the 2000 census data, make this book a valuable tool for anyone looking for information about the physical, cultural, or economic geography of our state. It can and probably will be an excellent reference tool not only for college and university professors and students, but also for planners, business leaders, community public servants and interested North Carolinian citizens from all walks of life. The book is visualized by the authors not only as a textbook, but also as a way of helping the citizens of North Carolina understand "aspects of land, life, and livelihood at the onset of the 3rd millennium."

North Carolina: People and Environments is divided into three major sections that cover the breadth of our state's physical and cultural landscapes. The first three chapters describe the physical geography, including fascinating accounts of severe weather events as well as the standard lengthy descriptions of soils and vegetation patterns across the state. Chapters 4 through 7 deal with human environments—population and economic geography, while chapter 8 provides an overview of one of the basic themes of geography—the interaction between the human population and the fragile environment in which we live. The last part of the book, which is

about half of the text material, can be categorized as regional geography. Chapter 9 tackles the problem of regionalization—how to best divide this varied and complicated state into manageable units of investigation and administration. Then, in chapters 10 through 13, the four major regions—Tidewater, Coastal Plain, Piedmont, and Mountains—are analyzed in much detail with interesting specific issues and problems of each region highlighted. These detailed regional chapters cover the last 234 pages of the text, and if pulled out and used as a separate text, would provide the reader with an excellent portrayal of the physical and cultural geography of the state.

Each of the regional chapters in *North Carolina: People and Environments* contains numerous maps and illustrations that help the reader see and understand better the geographic and spatial aspects of each respective region. One of the strongest highlights of this book is the inclusion of numerous sections of color plates (photographs) that profusely illustrate many aspects of our state's geography. In fact the liberal use of illustrations (861) includes 257 maps (31 in full color), 379 photos (234 in full color) and 225 other illustrations. As the reader thumbs through the pages, it's almost like taking a "virtual" field trip as one sees the different geographical features on the North Carolina environment.

For the public school teachers of North Carolina, the "five themes of geography" as developed by the National Geographic Society—the themes of location, place, human-environment relationships, movement, and region—can all be gleaned from the organization of this book. There is a natural pro-

gression of geographic information from the broad introductory physical chapters, continuing with the impact of the human population of the landscapes of North Carolina, and culminating in the regionalization of the state from the four main regions down to the individual county level.

I used *North Carolina: People and Environments* as a textbook in my GGY 282—"Geography of North Carolina" in the summer of 2003. Generally the students liked the amount of information in the book, especially the visual information provided by the abundant illustrations. *North Carolina: People and Environments* is mostly well-written, easy to understand, and most of my students who used this textbook found it "user-friendly." The first section on physical geography and especially the last four chapters on regional geography, with the analysis of individual counties and interesting case studies, were endorsed enthusiastically by the students.

But in the middle of the book, students were a little overwhelmed by all the statistical detail that gives much of those chapters the characteristics of an almanac. This section on economic geography tended to be the least well received part of the book. The problem, pointed out by several readers, was that most of it was a collection of facts, figures, tables, and generally "dismal" and boring information that would probably best be relegated to a lengthy appendix. Chapter 7 on social issues, health, education, and civic justice seemed to be the stumbling block in an otherwise fairly readable textbook.

In summary, I feel that *North Carolina: People and Environments* very adequately serves the needs of providing information about North Carolina to its various audiences, for the students who use it to the general citizens who add it to their libraries. There are no glaring deficiencies, and *North Carolina: People and Environments* can serve as a good model for providing a rather complete comprehensive overview of the facts and figures pertinent to the understanding of other state geographies.

NOTE FROM THE EDITORS

The North Carolina Geographer is one of a small number of state-based geography journals in the country. Its continued existence, and consistently high quality, are testaments to the strength and dedication of the community of geographers in North Carolina and surrounding states. As we complete our fifth and final issue as editors, we would like to take the opportunity to express our appreciation to the members of our editorial board, and to recognize those individuals (listed below) who have served as manuscript reviewers during our tenure. The peer-review process is essential to maintaining the quality of any journal, and perhaps especially a regional journal such as the *NCG*. To the many individuals who have offered their time and support to the journal over the past five years, we extend our thanks.

- Patrick Pease and Jeff Popke

Manuscript Reviewers, 2000-2003

Derek Alderman
Craig Allan
Lenny Baer
Mike Benedetti
Greg Bierly
Mark Brinson
Rob Brown
Jeff Colby
Chip Conrad
Tom Crawford
Malcolm Cutchin
Vincent Del Casino
Mike Dorn
Owen Furuseth
Paul Gares
John Grimes
Joanne Halls
Stephen Hanna
Holly Hapke
Liz Hines
Bob Janiskee
Mark Lange
Ron Mitchelson
Roy Stine



Department of Geography

PROGRAMS AND RESEARCH FACILITIES

Undergraduate tracks include the B.A. in Geography and the B.S. in Applied Geography. The former is a broadly-based geography program, drawing courses from human and physical geography, as well as techniques. The latter has a strong emphasis on spatial analysis, and requires an internship in a state agency or private firm.

At the graduate level the Department specializes in human geography, physical geography and spatial information technologies, and supports a variety of philosophical and methodological approaches within each of these areas. Students are encouraged to develop their research in conjunction with faculty, and to disseminate their findings via professional meetings and journals. Faculty expertise is clustered around the following:

Economic Geography: development policies, practices, and impacts; urban and rural restructuring; and geographic thought (political economy, feminist theory, critical geopolitics).

Cultural Geography: community development; tourist landscapes; cultural ecology; and field methods.

Coastal Plain Geomorphology: coastal geomorphology (aeolian processes and dune formation); drainage basin hydrology; fluvial geomorphology; soil geomorphology; and environmental management (natural hazards research, land and water use planning).

Spatial Information Technologies: geographic information systems (watershed/ environmental modeling, topographic effects on digital data); remote sensing and image processing, computer cartography (global databases and map projections), and spatial quantitative methods.

Regional Specializations: Africa-East; Africa-South; Asia-South; Caribbean; Middle East; North Carolina; Western Europe.

Faculty are actively engaged in research in all four clusters, and have received multiple-year grants from, amongst others, the U.S. Department of Agriculture, the National Science Foundation, the New Jersey Sea Grant Program, N.A.S.A. and the U.S. Forest Service.

The department maintains both a fully equipped physical geography laboratory and a Unix-based Spatial Data Analysis Laboratory. The physical geography laboratory is designed for mechanical analyses of soil and sediment, but also includes state-of-the-art GPS, electronic surveying equipment, and instrumentation for monitoring hydrologic and aeolian processes and responses. The spatial laboratory consists of ten Sun workstations, a large format digitizer, and an Esize DesignJet plotter for teaching and research. Primary software includes Arc/Info, ArcView, and Imagine. A PC-based cartography laboratory was recently established. Students also have access to a wide variety of university facilities including the Institute for Coastal and Marine Resources, the Regional Development Institute, International Programs, and the Y.H. Kim Social Sciences Computer Laboratory. The Kim laboratory provides access to PC-based software such as Adobe Illustrator, ArcView, Atlas*GIS, IDRISI, SAS, SPSS, and Surfer.

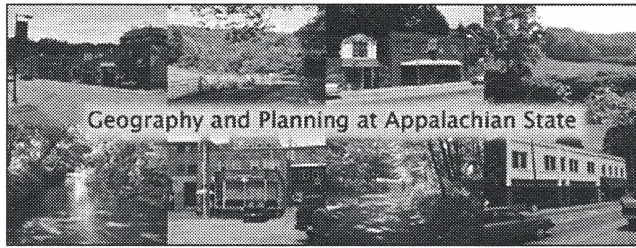
FOR CATALOG AND FURTHER INFORMATION WRITE TO:

Undergraduate Catalog: Director of Admissions, Office of Undergraduate Admissions, East Carolina University, Greenville, North Carolina 27858-4353.

Tel.: (919) 328-6640. World Wide Web: <http://www.ecu.edu/geog>

Graduate Catalog: Graduate School, East Carolina University, Greenville, North Carolina 27858-4353.

Tel.: (919) 328-6012. Fax: (919) 328-6054.



APPALACHIAN STATE UNIVERSITY

Department of Geography & Planning

www.geo.appstate.edu

DEGREES OFFERED

- B.A in Geography
- B.S. in Geography (teaching)
- B.S. in Geography (general concentration)
- B.S. in Geography (geographic information systems)
- B.S. in Community and Regional Planning
- M.A. in Geography with liberal arts option (thesis or applied)

RESEARCH FACILITIES

The Department occupies the third and fourth floors of a soon-to-be renovated science facility adjacent to the main library and contains four computer laboratories for work in computer cartography, GIS, and image processing. The laboratories have numerous microcomputers and SUN workstations, which are networked to each other and to the campus mainframe cluster. Appropriate peripherals include digitizers, scanners, printers, and plotters. The Department maintains a full suite of professional GIS, image processing, graphic design and statistical software applications in its laboratories. The Department is a USGS repository, and its map library presently possesses over 100,000 maps and 5,000 volumes of atlases, journals, and periodicals; and is also a repository for census material available on CD-ROM including TIGER files, DLGs, and other digital data. Other facilities include a large cartographic laboratory, research space, space for remote sensing, and telephone linkage to department-maintained weather stations for research in microclimatology.

GRADUATE PROGRAM

The Masters program in geography is designed to provide students with a relatively broad range of academic and professional options, preparing them for Ph.D. work in geography and planning, professional applications in GIS, or opportunities in teaching at all educational levels. Accordingly, concentrations are offered in liberal arts with thesis or in applied geography with internship in regional, urban, and environmental analysis and planning. In addition, the Department participates in a program leading to the Master of Arts degree in Social Science with preparation in geographic education.

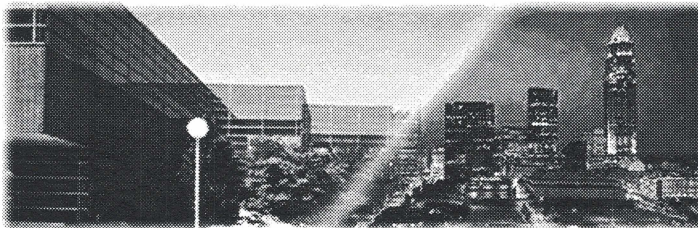
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- Department Chair: Jim Young (youngje@appstate.edu)
- Graduate Program Coordinator: Kathy Schroeder (schroederk@appstate.edu)
- Program Inquiries: Kathy Brown (brownkv@appstate.edu)

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THE UNIVERSITY OF NORTH CAROLINA CHARLOTTE

Master of Arts in Geography



The Master of Arts Program in Geography at UNC Charlotte emphasizes the application of skills, methods and theories to problem solving in contemporary society. Students are offered a solid foundation in research methods, problem formulation, quantitative methods, spatial analysis, and GIS skills. Our graduates have used these skills to enjoy successful careers as professional geographers, community planners, site location and marketing analysts, and private consultants. Approximately 10% of the program's 250 graduates have gone on to study in Ph.D. programs.

Characteristics:

- About 50 students and 23 faculty are in residence
- Class sizes are small; students and faculty maintain close contact
- Most of our full-time students are currently funded via assistantships and contracts
- PC-based ArcGIS equips an excellent spatial analysis laboratory
- Community-based class projects are featured in many of our classes

Program Concentrations:

Community Planning Track

Students who choose the Community Planning Track are awarded the M.A. in Geography and complete a formally structured multi-disciplinary core curriculum with course work in Geography, Architecture, Economics and Public Administration.

Urban-Regional Analysis

The urban-regional analysis concentration offers a broad background that provides training for public and private sector planning and development, and Geographic Information Systems. Course work may be concentrated in one of the following areas:

Community and Regional Development	Site Feasibility Analysis
GIS Analysis	Impact Analysis
Public Facility Siting	Urban Development

Location Analysis

The location Analysis concentration prepares students for jobs in location research with retailers, real estate developers, consulting firms, commercial banks, and economic development agencies. Course work is offered in:

Retail Location	Market Area Analysis
Industrial Location	Real Estate Development
Facility Siting	Applied Population Analysis

Transportation Studies

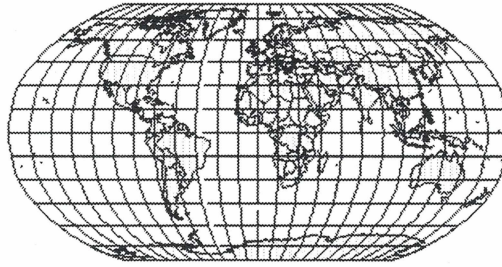
The University's Center for Transportation Policy Studies is affiliated with the department.

Careers are available in public and private sector agencies and in consulting firms. Students pursue course work in:

Transportation systems Analysis	Impact Analysis
Transportation Policy Analysis	Transportation Planning

The Internship: As a program which emphasizes applied geography, client-based internships are an important element and normally replace the traditional thesis as the capstone research project of the graduate program. Projects involve students in the execution of a substantive research task for private or public sector clients. The student is the primary investigator in a specific "real world" research project.

For further information, visit our website at [http:// www.geoearth.uncc.edu/](http://www.geoearth.uncc.edu/) or contact Dr. Tyrel G. Moore, Graduate Coordinator, Geography M.A. Program at tgmoores@email.uncc.edu, or via telephone (704-687-4250).



**GEOGRAPHY
AT
UNIVERSITY OF NORTH CAROLINA AT WILMINGTON**

Geography at the University of North Carolina at Wilmington is housed in the Department of Earth Sciences. There are six full-time geography faculty. Research interests and specialties include: cultural-historical geography; material culture studies; environmental planning; climatology; and fluvial geomorphology. Equipment available for teaching and research includes modern PC-based cartographic and image-processing lab, and photographic and darkroom facilities. The university library contains a strong geography collection including all major journals, and is a repository for government documents and maps. About 40 majors are currently working towards a B.A. in geography.

Wilmington, North Carolina's premier port city, is located on the Cape Fear River and is only ten miles from the Atlantic shore. It is linked to the research Triangle area directly via Interstate 40. With a metropolitan area of over 130,000 residents, Wilmington is the economic and cultural hub of southeastern North Carolina. Climate is warm and humid during the summer, and exceptionally pleasant during the rest of the year, enhancing the variety of coastal recreational activities of the region.

For further information on our undergraduate program contact:

**Dr. Frank Ainsley
Department of Earth Sciences
The University of North Carolina at Wilmington
Wilmington, NC 28403
TEL: (910) 962-3490
FAX: (910) 962-7077**

THE UNIVERSITY OF NORTH CAROLINA
GREENSBORO
DEPARTMENT of GEOGRAPHY

**UNDERGRADUATE
PROGRAM:**

For over half a century, the Geography Department at UNCG has developed its programs and resources to prepare students for careers and advanced research in Geography. Today the program is characterized by a strong integration of the human, physical, and technical components of the discipline. The geography major can choose a general degree or a degree with a concentration in Urban Planning or Earth Science/Environmental Studies.

**MASTERS in APPLIED
GEOGRAPHY:**

This program focuses on the application of geographic theory and methods toward the understanding of problems related to land use, economic development, environmental quality, population dynamics and social well being in different locational contexts: urban, rural, regional, and international. The curriculum leads to the acquisition of the theoretical constructs of geography and the research skills appropriate to geographic analysis, including spatial statistics, cartography, remote sensing and GIS.

**POST-BACCALAUREATE
CERTIFICATE in
GEOGRAPHIC
INFORMATION SCIENCE:**

The Department offers an innovative Post-Baccalaureate Certificate in Geographic Information Science. The 18 hour program provides professionals with the knowledge and skills needed to effectively utilize spatial analytic tools, geographic data visualization techniques, spatial programming, mapping, and geographic image processing software. Emphasis is on the application Geographic Information Science in the fields of planning, environmental assessment, remote sensing, cartography, and economic development.

**ANNOUNCING THE
NEW Ph.D. PROGRAM
in GEOGRAPHY:**

Beginning in the Fall of 2004 the Department of Geography will offer a new graduate program of study leading to the Ph.D. in Geography. Building on the traditional strengths of the department and the anticipated addition of three new faculty lines the program will be an innovative doctoral program designed primarily for persons who are preparing for careers which apply geographic theory, method, information theory, and other skills to solving real-world spatial problems.

FOR UNDERGRADUATE INFORMATION:

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Guidelines for Authors

The North Carolina Geographer is an annual, peer-reviewed journal published by the North Carolina Geographical Society. The journal serves as an outlet for research related to the geographical phenomena of local interest.

All manuscripts submitted to the North Carolina Geographer should be in acceptable form and ready for peer-review. Contributions should adhere to the following general guidelines.

- ¥ Send one original and two copies of manuscripts. Only original, unpublished material will be accepted
- ¥ All manuscripts should be on 8½ x 11 paper. Type on only one side of the page. Type should be 10 or 12 point font and double spaced. One inch margins should be used on all sides.
- ¥ References are to be listed on separate pages, double spaced, and in alphabetical order by authors last name.
- ¥ Figures and tables should be submitted on separate pages with each copy of the manuscript.
- ¥ High quality, black and white photographs may be included.

Send manuscripts to:

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