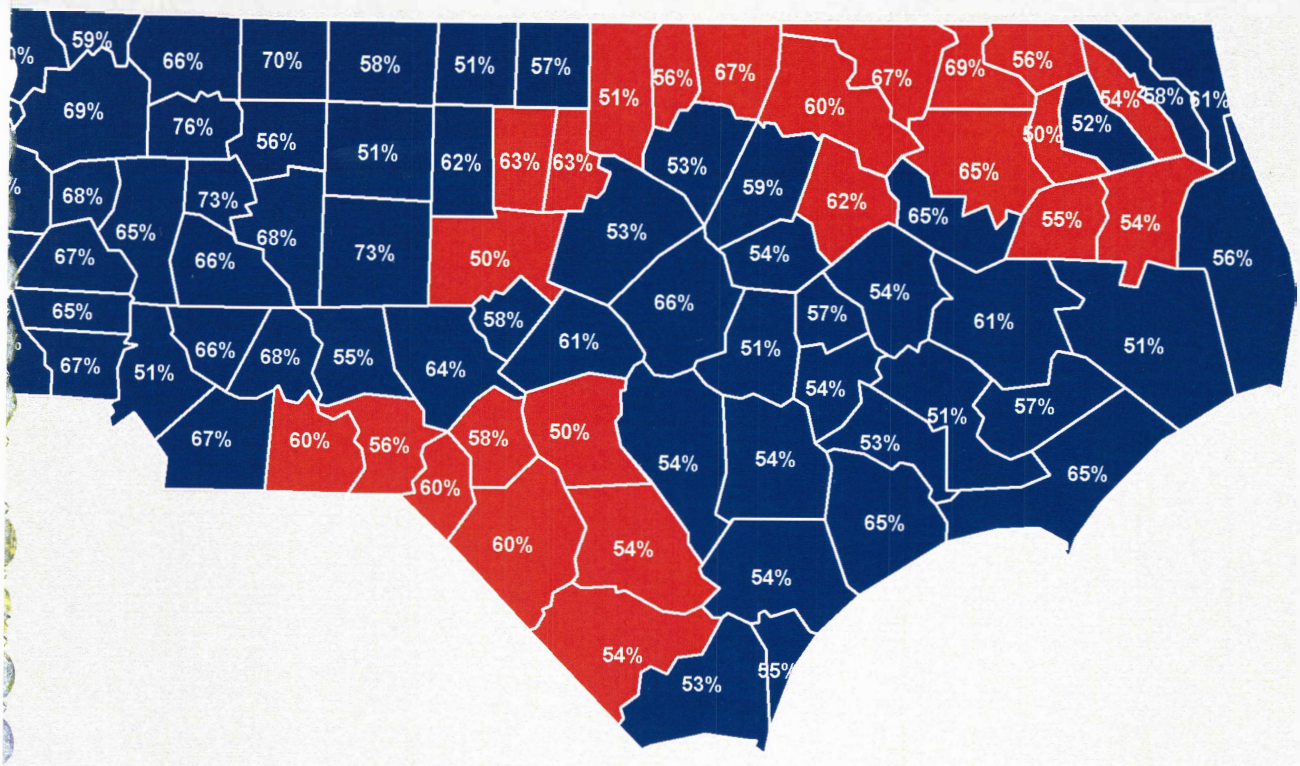

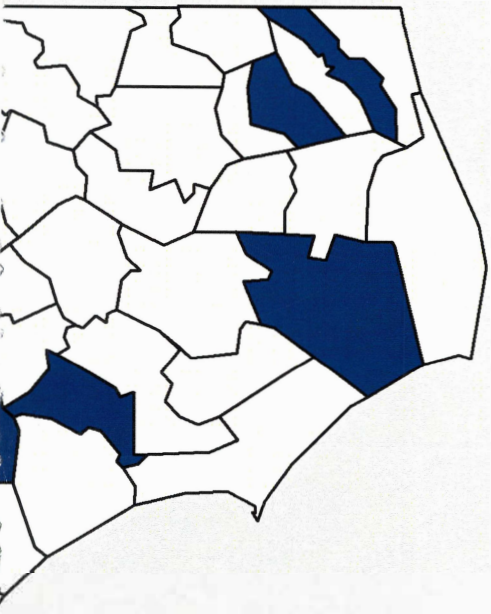

The North Carolina Geographer

Volume 8, 2000

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About the Cover

As all eyes of the nation have been focused on the unclaimed electoral votes in Florida during the production of this year's issue, the editors of the *NCG* thought it would be interesting to take a look at the results of the presidential election in North Carolina. Data are from the certified results of the State Board of Elections. Readers interested in the cover data should read the companion piece by John Heppen in the Reports section of this issue.

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The North Carolina Geographer
Volume 8, 2000

Research Articles

Reports

A Geographic Examination of North Carolina Farms and Farmland: 1969 to the Present

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The farmland of the eastern United States, including that of North Carolina, has changed greatly in its configuration, distribution, usage, and ownership since the 1960s. Using 1969 as a baseline for comparison, the farmland and farms of North Carolina are examined here to ascertain the form, processes, locations, and changes in North Carolina's agricultural geography. These North Carolina characteristics of farmland change will also be briefly compared to those of other eastern states over the same period. Important variables for this study include cleared farmland (computed as total farmland minus farm woodland), number of farms, and average farm size. Distinctive regions of farmland change emerge as this study progresses.

Introduction

The patterns, distributions, and processes of agricultural land use changes in the United States offer a continuing focus for geographical study and understanding. The market forces for agricultural land and production, the varied and complex influences of demographic and other social forces within the farming populations, government activities and policies, transport systems, and other factors create a constantly dynamic picture of an area's agricultual land and land usage. This applies to the agricultural sector of North Carolina, as well. Despite a decline in traditional cash crops like tobacco and cotton, North Carolina's farmers receive over $7.2 billion in cash receipts according to North Carolina's Deprtment of Agriculture (1999). This study will examine several of these forces for change in North Carolina farmland, using census data, and will compare these changes to those in other areas of the eastern half of the country over a time period from 1969 to 1997. Following a brief mention of the agricultural regions of North Carolina, this article will examine these farmland changes during the past thirty years, using a work by Hart as a point of departure and will also in a preliminary way offer some comment on the forces for these changing dimensions in North Carolina's farming sector and landscapes.

Agricultural Regions of North Carolina

There are three very broad and general environmental regions in North Carolina that provide the basis for much of the state's agricultural regions. Moving from east to west, the first of these areas consists of the low-lying, generally flat and depositional landscape of the Coastal Plain. With a coastal fringe of lagoons, barrier reefs, and wetlands, this flood-prone landscape was the earliest focus for European settlers who established commercial (plantation) agriculture founded on involuntary servitude, large holdings, and export crops such as tobacco and cotton. The second region, the Piedmont, begins to emerge approximately 100-120 miles inland from North Carolina's Atlantic coast, and continues to rise steadily for yet another 100 to 150 miles further westward. Finally, west of Charlotte and Greensboro, the Appalachians create a mountainous terrain and landscape (Paterson, 1994).

In an article written in 1968, John Fraser Hart identified a number of significant changes in the distribution and structure of agricultural land use in the eastern half of the United States during the twentieth century up to 1968. Hart examined the altered character of a basic element of the American economy, agricultural land, for thirty-one states comprising what he envisioned as the "eastern" United States. He computed and then mapped the developing characteristics of cleared farmland acreage for these thirty-one states, including North Carolina, for the period from 1910 to 1959 by differentiating between total farmland per county and total farm woodland, thereby focusing on the more used and commercially lucrative portions of most farmers' properties.

In general, his results were mixed, both temporally and spatially. Farmland losses and abandonment occurred at different rates and times in different areas throughout his study area. Also, the causes for such land use change varied in complex ways. Urban and suburban expansion, strip mining and quarrying, the loss of a locally predominant crop, and the activities of Soil Bank retirement of marginally productive lands were all components of this process, though none of these factors by itself was pervasive or dominating. Usually, the single most important variable that Hart found for the loss of agriculturally-productive land was the quality of that land. This was found repeatedly, despite the difficulty in isolating the variable in a consistently measurable fashion. The long-term decline of use from intensive to extensive forms of agriculture to finally wood lot was also recognized by Hart (1968).

Within this broader picture of macro-regional decline and contraction of agriculturally-used lands, North Carolina stood out as a state that seemed to parallel the larger trends, with a net loss of 1,849,000 acres of farmland from 1910 to 1959, and with 77 of 100 counties actually losing land in farms (Hart, 1968). What has happened in the more than thirty years since Hart's study, however? What has happened to the farmlands of the original thirty-one state region compared to North Carolina? What are the current regional distributions of farmland use, gain, and losses? How different or similar are these North Carolina patterns when compared to the macro-region? And, what might be some of the causes for such patterns, if indeed they exist?

Post-1968 Changes at the Macro-Scale

Since 1968, the patterns of agricultural land use in the eastern thirty-one states of the United States has gone through a continuing series of alterations, including serious levels of abandonment and loss of acreage, and a decline in the number of farms and average farm size. Not surprisingly, too, there has been an unevenly distributed change in cleared acreage.

In order to create a benchmark for comparison of North Carolina's agricultural land changes to the broader macro-region of the eastern United States, a number of general macro-regional dimensions are described here. In 1969, states in the macro-study region had a total of 356,981,000 acres in all categories of farmland. By 1997, the amount of farmland recorded for the same areas amounted to 301,040,849 acres, a loss of 55,940,159 acres (or 15.7%). The corresponding amounts of total farmland of all types for North Carolina were 12,733,751 acres in 1969 and 9,122,379 acres in 1997, a decline of 3,611,372 acres (or 28,4%). Total "cleared" farmland (or the total farmland amounts minus total farm woodland per county) for the macro-region was 290,450,990 acres in 1969 and 250,936,021 acres in 1997; a decrease of 40,514,969 acres (or 13.1%). For North Carolina, these data for

Table 1. North Carolina Agricultural Land Dimensions, 1969-1997

Year	Cleared Farmland*	No. Farms	Average Farm Size*
1969	8,699,458	119,386	107
1974	7,206,640	91,280	123
1978	7,129,457	81,706	135
1982	6,993,652	72,792	142
1987	7,694,450	59,264	159
1992	6,323,501	51,854	172
1997	6,482,653	49,406	185

*Acres

Sources: U.S. Census of Agriculture: North Carolina State and County Data for 1969, 1974, 1978, 1982, 1987, 1992, and 1997

Table 2: Cleared Farmland in Eastern North Carolina, 1969-1997, in Acres

County	1969	1997	% Change
Duplin	176,126	181,354	+3.0%
Hyde	53,175	86,299	+62.3%
Lenoir	107,182	118,638	+10.8%
Pamlico	27,807	45,651	+64.2%
Pasquotuck	58,777	83,711	+42.4%
Perquimans	66,167	71,137	+7.5%
Tyrell	21,623	52,046	+140.7%
Washington	71,415	95,115	+33.2%

Sources: U.S. Census of Agriculture: North Carolina State and County Data for 1969 and 1997

1969 were 8,696,458 acres of cleared farmland. For 1997, there were 6,482,653 acres, or a decline of 2,213,802 acres (25.5%). North Carolina actually lost farmland in use at a rate that was significantly higher than the pattern for the thirty-one state macro-region (Table 1 and Figures 1 and 2).

Closely related to the variable of cleared farmland are two other variables; the number of farms and average farm size. Again, from the view of the larger region, there were 1,918,141 farms in the eastern United States in 1969, and 1,203,969 in 1997. This was a loss of 714,172 farms (or 37.2%). In North Carolina, in contrast, there were 119,386 farms in 1969 and 49,406 farms in 1997; a massive loss of 69,980 farms (or 58.6%) (Figures 3 and 4). North Carolina also saw a state-wide increase in average farm size from 107 acres in 1969 to 185 acres in 1997 (an increase of 130.3% for the macro-region and an increase of 72.9% for North Carolina) (Figures 5 and 6).

Patterns of North Carolina Agricultural Land, 1969 to 1997

The patterns of agricultural land change within North Carolina from 1969 to 1997 were as striking and distinctive as were those at the state-by-state scale. One of the characteristics that distinguished North Carolina from the rest of the original study area was the patterns of change for all three of the state's environmental/agricultural regions.

Upon examining its dimensions of cleared farmland from 1969 to 1997, the Coastal Plain areas of eastern North Carolina stand out in stark contrast to much of the rest of the state. A total of eight counties (Duplin, Hyde, Lenoir, Pamlico, Pasquotunk, Perquimans, Tyrrell, and Washington) experienced a gain in the amount of cleared land on their farms for the time 1969 to 1997 (Table 2). All are within the Coastal Plain. Much of this increase in cleared farmland and implied farming activity is related to a fundamental alteration in the agricultural activities of the past and the development of several new specialties over the past thirty years. Much of the lands in the coastal plains area once planted mostly in tobacco have experienced a significant decline in their tobacco activities (Hapke, et al., 1998). In the place of tobacco have evolved large and growing acreage and production in other crops, especially soybeans, and the development of a number of large-scale commercial producers of hogs (U.S. Census of Agriculture, 1969-1997; Furuseth, 1997a). As market conditions for tobacco waned and the future of tobacco as a profitable crop has become murky with law suits against tobacco businesses, soybeans and hogs have become the leading economic components of the coastal plains agricultural sector of North Carolina.

Most of the rest of the counties of the eastern section of the state witnessed much smaller amounts and intensities of cleared farmland losses when compared to the other regions of the state. Arguably, the highest rates of loss of cleared farmland occurred in the western areas of the state within the Appalachian realm. When combined with the facts that this west-

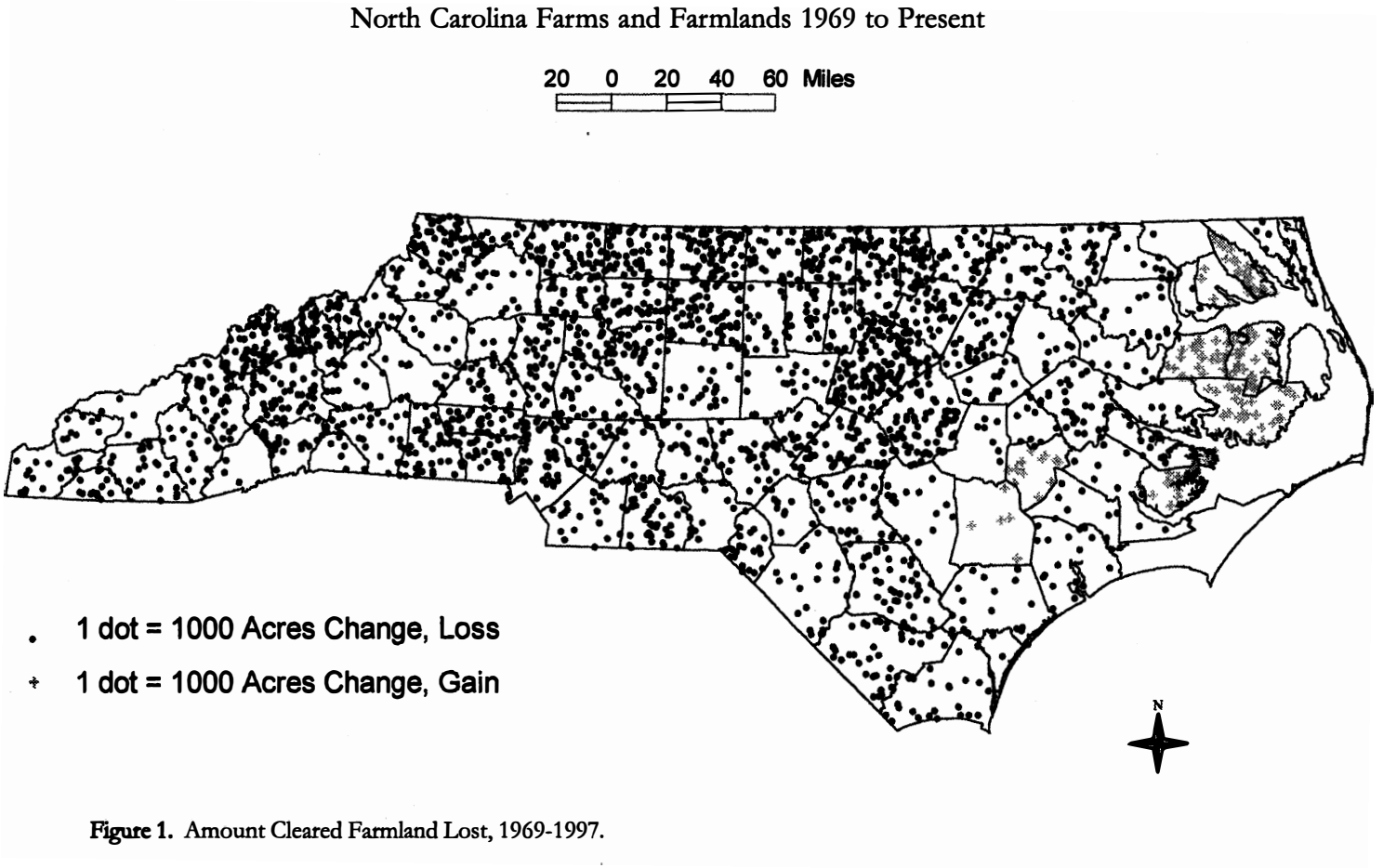

Figure 1. Amount Cleared Farmland Lost, 1969-1997.

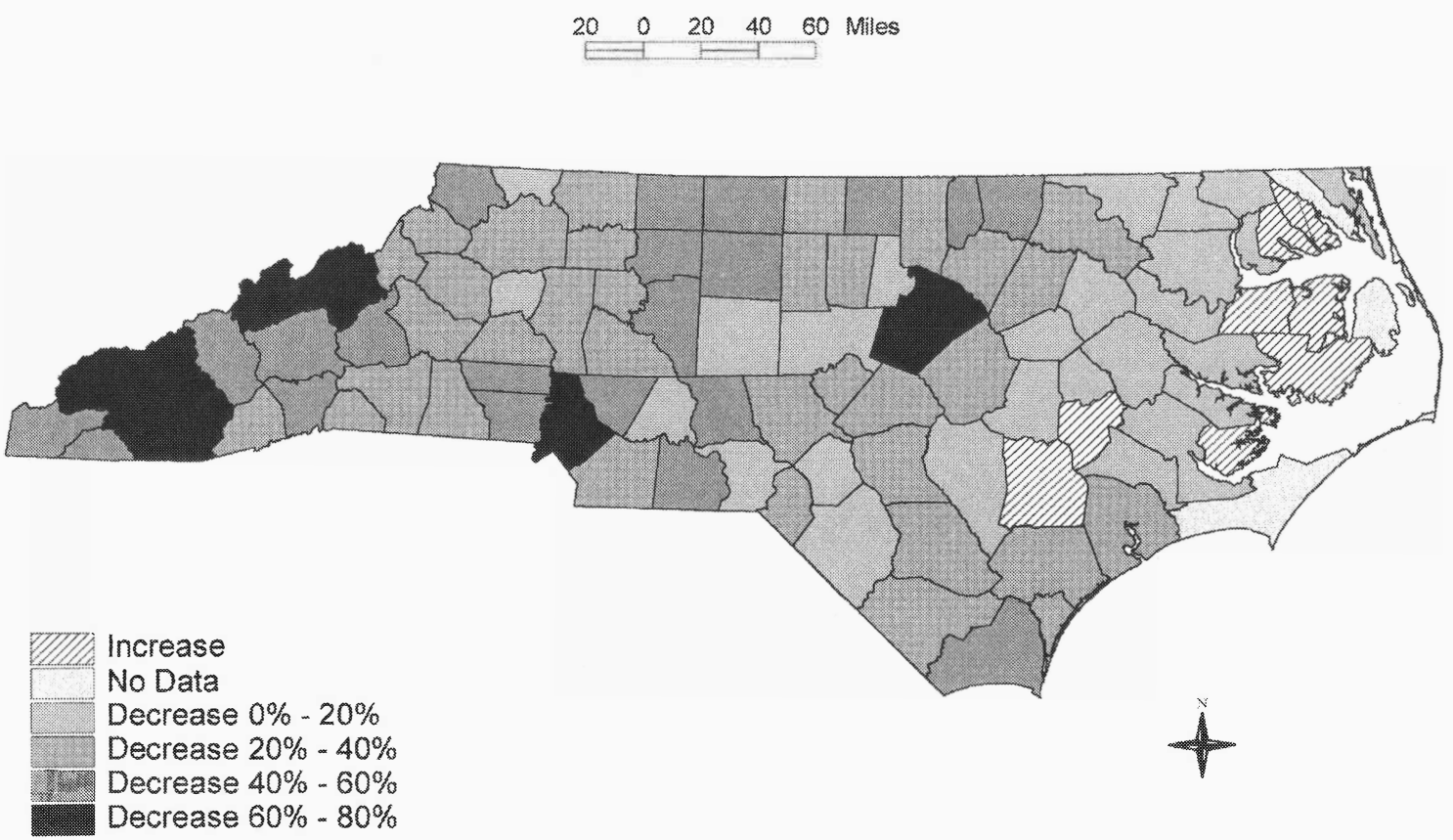

Figure2. Cleared Farmland, Percent Change in Acreage 1969-1997.

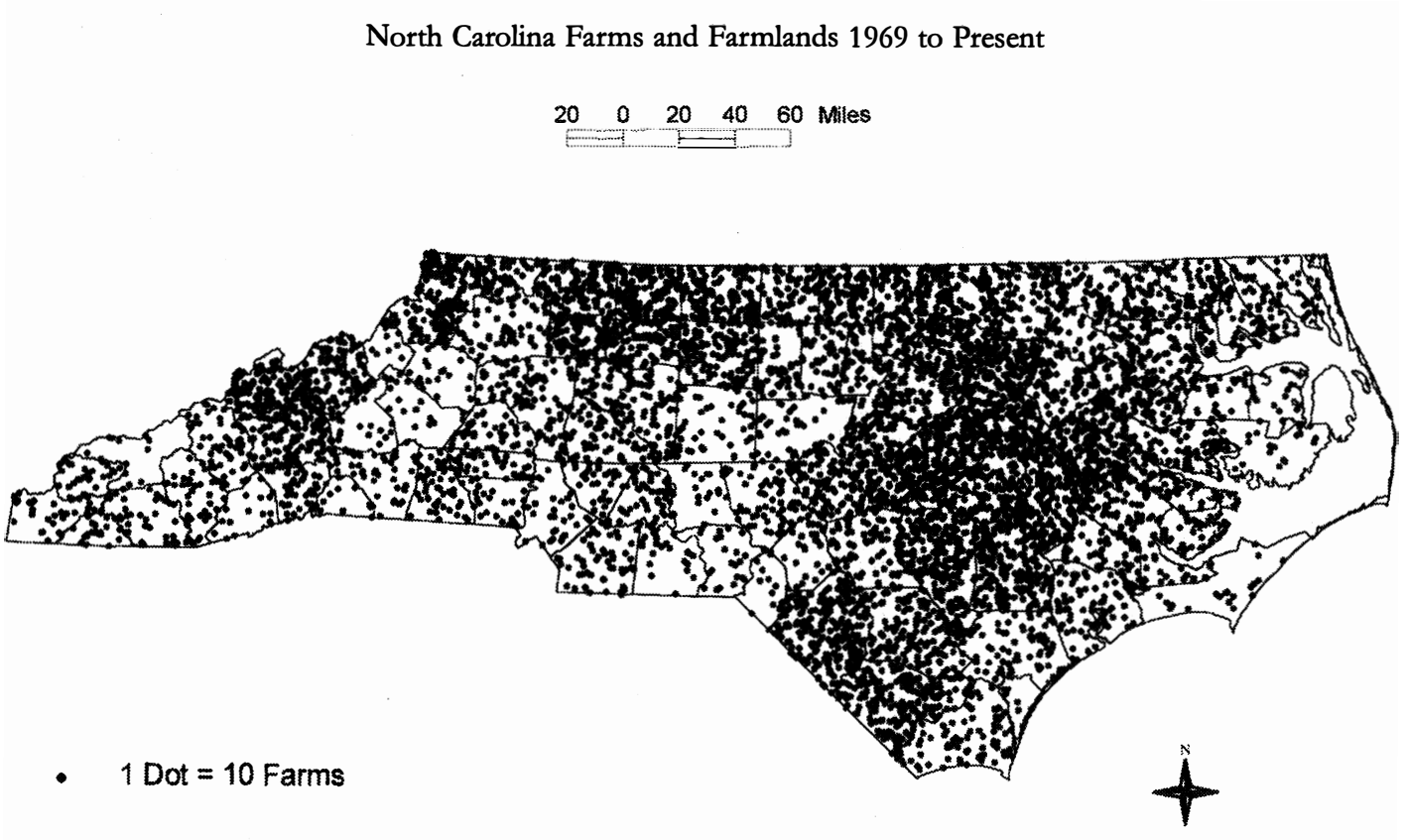

Figure 3. Decrease in Number of Farms, 1969-1997

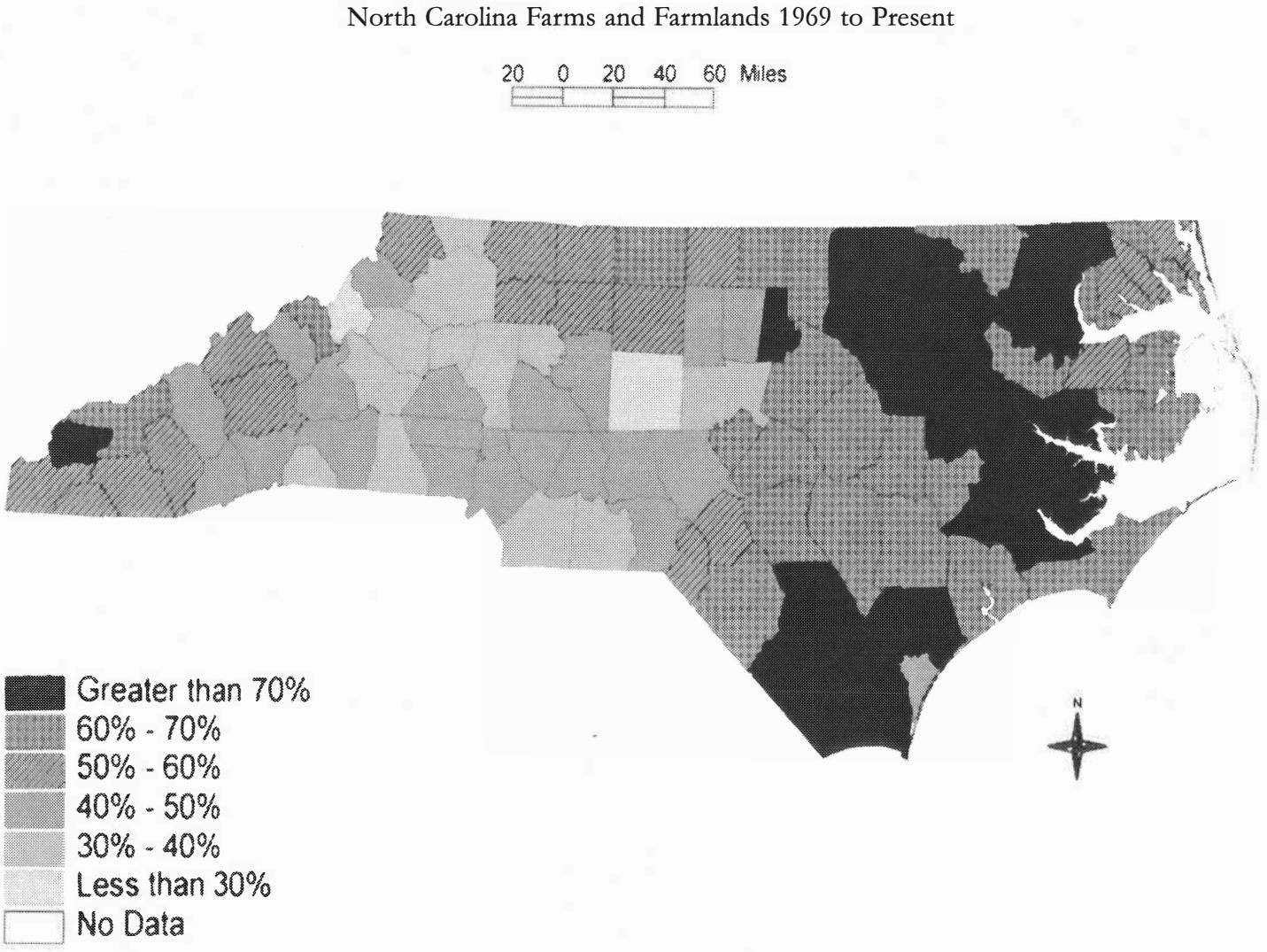

Figure 4. Percent Decline in Number of Farms, 1969-1997.

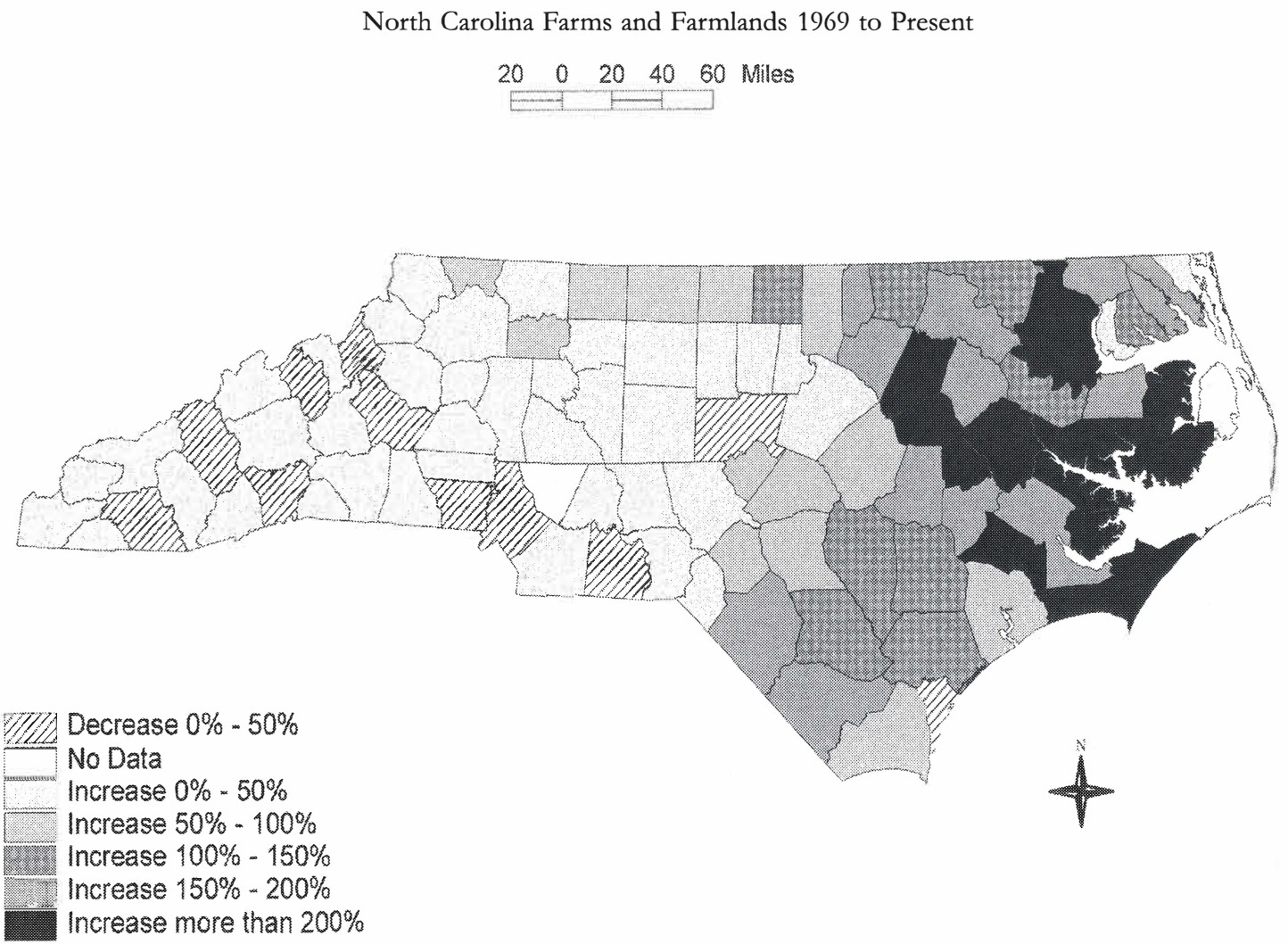

Figure 5. Percent Change in Average Farm Size, 1969-1997.

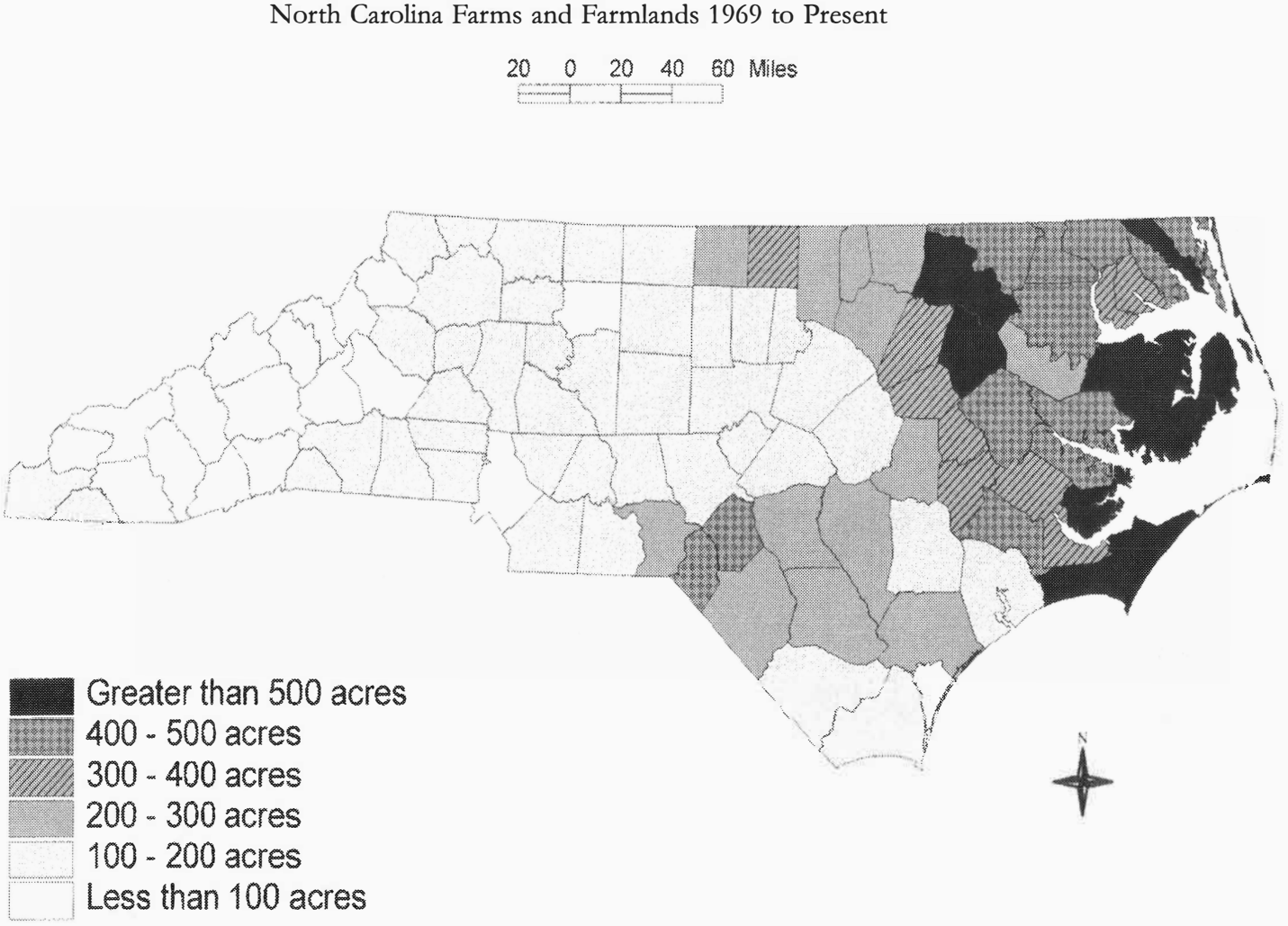

Figure 6. Average Acreage Per Farm for 1997.

ern area also declined in numbers of farms and average farm size, it becomes evident that this mountainous west of North Carolina is in active "agricultural decline" and evidently is being converted to other land and economic uses such as tourism, forest preserves, and second home properties. The "Piedmont" areas of the state show a more mixed though still substantial loss in cleared farmland since 1969. One probable cause for this varied pattern, the effects of urban sprawl and suburbanization, has an uneven pattern. For example, Mecklenberg County (Charlotte –63.6%), Wake County (Raleigh, -76.2%), and Guilford County (Greensboro, -48.5%) all had sharp losses in cleared farmland as their urban areas grew significantly in area, content and complexity since 1969 (Henderson and Walsh, 1995). Counties with smaller urban areas and levels of urbanization, like Cumberland (Fayettteville, -29.1%), and Durham (Durham, -16.3%) counties, experienced less farmland loss. The less urbanized counties of this Piedmont area fell between the extreme losses of the western areas of the state and the actual gains in the east.

Numbers of Farms and Farm Sizes, 1969-1997

While North Carolina's agricultural sector experienced a variable regional pattern of change in cleared farmland over the study time, all counties of the state saw losses in total number of farms with the abandonment of more marginal lands, the conversion of farmland to other land uses, and farm consolidation. Again, however, this variable was distinctly regional in its distribution and in the intensity of loss. First, in contrast to the increase or very modest losses in cleared farmland by county, the eastern third of North Carolina experienced large and pervasive losses in the number of farms (Figures 3 and 4). Obviously, the remaining farm units have gone through a significant process of consolidation and an increased level of commercialism and industrialization as their activities, products, and structure have evolved over the past thirty years (Hart and Chestang, 1978). Toward the central and western areas of the state, a more mixed picture of farm loss exists. Randolph County, in the geometric center of the state, and Avery County, on the state's border with Tennessee, were the two counties in the state with the least losses of farms, probably resulting in part from earlier declines and local legislation/planning initiatives to halt the loss of what is left of their farms. The far southwest corner of the state, however, lost farms at a rate of (usually) over 50% from 1969 to 1997, as did counties along the northern tier bordering Virginia. Much of the rest of this western two-thirds of the state had already experienced large farm losses, however, and had simply fewer marginal farm units to lose.

Farm size dimensions also has distinctive patterns. Again, most of the eastern third of the state experienced the largest average increases in farm size by county. This is another indication of farm consolidation, increased industrialization, and commercial change in this region. Again, in contrast, most of the central and western counties of North Carolina increased their farm size average less than 50% between 1969 to 1997 (as opposed to several eastern counties that saw their average farm size by county increase by over 200%, including Hertford, Hyde, Jones, Nash, Pamlico, Pitt, and Tyrrell counties). Ten other counties in the Piedmont and Appalachian areas actually declined in their average farm size (Macon, Haywood, Henderson, Yancey, Avery, Burke, Gaston, Mecklenberg, Anson, and Chatham counties). And, one tiny county on the east coast, New Hanover (with the city of Wilmington) also decreased in average farm size. While urbanization is an obvious factor for such decline in a few of these counties (e.g., New Hanover, Mecklenberg, and Gaston), other reasons such as a more general decline in farming and land abandonment seem to be at work in the other counties as more traditional tobacco and other forms of farming decline in profitability (Furuseth 1997a; Hart and Chestang 1978).

Reflections and Summary

A most compelling question now is "what is causing these patterns?" These causes appear to be complex, interrelated with regional and national forces, and are associated with non-agricultural influences. Perhaps foremost among these forces for regional change in North Carolina's agricultural sector is the

fundamental refocusing by North Carolina farmers on very different products and styles of farming.

The traditional and long-time commercial crop of a large number of North Carolina farmers has been tobacco. Few crops in North Carolina's existence have been so important, dominating, and lucrative as has been tobacco, but that has been changing during the past thirty years. There have been several factors of change in the tobacco industry that have been a part of the farmland changes of the state. This once-hand labor oriented activity has finally become mechanized at all levels of its production. This, in turn, has encouraged land consolidation and has produced an increased need for capital used in such consolidation and industrialization. This has also meant that fewer farmers were needed, which in turn reduced the number of people who do plant tobacco. Where human labor is still used, increasingly it is immigrant labor from Latin America. Larger marketing patterns, the end of "local" storage, processing, and handling has pushed the business more toward large (and sometimes internationally oriented) companies. And, the concerns of many over the health aspects of tobacco use have, at best, made the near future of tobacco growing uncertain and suspect (Hapke, et al, 1998). Since many of the tobacco farms of the past were more numerous and smaller in size, this consolidation force becomes very evident now.

While tobacco's contributions to the agricultural sector of North Carolina have changed a great deal, there has also been a refocusing of agricultural activities, particularly in the eastern third of the state. Much of this revolves about a massive "boom" in hog raising and poultry farming (Hart, 1991; Furuseth, 1997a; Furuseth, 1997b). Hogs and poultry were part of the products of North Carolina from its earliest of colonial days, and some commercial activity regarding the raising of both have long been components of the North Carolina agricultural scene. However, since the 1970s both poultry and hog raising have exploded in North Carolina in terms of the numbers of farmers, agri-business firms, and workers involved, land used, capital expended, profits made, and other aspects such as environmental impacts of animal manure (Furuseth 1997A; Furuseth 1997b). These operations producing the "other white meat," broilers, eggs, and other products have focused in the eastern counties of the state and have been the prime focus for farmland con-

Table 3: Agricultural Losses in North Carolina, Fall, 1999

Livestock	Number Lost	Total $ Lost
Hogs	28,000	$1,680,000
Chickens	2,107,857	$3,583,357
Turkeys	752,970	$7,153,215
Cattle	1,180	$495,600
		$12,912,172

Crops	Acres Affected	Total $ Lost
Corn	379,716	$49,377,709
Soybeans	1,086,566	$69,580,564
Tobacco	80,911	$95,114,346
Cotton	781,564	$193,587,047
Peanuts	119,536	$39,925,706
Fruit-Veg.	55,861	$79,590,892
		$543,275,892

Source: North Carolina Department of Agriculture and Consumer Services

solidation and increased cleared farmland in the same area. The land holdings where these changes have occurred have also expanded on average over time (Furuseth, 1997a). The areas of the state which have not experienced this conversion to hog and poultry raising, and that are not engaged in growing soybeans and corn to be used for animal fodder, have experienced either a lack of growth in their agricultural activities and production, or have suffered actual declines.

In sum, much of the state's agricultural sector is now being driven by the burgeoning hog and poultry businesses concentrated and developing in the eastern portion of the state. This includes the expanding cleared farmland in the east, as opposed to its loss in the west and some of the Piedmont and the unexpected increases in some eastern counties of numbers of farms and farm sizes.

Postscript

Fall of 1999 brought to North Carolina a set of natural disasters named "Floyd" that was not only deadly and destructive to the people, homes and communities of the state, but was also immensely damaging to the state's agriculture. Much of this disaster impact occurred in the eastern areas of the state, exactly where most of the hog and poultry activities have redirected the state's agricultural geography. Although the state's Department of Agricultural and Consumer Services have not provided county breakdowns of losses, the data in Table 3 provide at least a partial review of losses by the farmers of North Carolina from this storm and resulting floods.

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North Carolina's HMO Provider Networks: A Comparison Between HMO Providers and All Physicians in the State

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The relative strengths of fee-for-service versus managed care are discussed. Trends occurring in health management organizations (HMO) enrollment for the United States and North Carolina are presented. The spatial distributions of North Carolina physicians associated with HMOs and all North Carolina physicians are compared using data aggregated from directories of HMO plans and from the North Carolina Board of Medical Examiners. Physician distributions were compared for regional concentrations (mountain, piedmont, and coastal) and undesirable locations. No dramatic differences were found to exist between the distributions of HMO and all physicians. This means that physicians, regardless of HMO status, were more apt to be located in urban and affluent areas. The bottom line, therefore, is that the geography of physicians remains largely unchanged with the rise of HMOs in North Carolina.

Introduction

For most of the twentieth century, hospitals were at the vanguard of patient care, and the health care universe revolved around them (Robinson 1996); hospitals had little competition, and little incentive to control costs. The introduction of health management organizations (HMOs) in recent years has dampened spiraling costs through lower overhead expenses and a case management approach to patient care. The result of these cost-cutting measures has been a shift of primary care doctors (i.e., general and family practitioners) to the center of the health care system, and the relative displacement of hospitals. The increasing importance of managed care has changed the contemporary health care landscape, such that it is no longer sufficient to simply have a physician nearby. Now the issue is whether the nearest physician is a participating provider in a person's health plan. If provider networks are not adequate, which populations are thought to have the least geographic accessibility to providers? This is an important and timely question as some recent studies have suggested that managed care might not be a viable option for rural, high unemployment, and minority populations (Fuchs 1994; Gaskin 1997; Mark and Mueller 1996; Harvard Law Review 1995; Ricketts et al. 1995).

Critics of HMOs charge that the desire to control costs could cause managed care plans to be reluctant to serve unprofitable populations and areas where costs exceed certain thresholds. For example, some rural populations have relatively high rates of chronic illnesses (Schneider and Greenberg 1992), and minorities have a higher incidence of diabetes and stroke (Gaskin 1997). Unfortunately, the same characteristics that label populations as unprofitable likewise indicate the existence of populations with tremendous health care needs. Supporters of HMOs, however, argue that if certain populations are not part of a managed care program, it is a factor of the immaturity of the markets. In the early stages of an HMO's development there is a greater emphasis on holding costs down. However, as the market matures an HMO can develop new product lines, and presumably reach patients who had been previously missed (Jennings et

al. 1997). Indeed, recent research may bear that out, as most rural counties are now in multiple HMO service areas (Lomicka 1997; Moscovice et al. 1998). However, even if rural areas are part of the service areas of HMOs that does not necessarily mean there are HMO physicians available to rural populations (Ricketts et al. 1995). Regardless of the root causes, neglected populations experience decreased availability (number) of network resources; less geographic accessibility (distribution); more cost and time to overcome space (distance), less access to routine or preventative care services, and, because of the latter problem, more serious medical conditions and therefore higher costs.

Our investigation addresses two of these issues - availability and accessibility. The purpose is to determine whether locational differences exist between all physicians and the subset of physicians networked within HMOs. Specifically, are these two sets of physicians located more or less in economically depressed, rural, and minority areas; in other words, areas that are unprofitable and therefore undesirable?

Medical Geography Perspective

An important aspect of medical geography is an analysis of the role location has on health. However, it is a challenge to discover what constitutes the geography of managed care. If managed care can be thought of as having three components, the plan, the provider, and the member, only one of these, the provider, has perhaps a clear geography. The HMO plan itself can be identified based upon its service area, which is almost always at the county level. This is a fairly coarse level of analysis for research at all but the regional and national scales. This coarseness means that at the state level most analysis of a plan's service area will be done with fairly broad strokes. With regard to HMO members there are two geographies at work: one is the member's work place, which is where he or she usually enrolls in an HMO; the other is the member's home. In North Carolina, as in most other states, enrollment numbers are collected according to the member's home county, and no information is collected with regard to where the member signed up for the plan. Since, in most instances, enrollment at the workplace is the driving force behind any new growth in HMOs, research focusing on the member's home county is missing an important part of the picture. Physicians in an HMO provider network, on the other hand, have a distinct geography, rooted in the location of their practices. While there is no readily available source of patient encounter data for HMO networks, physician's locations offer an opportunity to collect information on the managed care system below the county level.

Of course, physician location and health care delivery studies are a component of the medical geography specialty, and while it is not possible to list all relevant studies, there are several in this vein that have a bearing on this research and merit explicit mention.

Gary Shannon and Alan Dever's work, *Health Care Delivery* (1974) provides a valuable overview of factors behind physician location. Although the health care system has experienced significant changes since the original publication of this work a quarter century ago, the fundamental concepts still have relevance. Specifically, they note three factors that have a large influence on the locational decisions physician make. These factors are:

(1) Whether a location is stable economically;

(2) The presence of adequate medical facilities;

(3) The area of most recent training contact (Shannon and Dever 1974).

The work of Shannon and Dever has informed much of the scholarship behind the geography of physician location and many have used it as a foundation from which to build additional studies. One such example is the notion of push/pull factors in physician location as presented by Rena Gordon, Joel Meister and Robert Hughes (Gordon, Meister and Hughes 1992). They contend that there are factors that help pull physicians to a certain location or push them away from others. Push and pull factors are frequently used in migration studies, but the concept has bearing with regard to physician locations. According to the authors, the pull factor is the dominant force. An excess supply of physicians in one area is not enough to push a physician out of a location; instead, physicians locate because of pull factors. While managed care is not specifically mentioned, there might be merit in thinking of provider network development within a framework

of push/pull factors. In other words, managed care companies cannot be pushed into the creation of provider networks in undesirable areas, they must be pulled there by the potential for profits from increased market potential.

Perhaps the earliest geographical analysis of HMOs was published in 1983 (Cromley and Shannon, 1983). This study presents a valuable picture of HMOs ten years after the federal HMO Act of 1973 that sparked the development of HMOs in the U.S. The authors found that, nationally, service areas of HMOs were concentrated in areas where medical resources were already in place. This tends to support the notion that undesirable areas might not experience the same HMO penetration since these areas typically do not have many resources already in place.

The background section of this study compares the basic features of fee-for-service (FFS), where insurance and the provision of services are separate entities, and managed care, where insurance and the provision of services are integrated. Particular emphasis is given to describing U.S. and North Carolina growth trends in health management organizations (HMOs), the dominant form of managed care. The methods section describes the development and enhancement of HMO and Board of Medical Examiners (BME) physician databases for North Carolina. The results section incorporates tables and maps to present our findings on physician locations. Specifically, place characteristics (i.e., undesirable areas) are compared for the locations of all physicians (BME) and networked physicians (HMO). The discussion outlines possible explanations for the observed patterns, considers study limitations, and suggests some further studies.

Background

Managed care is considered to be an alternative to the "traditional" approach to health care in the U.S., known as fee-for-service (FFS) plans. In FFS a patient receives care and treatment from a doctor or hospital of choice; the provider then submits an invoice to an insurance carrier. After the patient meets a deductible, the carrier typically covers 80% to 100% of the bill. This approach offers the patient freedom in the choice of physician, hospital, and treatment; however, it provides little incentive to control costs.

"Managed care" describes health plans that attempt to control the cost, volume, and quality of care through the coordination of patient services (Morales-Burke 1996; Gray 1991). Providers become accountable, through strict case management measures, for a financial "bottom line." Primary care physicians function as "gatekeepers" who control patient access to expensive specialists and services. In 1995, 83% of physicians had at least one managed care contract (Simon et. al 1997). The most common type of plan is the health maintenance organization (HMO), but other types of managed care plan include preferred provider organizations (PPOs) and point of service (POS) plans. Our analysis focuses on HMOs as opposed to other managed care arrangements such as PPOs or POS plans. While these later varieties of managed care are increasingly important, HMOs are still the dominant form of managed care in North Carolina. Furthermore, HMOs must be licensed by the state of North Carolina (unlike PPOs or POS), and therefore the identity of HMOs in the state is known.

Under an HMO, the patient pays a fixed monthly cost and the plan provides all levels of care, from routine office visits to major surgery. To prevent the spiraling costs found in FFS plans, HMOs contract with physicians and facilities such as hospitals and clinics to provide care for its members for a negotiated fee, and patients are required to use that provider. This arrangement can benefit contracted physicians by providing a pool of patients as well as, in some cases, providing financial assistance for secretaries, building maintenance, and equipment purchases. In exchange, HMOs sometimes institute practice guidelines that physicians use to determine whether certain treatment options and specialist care are warranted for a patient.

There are three different approaches an HMO can take in the way it structures its relationship with providers. The first of these ways is the staff model, where the HMO employs the provider directly. Alternatively, the HMO can contract with multi-specialty medical group practices to provide health care services in what is known as the group model. The independent practice association (IPA) model is similar; however, under this arrangement the HMO contracts with community physicians and groups in private

practice. Most plans in North Carolina operate using this model, and of the three different types it could be the most likely to be influenced by a plan's attempts to avoid undesirable areas.

But there is more to the differences between FFS and managed care than just the mechanisms of payment. Managed care plans such as HMOs have brought about a fundamental shift in the American health care system. For most of the twentieth century, hospitals were at the center of an expensive health care system (Robinson 1996). HMOs and other managed care plans have rebelled against such high costs by favoring smaller, stand alone ambulatory care facilities. Such facilities have smaller overheads, as well as other advantages that allow them to operate on a much cheaper basis than comparable facilities run by hospitals. The result of these cost cutting measures is the shift of primary care doctors to the center of the health care system, and the displacement of hospitals. In a managed care plan, patients are treated first by their family doctor. Here every attempt is made to solve the problem within the primary care provider's office before going on to more expensive specialists.

From the patient's perspective the differences between the two approaches, FFS and HMO, may not be dramatic. If a patient's physician is part of an HMO network, then the patient may continue to see that doctor. In fact, participants in an HMO usually pay less in out of pocket expenses for routine office visits and prescriptions, sometimes as little as $5 to $10 a visit, with an additional nominal charge to fill a prescription. In addition, some HMOs pay for procedures traditional FFS plans would not cover such as vision care and routine preventative care. Critics point out, however, that patient dissatisfaction with HMOs comes in the less routine provision of care. The practice guidelines and case review procedures of HMOs can mean that for more serious illnesses or mental health therapy, the patient's choice of treatment or physician is limited or tightly controlled by the HMO. The differences could also be dramatic if an approved provider is not available nearby. It may then be a burden to reach an approved provider.

Perhaps the best analogy to assist in understanding the relative strengths and weaknesses between HMOs and FFS plans is presented by Dr. Patricia Roy (Roy 1992). For Dr. Roy, the difference between the two approaches is similar to the choice between taking the bus and owning a car. With a bus, one can get to one's destination cheaper, but the person is bound by the rules, schedule and route of the transit company. This means that he or she may have to wait before departure, may be forced to take a more circuitous route or even be forced to walk part of the trip, if their destination is not located exactly at a bus stop. Like the bus passenger, forced to follow others' rules, HMO enrollees must sometimes wait longer to see a specialist or pay out of pocket if they wish to visit a physician outside the network or receive a treatment not deemed "appropriate" by the HMO.

Owning a car, according to Roy, is much like the FFS plan. Car owners have the flexibility of leaving when they want, and going straight to their destination on their own schedule. The drawback to owning a car is that it is considerably more expensive than relying on the bus. A car owner has maintenance, insurance, as well as monthly car payments. For those covered by FFS plans, their health care is somewhat more flexible, they have the freedom of seeing nearly any physician they wish, and their plan will likely cover the cost. Such service comes at a premium, however. Routine maintenance such as physician office visits, and prescriptions are often the responsibility of the patient.

Although each approach has its advantages and disadvantages, HMOs have generally been credited with slowing the enormous growth in the cost of health care in the United States, while FFS is blamed for causing the increase in costs. (Zelman 1996). The desire to control costs prompted congress to write the HMO Act in 1973 (Fox 1996; Zelman 1996). This law provided federal assistance in the development of HMOs, including a provision that encompassed rural and underserved areas, and mandated that large employers offer HMOs to their employees, if such plans were available. Once HMOs were created, nationwide enrollment in the plans was slow through the rest of the 1970s. There were great geographic variations, with the Western region experiencing the highest enrollment and the Southeast the lowest (Figure 1). As costs associated with FFS plans continued to climb throughout the 1980s, HMOs became increasingly popular. Nationwide enrollment

in 1981 was 10 million; by 1987 it had grown to 30 million. During this period, growth continued strong in the West, the Northeast saw large gains, and the South still lagged behind (Interstudy 1991). In the 1990s HMOs have become even more popular. Estimates for 1997 HMO enrollment is 52.5 million, or about one fifth of the total population of the United States (Department of Health and Human Services 1997).

Compared to other parts of the U.S., managed care is a relatively recent phenomenon in North Carolina. The state licensed its first HMO in 1981, when Blue Cross/Blue Shield of North Carolina was approved. Starting in 1994, the number of operating HMOs in North Carolina began to grow dramatically (Figure 2). Between 1994 and 1997 HMOs grew from 10 to 24 plans with enrollments almost tripling from over one-half million to almost one and one-half million or approximately 20% of the state's population (North Carolina Department of Insurance 1998). However, this growth was not uniform with respect to rural and urban representation. The vast majority (84%) of the growth occurred in the state's urban areas, especially in Charlotte, Raleigh/Durham, and Winston-Salem/Greensboro; the non-metropolitan areas had the remaining 16% (North Carolina Department of Insurance 1998).

In a free market system such as ours, the profitability of a health care provider or health insurance plan is important. Critics, however, are concerned whether cost reductions will be achieved at the expense of the health of people in undesirable (i.e. unprofitable) locations (Fuchs 1994). If managed care plans are striving to reduce costs, they would be expected to avoid areas with exceptionally high costs (i.e., areas with low income and minority patients). Indeed, some HMOs use what are known as practice profiles to assess the practice patterns of physicians and help assess the types of patient seen by a physician (Kassirer 1994).

Methods

Concerns about the spatial distribution of provider networks of HMOs provide the basis for

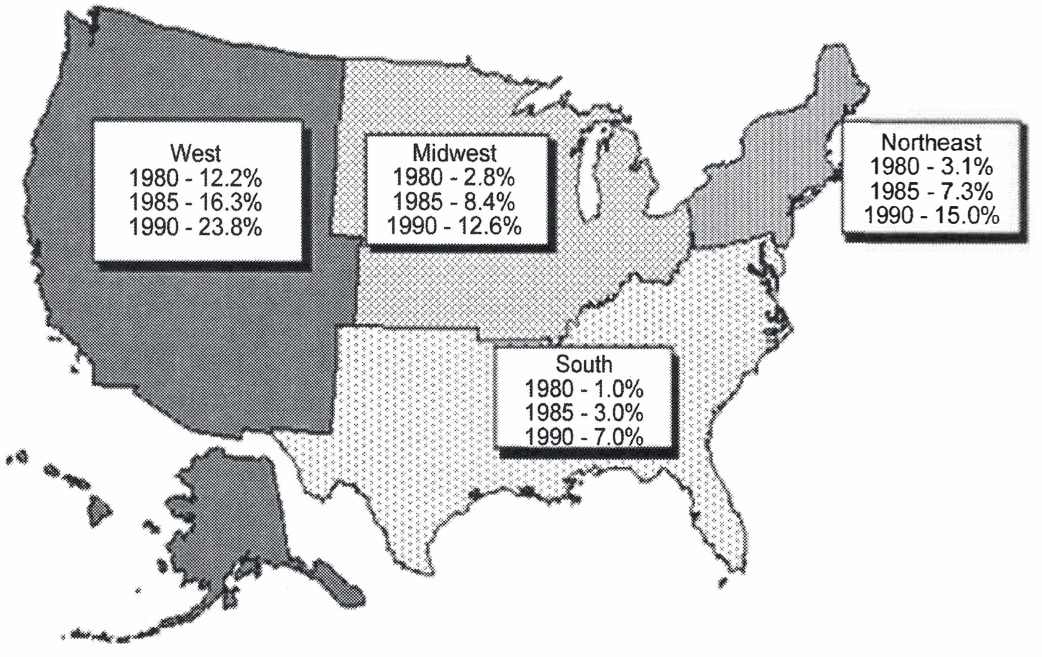

Figure 1. Percent of Population Enrolled in HMOs by Census Region 1980-1990 (Interstudy, 1991)

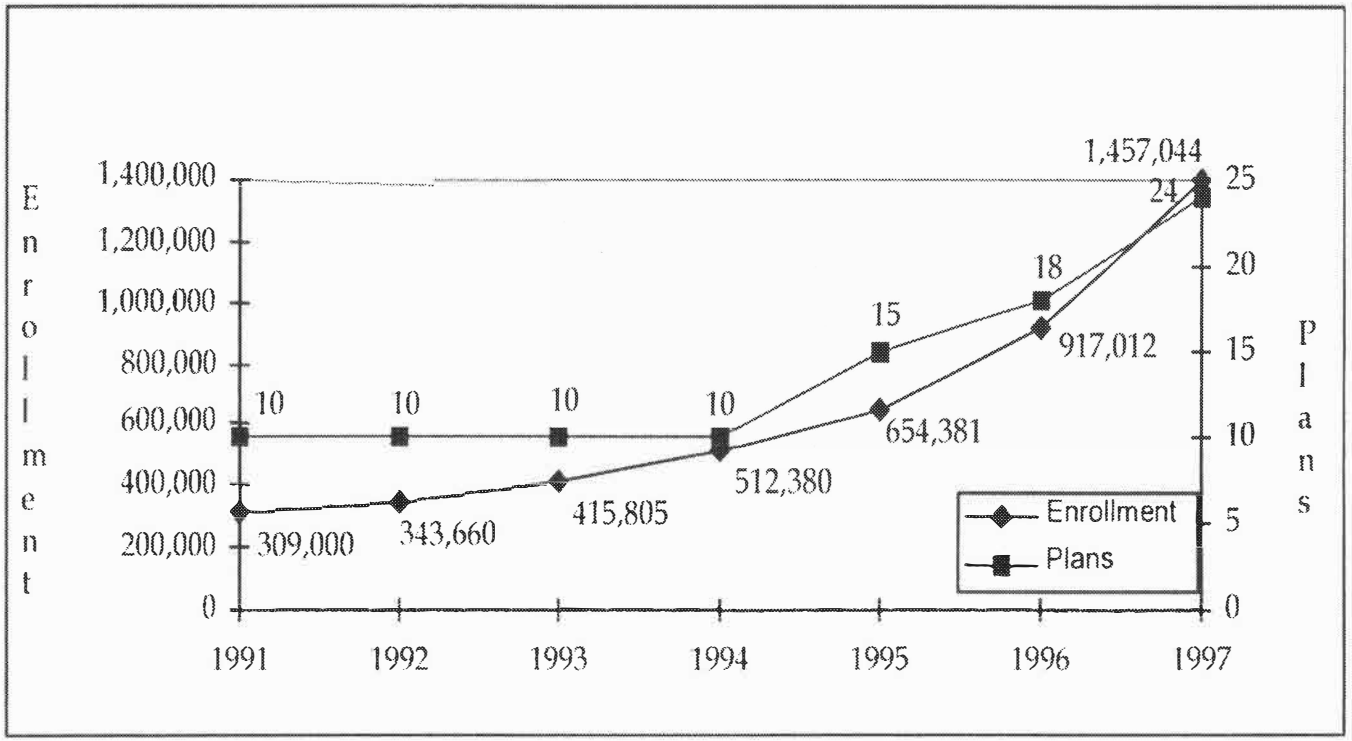

Figure 2. Growth in HMO enrollment and number of plans in North Carolina, 1991-1997 (North Carolina Department of Insurance 1998).

Table 1. Summary Tape File 3-B from the 1990 U.S. Census.

	Undesirability Trait Census Variable(s)
Rurality	Urban population
	Employment in industry classified as agriculture, forestry, and fisheries
Poverty	Persons with income 0.50 to 0.99 of poverty level
Education	Persons age 25 and over: Maximum educational attainment high school or equivalent
Race	Persons of Hispanic Origin
	Race, Non-white: Black, Amer. Indian, Eskimo, or Aleut, Asian or Pacific Islander, Other
Employment	Males 16+ in labor force: unemployed
	Females 16+ in labor force: unemployed
	Persons 16+ in labor force: unemployed

this research. The goal is to compare the locational patterns of HMO physicians to all physicians (BME). The specific research question is: "Are physicians in HMO provider networks located in areas with a lower degree of perceived undesirability compared to all physicians?" The measures of undesirability include one or more Census variables for rurality, poverty, education, race, and employment (Table 1). Percentages based on populations of ZIP Codes were calculated for each variable. Additionally, quartiles at the state level were determined; these quartiles provided a standard for regional comparisons.

Comparison characteristics will reflect what we will call *undesirableness* for brevity's sake, but simply reflect the presence of minority, rural, or impoverished (i.e., unemployed) populations or other traits that are suspected of not being a part of managed care plans. Though there are a considerable number of criteria that could be used to measure undesirability, we have chosen to use nine measures from the 1990 Census that reflect an area's poverty, its minority population, the rurality of the region, and the area's unemployment. This is important since many of the measures of undesirability will be associated with rurality. From the managed care company's perspective there are many perceptions about the patient populations mentioned above, and these perceptions could lead an HMO to feel these are undesirable groups for a managed care plan to target. This could, of course, be said for all providers in general.

This study compares two physician databases, an HMO database amalgamated from seven HMO directories, with the North Carolina Board of Medical Examiners (BME) physician licensure data. The BME is the licensing agency for all physicians working in North Carolina. The census variables (Table 1) were linked to physician records in both the HMO and BME databases. Zip Codes were selected as the geographic unit of analysis and these were aggregated into the mountain, piedmont, and coastal plain physiographic regions of North Carolina (Figure 3). These physiographic regions possess variations with respect to numerous socio-economic characteristics including patterns of health care services and therefore merit comparative analysis. For example, Asheville provides a large percentage of the tertiary health care services for most of the rural counties of western North Carolina (Albert 1994a, 1994b).

Directories from seven health plans, a mix of large and small, were used to create an HMO database

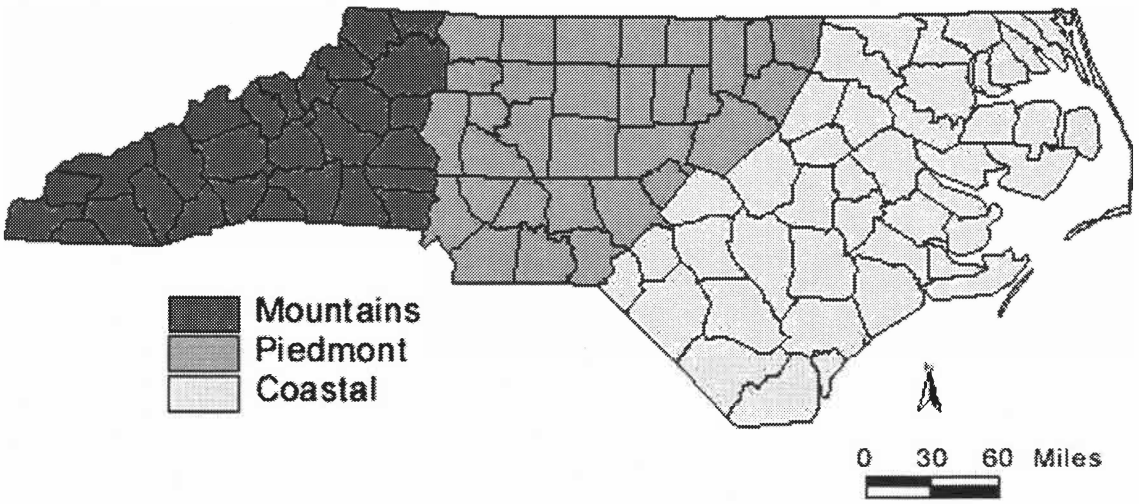

Figure 3. North Carolina physiographic regions.

Table 2. List of study HMOs, membership, enrollment ranking and share of total North Carolina Enrollment. Membership is as of 12/31/96 for commercially insured enrollment (North Carolina Department of Insurance 1998).

HMO	Rank	Membership	Share of NC Enrollment
Blue Cross Blue Shield	1	222,870	23.7%
Healthsource	2	194,302	20.7%
Partners Health Plan	4	125,397	13.3%
Prudential HMO	6	63,209	6.7%
Principal HMO	10	9,620	1.0%
Doctors Health Plan	11	8,564	0.9%
Personal Care Plan	14	5,606	0.6%
Total		**629,568**	**67.0%**

of 16,260 records with name, city, ZIP Code, physician specialty, and health plan fields. These seven HMOs accounted for a 67% share of North Carolina's HMO enrollment for 1996 (Table 2). It was necessary to match the HMO database to the BME database to determine the primary location of physicians (as opposed to their secondary and tertiary locations), because the BME includes a field of physicians' primary location, whereas the HMO database has multiple listings of physicians but does not confirm their primary location. As a result, 8,861 of the 16,260 HMO records could not be matched. After subtracting another 995 duplicate records, 6,404 HMO records remained. Therefore, the elimination of duplicate names (i.e., physicians who listed multiple locations and were associated with multiple plans) reduced the percentage matched to around forty percent (6,404/16,260). This moderate match rate was attributed to typographical errors and other variations in the name fields within and between the HMO and BME databases. The final record counts for BME and HMO physicians were further reduced because of a temporal mismatch between the Census and the BME database (1996). Because the Census file originated in 1990 and the BME database contained 1996 locations, 5,671 physicians were in ZIP Codes created after the 1990 Census, leaving 8,910 records in the BME database. There were 910 physicians from the HMO database in these new ZIP Codes; therefore, the final physician count for the HMO database was 5,494. These Census enhanced HMO and BME databases were used to generate descriptive statistics for the undesirability measures.

Results

Nine census variables were sorted and grouped into quartiles and used to measure "undesirableness" within the state's ZIP Codes. The upper limits of these quartiles (Q1, Q2, Q3,and Q4) are shown in Table 3. For example, the upper limits for percent urban are Q1=0.0%, Q2=0.0%, Q3=45.3%, and Q4=100%. Quartiles separate the rural (Q1 and Q2) from the urbanized (or more urbanized) ZIP Codes (Q3 and 4). Therefore, since the other measures of undesirableness covary, either positively or negatively, with rurality, quartiles provide one approach to comparing BME and HMO physicians with the selected measures. However, the authors recognize that because physician distributions are very skewed toward urban centers, other data classifications might have been appropriate. Respective quartile limits for each Census variable were then used as a basis for comparing the percent BME and HMO physicians statewide and regionally (mountain, piedmont, and coast).

The rurality of a location is expected to have a detrimental effect on the potential for managed care, and the results do bear out that most HMO physicians locate in areas with a higher urban percentage (Table 4). However, their tendency to do so is no greater than the general physician population. The mean percent urban for the HMO Physician ZIP Codes was 70.2%, which is remarkably close to the 69.2% mean for the BME physicians (Table 4). Both BME and HMO physicians are locating in the most urban ZIP Codes. The data show that for both groups, approximately three-quarters of their physicians are located in urban areas, that is in the highest quartile (greater than 45.3% urban)(Table 4). In fact, at the statewide scale only 6.5% of physicians in the BME database and 5.5% of HMO physicians are in rural areas (ZIP Codes with 0% urban population). It should be noted, however, that for percent urban, the first and second quartiles are both comprised of ZIP Codes with 0% urban population. The third quartile represents those ZIP Codes whose percent urban population is between 0 and 45.3% (Table 4). This quartile contains 18.9% of the BME physicians and 19.4% of the HMO physicians at the state level (Table 4). So, as expected, the pattern of HMO physician locations is similar to the pattern of urban areas. The areas around the state's MSA's (especially the Triangle, Triad and Charlotte MSAs in the piedmont) have the highest concentrations of physicians while the western mountains and the coastal plain have the lowest concentrations. This pattern mirrors the distribution of BME physicians. Therefore, no obvious geographic urban/rural disparities between HMO and BME physician locations exist at the state level.

	Urban	AAF	Educational Attainment	Total Unemployment	Female Unemployment	Male Unemployment	Below Poverty	Non White	Hispanic
Q1	0.0	1.6	27.8	3.1	3.3	2.5	8.7	5.6	0.1
Q2	0.0	3.8	31.4	4.5	5.1	3.8	12.5	16.7	0.5
Q3	45.3	7.1	35.1	6.1	7.4	5.3	18.9	36.7	1.0
Q4	100.0	61.9	64.9	24.3	64.7	20.8	59.3	45.7	12.8

Figure 3. Quartile limits for the measures of undesirability.

When the numbers are considered at a regional, instead of statewide scale, only the relative availability of both BME and HMO physicians in rural areas changes. In the mountains and the coastal plain a greater percentage of physicians are located in the most rural ZIP Codes, in contrast to the piedmont. However, the differences between the HMO physicians and the BME physicians are relatively minor for all three regions. The greatest differences between these two groups is found in the mountain region's most urban quartiles. Here 54% of all HMO physicians are in those ZIP Codes with a percent urban population greater than 45.3% (Table 4). This is 4% larger than the 50.4% value found among BME physicians. A possible explanation for the higher percent of HMO physicians in the mountain region is the well developed and concentrated health care sector centered on the City of Asheville, in Buncombe County. Asheville is an urban enclave providing tertiary (high level care) health services for fifteen to twenty rural counties in western North Carolina. In completely rural ZIP Codes, the analysis shows 9.8% of HMO physicians, 2.7% less than BME physicians (Table 4). These differences are relatively small, however, and do not demonstrate a significant avoidance of rural areas by HMO providers.

Because of the slight differences between BME and HMO physicians across the other eight Census variables, separate descriptions for each variable are not warranted; however, some of the more noticeable differences are reviewed here. No quartile in any region had a difference greater than +/-6% for the two provider types (Table 5). Of the seven regional quartiles with at least a +/- 4% difference between BME and HMO physicians, five were in the mountain and two were in the coast regions. The mountain region had two quartiles with higher and three quartiles with lower HMO presence. The two quartiles with higher percents of HMO physicians were quartile 1 (lowest) for population below poverty (+6%) and quartile 4 (highest) for urban (+4%). This makes sense because these two quartiles represent optimum quartiles for these particular Census variables. The three quartiles with lower percentages of HMO physicians were quartile 2 for population below poverty (-5.2%), quartile 3 for total unemployment (-4.7%), and quartile

Table 4. Percentages of physicians within quartiles by region. Note that since the first two quartiles are 0%, no value appears for the second quartile.

Percent Urban (Quartile Limits)		Statewide		Mountain		Piedmont		Coast	
		BME	HMO	BME	HMO	BME	HMO	BME	HMO
Quartile 1	0.0%	6.5%	5.5%	12.5%	9.8%	2.6%	2.6%	11.7%	10.0%
Quartile 2	0.0%	--	--	--	--	--	--	--	--
Quartile 3	45.3%	18.9%	19.4%	37.1%	35.8%	15.4%	16.9%	12.8%	12.8%
Quartile 4	100%	74.6%	75.1%	50.4%	54.4%	82.0%	80.5%	75.5%	77.1%

Table 5. Measures where the difference between BME and HMO physicians in the quartile is four percent or greater.

Measure	Quartile	BME Percent	HMO Percent	Difference for HMO	Region
Population below Poverty	1	31.8%	37.1%	+6%	Mountain
Population below Poverty	2	24.7%	19.5%	-5.2%	Mountain
Hispanic Origin	3	44.3%	49.3%	+5%	Coast
Total Unemployment	3	30.0%	25.3%	-4.7%	Mountain
Female Unemployment	3	23.4%	19.3%	-4.1%	Mountain
Hispanic Origin	4	30.7%	26.6%	-4.1%	Coast
Urban	4	50.4%	54.4%	+4.0%	Mountain

4 for Hispanic (-4.1%). These all represent less than optimal quartiles for their respective variables and therefore suggest less than favorable ZIP Codes.

The remaining two quartiles with greater than +4% differences were in the coast region (Table 5). Here, within quartile 2 (0.5% Hispanic), a low percentage, there were more (+5%) HMO physicians than BME physicians. Whereas, in quartile 4 (12.8% Hispanic) of the same variable, there were less (–4.1%) HMO than BME physicians.

Overall the small differences in percent of HMO and BME physicians at the state and regional scales indicate that these distributions are in fact not different. There were some subtle differences regionally as noted above; however, these differences are inconsequential. With just seven quartiles between +/- 6% points and most other quartile differences considerably less, there does not appear to be any justification to state that such differences are substantial. Therefore we must conclude that HMO and BME physicians had similar locational patterns. The fear concerning the growth of managed care is its availability to provide care in undesirable areas, or areas that may not offer a sufficient potential for profit. When the database is analyzed to look at the potential undesirableness, the results indicate that physicians in HMO provider networks are *at least as available* as BME physicians. However, both groups display a tendency to avoid undesirable areas.

Discussion

The most striking finding from the analysis is the lack of any substantial difference between BME and HMO physicians with regard to measures of undesirableness. These results run counter to the fears discussed previously that HMOs would avoid such high cost populations and areas. Indeed HMOs seem quite willing to recruit physicians from undesirable areas - assuming physicians are available. In fact, many of the most rural, impoverished and undesirable areas, have no physicians. Therefore, HMOs don't have to actively avoid these areas, the health care system already has! The populations with the greatest undesirability and potential for high costs don't have access to a physician, are likely to be uninsured and exist outside the health care system. For instance, only 19.4% of all the state's physicians are in ZIP Codes in the fourth quartile (highest) for poverty, and just 6.5% are in completely rural ZIP Codes (Table 4). With such numbers, the options are limited for building a provider network. The result is that, even if an HMO

wanted a presence in a completely rural ZIP Code, most likely it could find no physicians to enroll.

This represents one of the flaws of managed care's mandate to serve rural areas, as presented in the 1973 HMO Act. The HMOs can claim, with some justification, that they are doing the best that they can with what they have to work with. Of course, as the prominence of HMOs in health care increases their role may change from one of adaptation to the extant physician distribution pattern to the ability of influencing it (Kane and Schoen 1996). The effect of such potential influence on future physician distributions is uncertain.

One explanation for the study's findings may be that the data were collected at a fairly mature stage in the development of HMO networks in North Carolina. If the data had been collected on a periodic basis (say every two years) since the inception of HMOs in the state and displayed on a series of maps, the maps might have shown initial penetration of relatively affluent urban markets and then diffusion to more rural populations. That is, HMOs might originally have been located in the most favorable areas and then "trickled down" into less favorable places.

Market forces may also play a role in the similarities between BME and HMO physicians. The HMO market in North Carolina is very competitive. At the time of the study, there were twenty active HMOs competing to provide health coverage to employers. A provider network that was as inclusive as possible and included physicians in a variety of locations would have the advantage over a plan with a limited provider network. In the future, HMOs may be required to provide the same level of care to a company's rural employees as to its urban employees as a condition of contracting with an employer (Feldman and Dowd 1993), thus reducing geographic disparities.

Limitations and Future Studies

The principal limitations of this research were: 1) overlap of HMO and BME physician databases 2) accounting for and appropriately weighting (hours and number of patient visits) for physicians' multiple practice locations and 3) scale issues and limitations of the ZIP Code. The authors recognize that there is a substantial overlap between the two physician databases; however, manually entering the provider lists from all 24 HMO plans was not feasible given our limited resources. Therefore the HMO database consists of just HMO physicians, whereas the BME database includes both HMO and nonHMO physicians. Our analysis is limited by this drawback.

Although the BME database includes hours per week in medicine for physicians' primary, secondary and tertiary locations, the data fields (columns) suffer from a large percentage of missing observations (Albert, 1997; Albert and Gesler 1996; 1997). Whereas the HMO database had information on physicians' multiple locations and multiple health plan associations, it lacked any information that would weight these practice locations according to number of hours or patients.

Since only physicians' primary locations were considered here, one might speculate on the contribution of physicians' secondary and tertiary locations. Previous studies of multiple locations found this phenomenon to contribute towards the dispersal of physicians (Cromley and Albertsen 1993). Some sixteen percent of North Carolina's physicians were traveling between at least two locations in 1992 (Albert 1995; Albert, Gesler, and Levergood 2000). Since some physicians have multiple locations on the urging of managed care organizations (Albert and Gesler 1998) there is some justification in assuming that the percentage of multiple locations has risen concomitantly along with managed care. Albert (1998) noted that a significant correlation existed between multiple locations, the dependent variable, with Health Professional Shortage Areas (HPSAs) (positive correlation), farm population (positive correlation) and Metropolitan Statistical Areas (MSAs) (negative correlation). This finding suggests that multiple-location physicians have a substantial effect on increasing access to "unfavorable" areas (Albert 1998). The accounting for these multiple-locations within our research frame would have provided a higher level of precision; however, data and time constraints rule out the inclusion of multiple locations in this, our initial endeavor into the realm of managed care.

ZIP Codes approximate economic trading areas and therefore, in general, conform to transportation

and communication patterns. However, the tenets of central place theory suggest that population (patient) thresholds and market areas would be smaller for the more common physician specialties and larger for the less common physician specialties. Therefore, for the lower order specialties such as general practice, family practice, pediatric, and internal medicine, one might assume a reasonable correspondence between these specialties' market area and ZIP Codes. However, for the higher order specialties such as neurology, radiology, and pathology, an appropriate assumption is that there is less correspondence between these specialties' market areas and ZIP Codes (Albert 1996; Albert and Gesler 1996). Therefore, some degree of spatial mismatch exists between specialty market areas and ZIP Codes. Without patient encounter data, it is impossible to accurately determine physicians' market areas or their patient characteristics; however, the ZIP Code level does provide a reasonable spatial scale to assess population characteristics of physicians' primary practice locations.

This research is, to our knowledge, the first attempt to examine geographic aspects of managed care in North Carolina. Our findings captured a historical moment in the development of HMO networks as the collection of physicians peaked. If North Carolina follows the same trend as other HMO markets, there will be a period of consolidation as unprofitable HMOs go out of business, and the more profitable HMOs eliminate unprofitable physicians. It is possible that avoidance of undesirable areas will become more evident once HMOs enter their next phase – cost cutting. Such a developing scenario necessitates ongoing research into the evolving dynamic of managed care. Future research might focus on examining other time periods (e.g., 1998, 2000, 2002) other plans (e.g., preferred provider organizations, point of service, independent practice association), large versus small plans, length of plan's existence, and physician characteristics (e.g., age, gender, and race).

Conclusion

We asked: "[A]re physicians in HMO provider networks located in areas with a lower degree of perceived undesirability compared to all physicians?" The answer is, no! HMO provider networks seem to be equally present in areas with an undesirable population characteristics as the general at large physician population. This appeared to be true at the state, regional, and ZIP Code levels. Except for slight differences for some measures in the mountain and coastal regions, overall HMO physicians were as consistently present in undesirable ZIP Codes as BME physicians. This means that physicians, regardless of HMO status, were more apt to be located in urban and affluent areas. The bottom line, therefore, is that the geography of physician distribution - to date - remains largely unchanged with the rise of HMOs in North Carolina.

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Fallacy of the 500-year Flood: A Cautionary Note on Flood Frequency Analysis

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The flood of 1999 on the Tar River in eastern North Carolina was the largest in nearly 100 years of stream flow records, where recurrence interval estimates at several gaging stations exceeded 500 years. Nevertheless, the estimation of recurrence intervals for low frequency, large magnitude floods involves considerable uncertainty. This paper uses annual flood records from four gaging stations in the Tar River basin to demonstrate the level of inaccuracy associated with flood frequency analysis (FFA). The margin of error (90% confidence interval) for recurrence interval estimates of large floods on the Tar River are suggestive of the inaccuracy of flood frequency curves, which show that the 100-year flood may be under or overestimated by as much as 1.5-2 times. Although FFA is necessary for the effective management of floodplains, estimates of discharge for various recurrence intervals should be evaluated in the context of several significant limitations: they are often based on short records, the underlying assumptions are routinely violated, and the margins of error are usually large.

Introduction

Torrential rainfall from hurricanes Dennis and Floyd produced the great flood of 1999 that was the most costly disaster in the history of North Carolina. Many news accounts touted the event as the "flood of the century" and reported the probability of experiencing such an event as one in 400 or 500 years (e.g., Royal 2000). Unquestionably, the magnitude of the flood was exceptionally large, however, the temptation to assign a probabilistic definition to the flood provides an opportunity to reexamine flood frequency analysis and the accuracy of recurrence interval estimates. The accuracy with which low frequency, large magnitude events like the 100-year flood are estimated has important implications for floodplain management because current federal flood insurance programs are linked to the 100-year floodplain. The purpose of this paper is to assess the difficulties inherent in flood frequency analysis using examples drawn from the Tar River basin in North Carolina.

Background: A Primer on Flood Frequency Analysis

Flood frequency analysis (FFA), or extreme value analysis, is based on the notion that the magnitude and frequency of extreme events can be estimated by fitting theoretical probability distributions to flood events (Gumbel 1941, 1958). Estimates are made of the probability that a certain discharge will be equaled or exceeded in any given year. This is usually applied to the *annual flood*, the largest peak discharge of each year of record, and is expressed as the exceedence probability p. The inverse of the exceedence probability ($1/p$) is the *recurrence interval* or *return period* T. For example, if the calculated exceedence probability for a peak discharge of 50,000 ft^3/s is 0.02, there is a 2% chance in any given year that this discharge will be equaled or exceeded. The recurrence interval for this example is 50 years, which means that over a long period of time the 50-year flood (50,000 ft^3/s) will occur an average of once every 50 years. It is important to recognize that the recurrence interval implies nothing about the time sequence of floods. In other words, it does not mean that the 50-year flood will occur exactly every 50 years. In fact, the 50-year flood could be equaled or exceeded in successive years or more than once in the same year.

Although the recurrence interval and the exceedence probability are the most commonly used probability estimates associated with floods, they only provide probabilities for individual years. If we want to know the probability of a flood magnitude occurring once over some longer timperiod, then:

$$P = 1-(1-p)^n \quad (1)$$

where P is the probability that an event will occur *once* during a time period of n years and p is the exceedence probability. The probability of more than one event occurring over a time period greater than one year could also be calculated using the binomial distribution:

$$P = \left(\frac{n!}{y!(n-y)!}\right) p^y(1-p)^{n-y} \quad (2)$$

where P is the probability that an event will occur *more than once* during a time period greater than one year, n is the time period (years), y is the number of occurrences (i.e., floods), and p is the exceedence probability. For example, using equation 1 the probability of the 50-year flood occurring once during the duration of a typical home mortgage (30 years) is 0.45 (Table 1). So while there is only a 2% chance of experiencing a 50-year flood in a single year, the chance of this event occurring once over a 30 year period is much higher (45%). During a human life time of 70 years, there is more than a three-in-four chance that the 50-year flood will be equaled or exceeded (p = 0.76). Even a 500-year flood with a 0.2% chance of occurring in a single year, has a 13% chance of occurring once during a 70 year time span. It seems likely that the public perception of flood risk would be quite different if probabilities were stated using equation 1 because it demonstrates that although large floods may be unlikely in any single year, the odds are fairly high that a large flood will occur over an extended period of time.

The objective of FFA is to relate the magnitude of flood events to their frequency of occurrence through the use of probability distributions (Chow et al. 1988). Although many statistics are based on the normal distribution, flood series are not normally distributed. Instead, flood distributions are negatively

Table 1. Percentage probability of the N-year flood occurring during a particular time span.

Time Span (yrs)	N = Return Period (yrs)							
	5	10	20	50	100	200	500	1000
1	20	10	5	2	1	–	–	–
2	36	19	10	4	2	1	–	–
5	67	41	23	10	5	2	1	–
10	89	65	40	18	10	5	2	1
20	99	88	64	33	18	10	4	2
30	–	96	79	45	26	14	6	3
50	–	99	92	64	39	22	10	5
100	–	–	99	87	63	39	18	10
200	–	–	–	98	87	63	33	18
500	–	–	–	–	99	92	63	39
1000	–	–	–	–	–	99	86	63

Modified from Smith and Ward (1998).

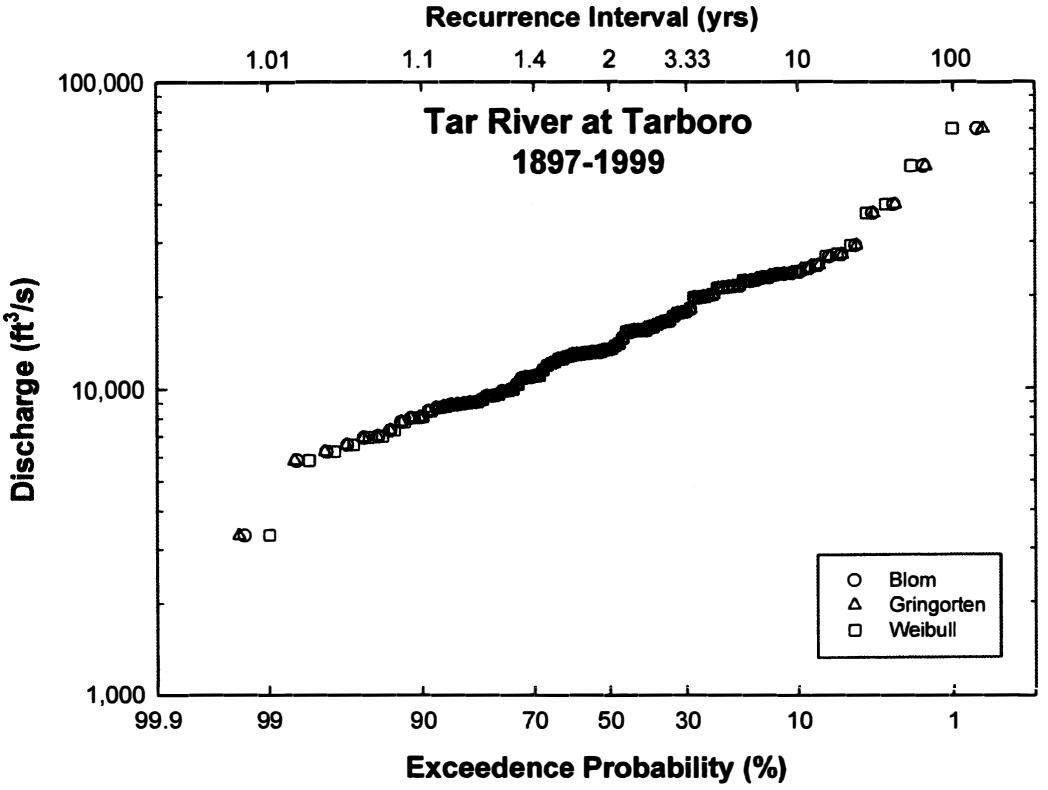

Figure 1. The flood series for the Tar River at Tarboro plotted using different plotting position formulas.

skewed, that is, small floods occur more often than large floods. Nevertheless, there is little theoretical rationale to guide the selection of the most appropriate, negatively skewed, probability distribution. In fact, different distributions are used by the United States (log-Pearson Type III) and the United Kingdom (log-Gumbel or Extreme Value Type II), and the selection of the log-Pearson Type III distribution by the U.S. Water Resources Council (1981) was met with considerable opposition (Benson 1968, 1969; Kisiel 1969). The method of moments or maximum likelihood estimates are used to fit the probability distribution to the empirical data. This produces a flood frequency curve that is used to estimate the discharge of any *n-year* event. Although the method of maximum likelihood is considered superior to the methods of moments for fitting the data to a particular probability distribution, the former is more computationally complex.

In order to assure that the theoretical (fitted) probability distribution fits the flood series, the empirical data are plotted on specially designed probability paper that linearizes the flood frequency curve for a particular distribution. Quantitative measures such as the chi-squared statistic and the Kolmogorov-Smirnov test may be used to assess which distribution best fits the data, however, a graphical comparison is often equally useful. Probability paper cannot be constructed for the log-Pearson Type III distribution because a different probability scale would be needed for each value of the coefficient of skewness, therefore, lognormal probability paper is usually used. The data are plotted by calculating plotting positions, which assign a

Table 2. Gaging record and drainage area for stations in the Tar river basin.

Station	Gage ID	Period of Record	Record Length (yrs)	Drainage Area (mi^2)
Little Fishing Creek near White Oak	02082950	1960-1999	40	177
Tar River at US 401 at Louisburg	02081747	1964-1999	36	427
Tar River at NC 97 at Rocky Mount	02082585	1977-1999	23	925
Tar River at Tarboro	02083500	1897-1900, 1906-1999	98	2,183

probability value to each flood discharge to be plotted. The most common plotting position used for floods is the Weibull formula:

$$T = \frac{n + 1}{m} \quad (3)$$

where n is the number of floods, m is the rank of each flood (ranked from largest to smallest where the largest is $m = 1$), and p is the inverse of equation 3. Although the Weibull formula remains widely used in hydrology (U.S. Water Resources Council 1981), it has been criticized for under-estimating the recurrence interval of large magnitude floods (Cunnane 1978). A variety of alternative plotting position formulas may be used, many of which have the general form:

$$T = \frac{n + 1 - 2a}{m - a} \quad (4)$$

where the parameter $a = 0$ for Weibull's formula, $a = 0.375$ for Blom's, and $a = 0.44$ for Gringorten's (Chow et al. 1988). Figure 1 shows that the plotting positions calculated by equation 4 can be significantly different for the larger magnitude floods. In order to obtain unbiased plotting positions, Cunnane (1978) found that Blom's plotting position should be used for the normal (or lognormal) distribution and Gringorten's for the Gumbel (Extreme Value Type I). The value of a for the log-Pearson Type III distribution depends on the value of the coefficient of skewness, with $a > 0.375$ for positively skewed data, and $a < 0.375$ for negatively skewed data (Chow et al. 1988).

Data

Historical records of annual floods at four stations in the Tar River basin were obtained from the USGS (Table 2; Figure 2). The USGS has published preliminary discharge estimates for the 1999 flood at each of the stations, which represent a range of drainage

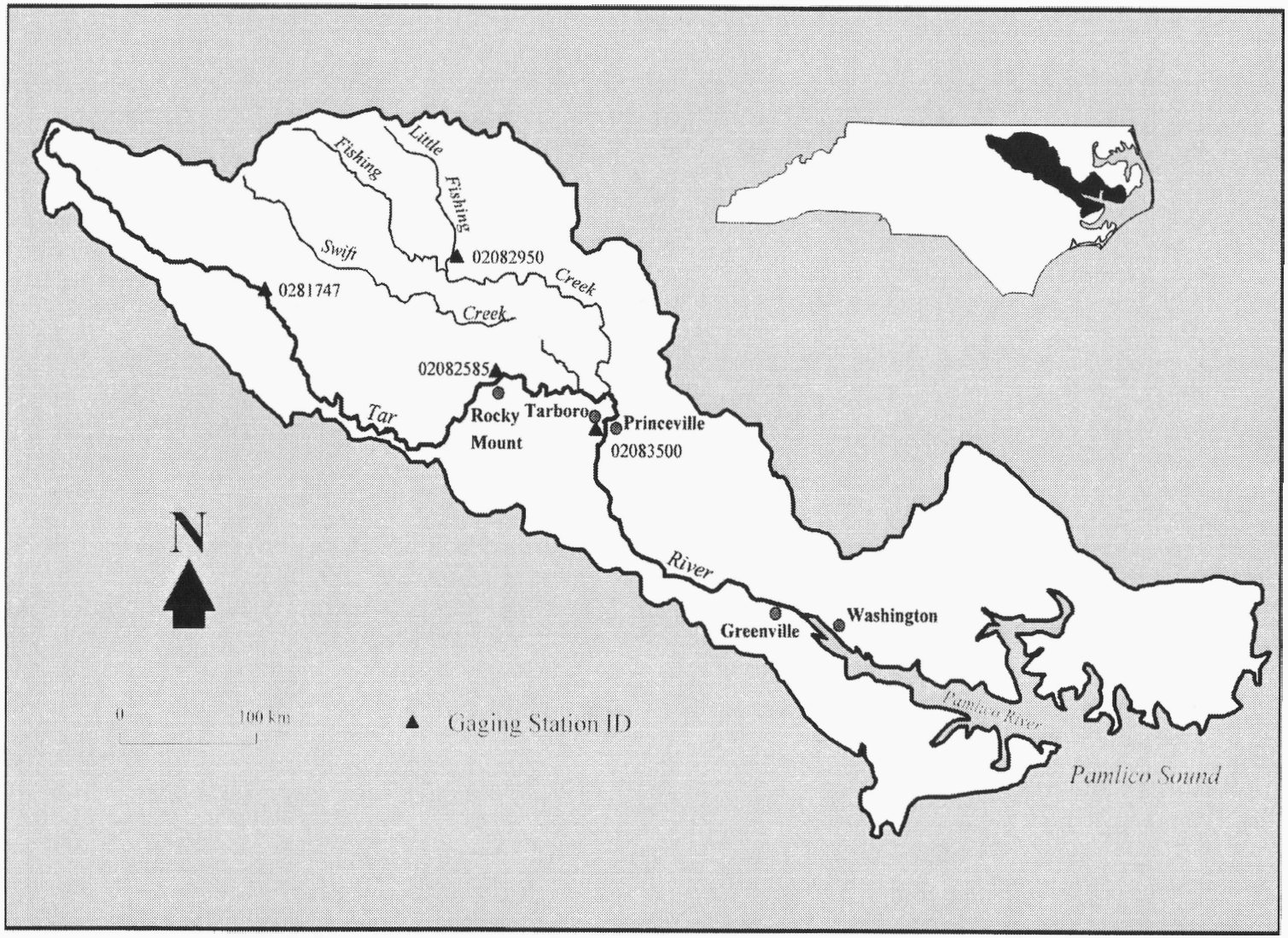

Figure 2. Map of the Tar River basin, North Carolina, showing the locations of the four USGS gaging stations.

areas and record lengths. Flood frequency curves were produced by fitting the log-Pearson Type III distribution to the data using the method of moments. Blom's formula ($a = 0.375$ in equation 4) was used to plot the data because it is closer to being unbiased than Weibull's. Confidence limits were calculated following the procedures outlined in Chow et al. (1988).

Results

FFA assumes that the period of record sampled is representative of the distribution of annual floods that would occur over a very long period of time. This is, of course, unlikely because record lengths are usually less than 50 years and seldom as long as 100 years. Confidence limits around the flood frequency curve define the degree of statistical uncertainty associated with recurrence interval estimates derived from the curve. Figure 3 shows 5% and 95% confidence limits for the flood frequency curves at the four stations in the Tar River basin. That is, there is a 90% chance that the curve at a given recurrence interval should be located between these confidence limits.

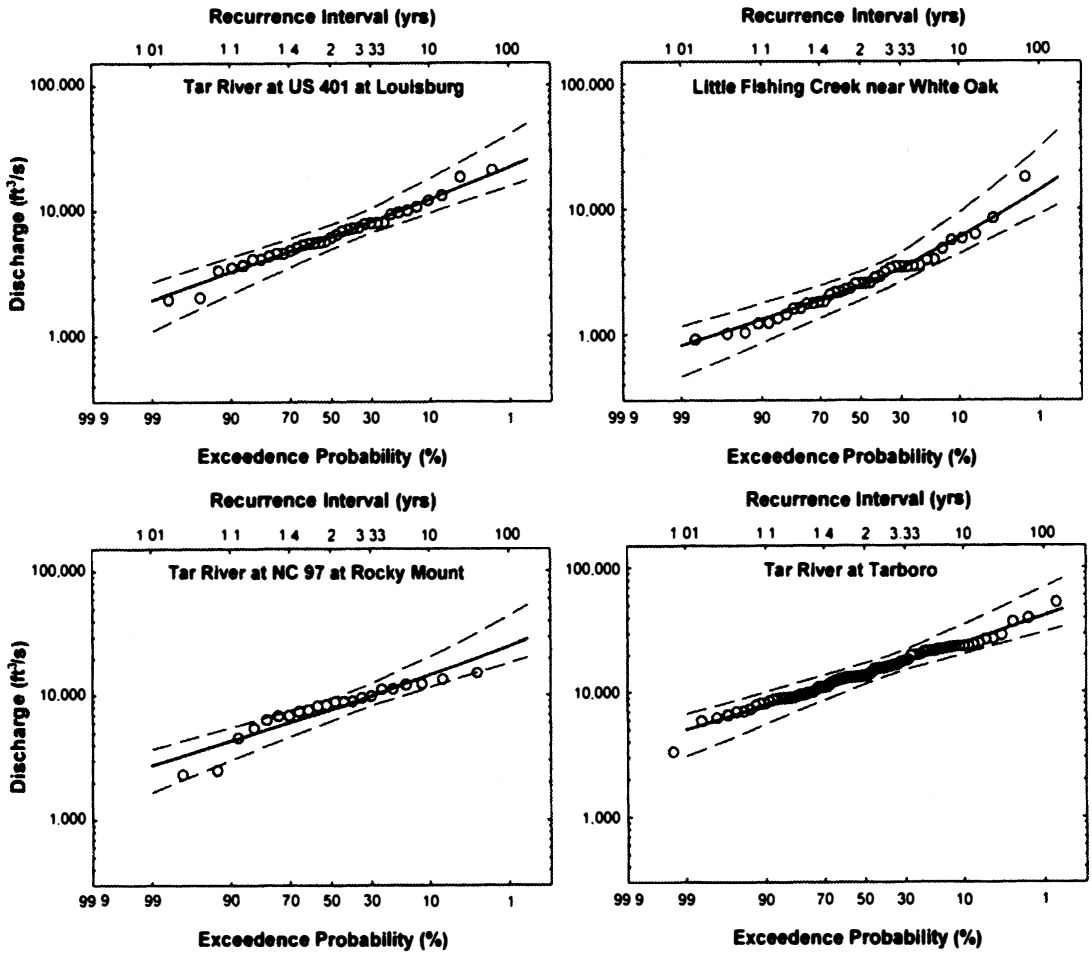

Figure 3. Flood frequency curves (solid lines) and 90% confidence limits (dashed lines) on lognormal probability paper for four gaging stations in the Tar River basin. Data plotted using Blom's formula.

The range of discharge between the confidence limits is indicative of the relative inaccuracy of flood frequency curves. For example, the 100-year flood discharge for the Tar River at Tarboro (which has an unusually long record at 97 years) is 40,868 ft^3/s. The confidence limits indicate, however, that there is a 90% chance that the 100-year flood lies between 30,362 ft^3/s and 67,960 ft^3/s, a range of 37,598 ft^3/s. Increasing the confidence interval to 95% or 99% would increase this range substantially. Furthermore, the logarithmic axes used in Figure 3 provide a misleading visual display of changes in the confidence interval as the recurrence interval increases. When plotted on arithmetic probability paper (Figure 4), the confidence interval increases exponentially for the larger recurrence intervals. Thus, there is a large degree of statistical "uncertainty" associated with recurrence interval estimates of large flood discharges, even with large data sets like the Tar River at Tarboro. The technique produces good results for the small floods, but not for the large events with which we are most interested. Because obtaining improved estimates of large floods would require a much longer period of record, this problem is largely unavoidable.

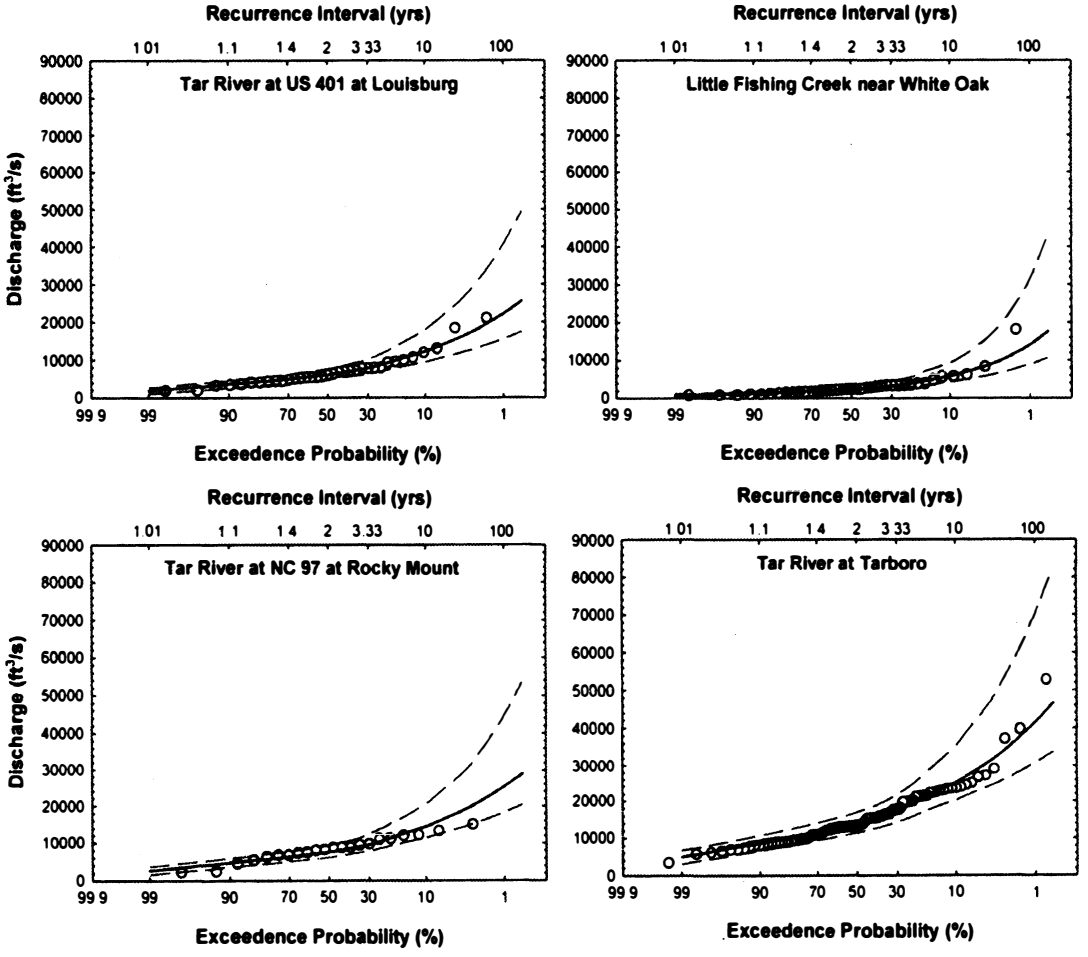

Figure 4. Flood frequency curves (solid lines) and 90% confidence limits (dashed lines) on an arithmetic probability plot for four gaging stations in the Tar River basin. Data plotted using Blom's formula.

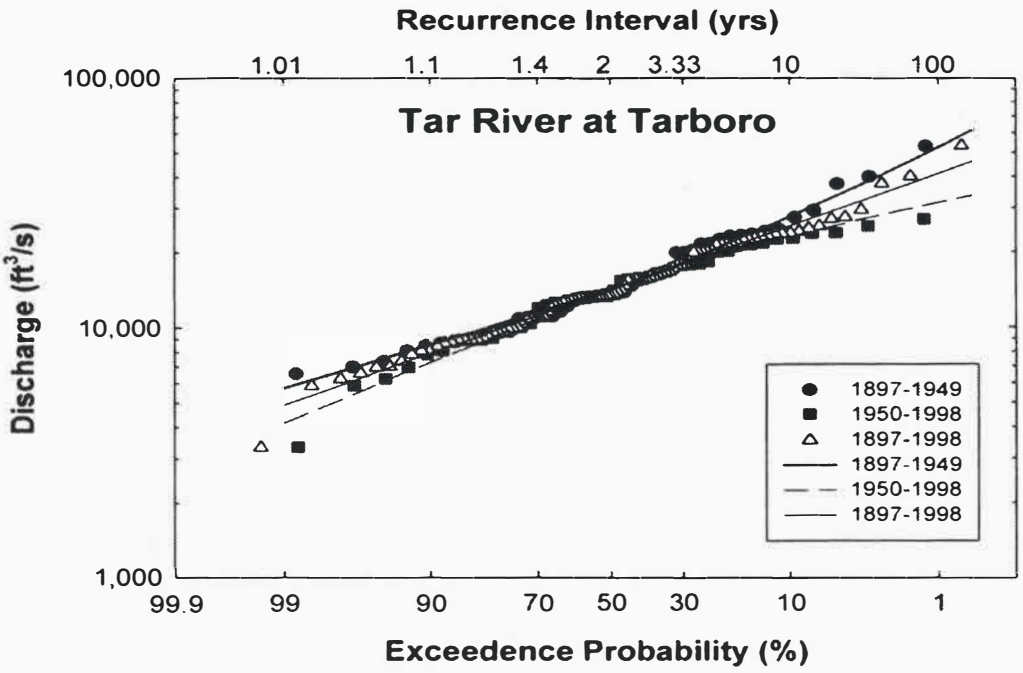

Figure 5. Flood frequency curves for the Tar River at Tarboro.

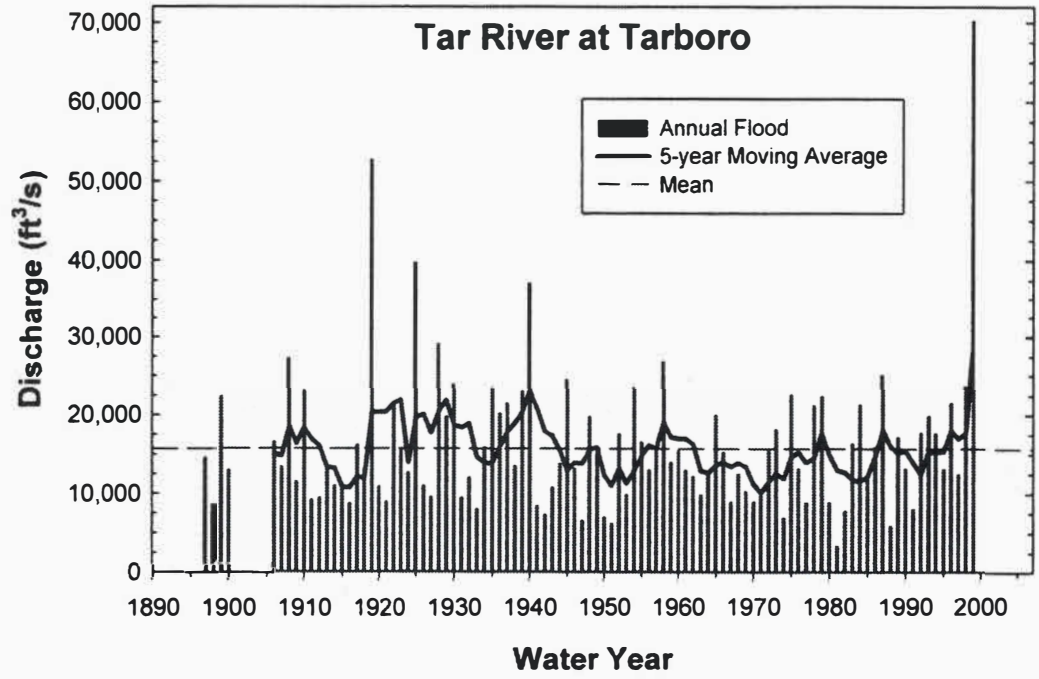

Figure 6. Historical variations in annual flood magnitudes for the Tar River at Tarboro.

Table 3. Flood frequency estimates for the Tar River at Tarboro, 1897-1949, 1950-1998.

	1897-1949			1950-1998			Change		
Recurrence Interval (yrs)	Q (ft^3/s)	5% Conf. Limit (ft^3/s)	95% Conf. Limit (ft^3/s)	Q (ft^3/s)	5% Conf. Limit (ft^3/s)	95% Conf. Limit (ft^3/s)	Q (%)	5% Conf. Limit (%)	95% Conf. Limit (%)
1.01	5,764	3,629	7,607	4,190	2,431	5,729	-27	-33	-25
2	14,123	11,463	17,271	13,989	11,641	16,934	-1	-2	-2
5	21,537	17,587	28,461	19,545	16,215	25,359	-9	-8	-11
10	27,466	21,847	39,103	22,829	18,633	31,050	-17	-15	-21
25	36,211	27,584	56,865	26,551	21,214	38,008	-27	-23	-33
50	43,724	32,190	73,754	29,056	22,882	42,962	-34	-29	-42
100	52,144	37,106	94,231	31,360	24,377	47,695	-40	-34	-49
200	61,598	42,390	118,970	33,479	25,723	52,186	-46	-39	-56

The annual flood series for the Tar River at Tarboro can be used to illustrate another element of statistical uncertainty associated with FFA. If this series was split in half, the 48 year and 49 year sub-series would still be longer than those at most USGS gaging stations. If these sub-series were representative of the long-term distribution of flood discharges, they should plot similarly in Figure 5. Clearly, this is not the case. Because many more large floods were experienced during the first half of the century (Figure 6), the flood frequency curve calculated for the 1897-1949 period would produce a 100-year flood discharge of 52,144 ft^3/s, while the 1950-1998 series would give a 100-year flood discharge of only 31,360 ft^3/s (Table 3). Furthermore, the 100-year flood for the 1897-1949 period is not even within the 90% confidence interval for 1950-1998 series (24,377-47,695 ft^3/s). Thus, if the collection of gaging station data had been initiated in 1950, rather than 1897, the 100-year discharge would be 9,508 ft^3/s lower than that obtained using the full record (1897-1998), and 20,784 ft^3/s lower than that for the 1897-1949 period.

Although FFA assumes that the flood series is stationary (i.e., the mean and variance are constant through time), periods of high rainfall and drought appear to cluster. Such non-stationarity in the historical record might be explained by climatic trends or cycles. The allocation of the flow of the Colorado River, which began in 1922 with the partitioning of water rights between the upper basin states and the lower basin states, provides a useful example of decade-scale variability of stream flows and adverse effects on water management decisions. The apportionment of water rights on the Colorado River was, unfortunately, based on records from an unusually wet period. Average stream flow during 1896-1930 was much higher (17 million acre-feet) than that from 1931-1965 (13 million acre-feet). Nevertheless, flows during this anomalous period played an important role in the over-appropriation of the river's water between competing states (Graf 1985). Non-stationarity in the flood series may also be generated by a variety of human activities such as urbanization, deforestation, agriculture, channelization, levees, damming by road crossings, and human-induced global warming. These all suggest that historical flood records might not be a good guide to future flood risks.

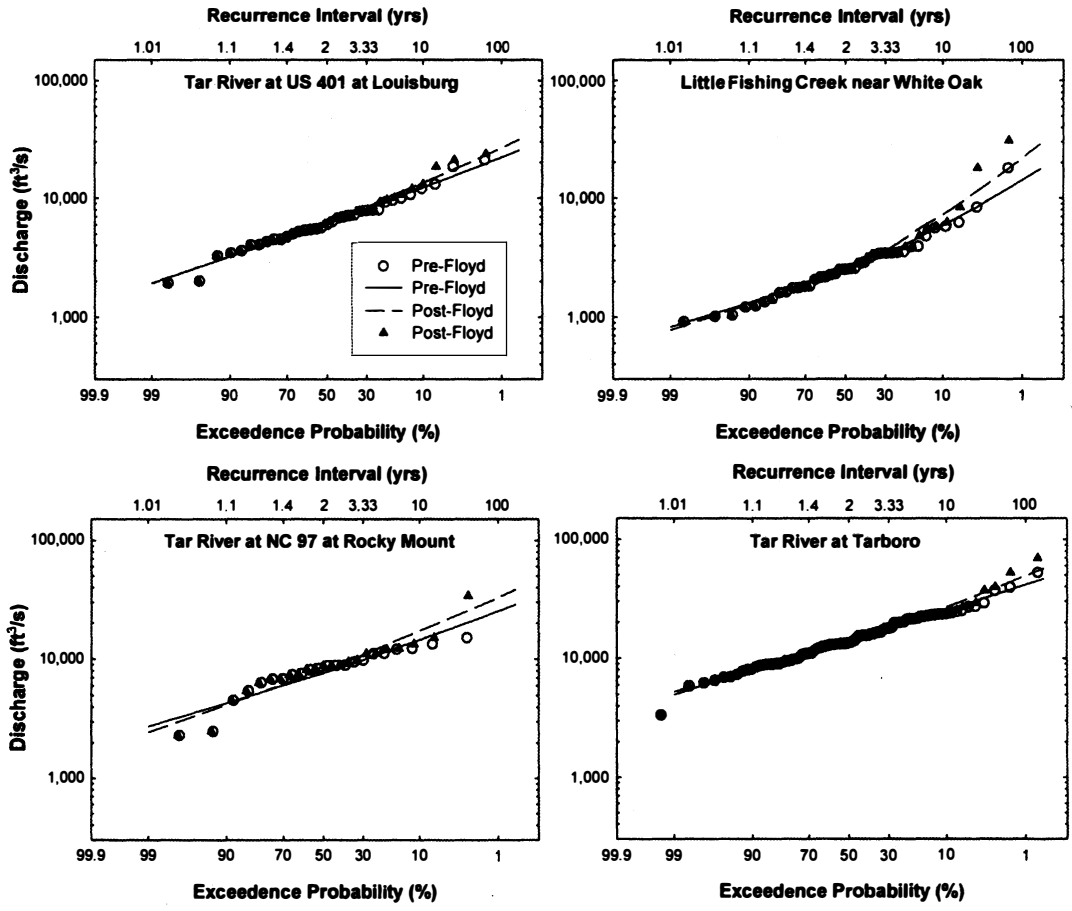

Figure 7. Effect of adding the 1999 flood on flood frequency estimates.

A fundamental problem with FFA is that flood records are too short to estimate low frequency events accurately. Because flood distributions are negatively skewed, few observations exist for the large events that are used to fit the high end of the flood frequency curve. This may be illustrated by adding the 1999 flood to the flood series at the four gaging stations in the Tar River basin (Figure 7). The magnitude of the 100-year flood increases at each station, from a minimum of 18% to a maximum of 54% (Table 4). Although the 1999 flood would be treated as an outlier by the USGS (U.S. Water Resources Council 1981) at three of the four stations (exception: Tar River at US 401 at Louisburg), the fact remains that a single large flood, even one that passes the outlier test, would increase recurrence interval estimates substantially. This effect is even more pronounced where the record length is short.

Another fundamental assumption of FFA is that the flood series is homogeneous, that is, the underlying population of floods is generated by only one type of event. Despite this, most hydrologists recognize that flood series consist of mixed populations, and thus, violate the homogeneity assumption (Hirschboeck 1988). For example, Diehl and Potter (1987) and Knox (1988) have shown that failing to separate the flood series into seasonal subpopulations (i.e., summer thunderstorm floods and spring snowmelt floods) can give unrealistic estimates of the magnitude and frequency of floods. In the Tar

Table 4. Pre-and post-Floyd 100-year discharge estimates.

	Pre-Floyd			Post-Floyd			Change		
Station	Q (ft^3/s)	5% Conf. Limit (ft^3/s)	95% Conf. Limit (ft^3/s)	Q (ft^3/s)	5% Conf. Limit (ft^3/s)	95% Conf. Limit (ft^3/s)	Q (%)	5% Conf. Limit (%)	95% Conf. Limit (%)
Little Fishing Creek near White Oak	14,106	9,000	30,903	21,767	12,641	56,399	54	41	83
Tar River at US 401 at Louisburg	22,198	15,630	40,571	26,753	18,161	52,247	21	16	29
Tar River at NC 97 at Rocky Mount	25,291	18,309	44,124	32,980	22,593	63,278	30	23	43
Tar River at Tarboro	40,868	30,362	67,960	48,302	34,679	85,638	18	14	26

River basin, and elsewhere in the southeastern U.S., mixed distributions can be a problem because floods are generated by a variety of meteorological mechanisms (Lecce 2000a, 2000b). For example, hurricanes are often responsible for generating the largest floods on record in North Carolina (Zembrzuski et al. 1987). Although most would agree that separating flood series into homogeneous sub-populations would improve flood frequency estimates, this is rarely done in practice (Knox 1988).

Conclusion

A review of probabilistic estimates of flood frequency showed that although large floods are unlikely in any single year, the odds are considerably higher that a large flood will occur over an extended period of time. An examination of annual floods at four stations in the Tar River basin, North Carolina, illustrates the difficulties inherent in estimating the recurrence intervals of large floods using traditional flood frequency analysis. Flood frequency estimates are sensitive to large floods, particularly where flood records are short, and 90% confidence limits suggest that the 100-year flood discharge may be under or overestimated by as much as 1.5-2 times. The gaged period of record may also not be representative of the long-term distribution of flood discharges if cyclic variations in climate are significant.

Because flood distributions are negatively skewed, because we are interested in that part of the distribution with which we are most uncertain (i.e., high magnitude, low frequency events), and because flood records are inevitably too short to effectively deal with the infrequent events, flood frequency estimates should be regarded as best guesses based on historical data. Although this paper has focused on the degree of uncertainty associated with estimates of the 100-year flood, attempting to estimate recurrence intervals for larger magnitude events like the flood of 1999 is fraught with even more uncertainty. Perhaps the most meaningful description of the flood of 1999 is the catch-phrase "the flood of the century". With this, there can be no debate.

Acknowlegment

This paper is contribution number 51 to the Tobacco Road Research Team.

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AIDS Among Women in North Carolina

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This paper focuses on the diffusion of AIDS among women in North Carolina. Heterosexual women are the fastest-growing category of people with AIDS in the United States. In 1990, women comprised less than 10% of United States AIDS cases. As of June 1999, however, women were more than 16% of all AIDS cases in the country and one-quarter of new cases.This paper investigates two primary hypotheses: (1) that over time, increases in the number of cases of AIDS have diffused from North Carolina's urban centers to its rural areas; and, (2) following a nation-wide trend, HIV/AIDS in North Carolina has mainly impacted African American women.Analysis of new cases of AIDS among women in North Carolina from 1987 to 1999 is performed via assessment of the mapped patterns. The cumulative totals through 1999 show that only seven of North Carolina's 100 counties had yet to report a case of AIDS among women. Although the dominant urban areas of North Carolina (including cities such as Charlotte, Raleigh and Durham) have the highest AIDS totals, AIDS cases among North Carolina women have occurred also in the small, rural communities.

Introduction

In recent years, the Human Immunodeficiency Virus (HIV) infection, the agent of Acquired Immune Deficiency Syndrome (AIDS), has spread rapidly into the heterosexual community in the United States. Indeed, heterosexual women are the fastest-growing category of people with AIDS in the United States. Each year since 1992, the number of new AIDS cases among women in the United States has increased, particularly among minority women (CDC 2000a). In 1990, women comprised less than 10% of United States AIDS cases. As of June 1999, however, 114,621 women in the United States had been diagnosed with AIDS, representing more than 16% of all AIDS cases in the country and one-quarter of new cases (CDC 2000a).

Women are more susceptible to HIV/AIDS for several reasons. In general, women are biologically more susceptible to sexually transmitted diseases because they have a larger portion of mucosal surfaces exposed during sexual intercourse (Grinstead, Faigeles, Benson and Eversley 1993). This causes HIV/AIDS to affect women differently than men. Second, women tend to have sex with men older than themselves, who in turn are more likely to have had more sexual partners and therefore have had a greater chance of exposure to the disease.

Geography provides a unique perspective for the study of HIV/AIDS. Although diseases occur over time and therefore have a history, they also have a spatial component. Today, new transportation technologies shrink the globe, and places which formerly were separated by weeks or months are now a short airplane flight away. Medical geographers have a role in fighting the epidemic by using their knowledge in several ways: (1) examining the spatial aspects of disease, including diffusion and distribution (Gould 1989; Shannon, Pyle and Bashshur 1991; Cliff and Smallman-Raynor 1992); (2) describing characteristics of regions, including cultural practices and attitudes, and population mobility (Ellis and Muschkin 1996); (3) examining how the epidemic has changed over time (Lam and Liu 1994); and (4) helping identify optimal locations for efforts to stop the spread of HIV/AIDS, including the utilization of scarce public health resources where they will have the most benefit (Berry, McKinney and Marconi 1997). Some further areas of study in HIV/AIDS geography include: regional and local studies (Pyle and Gross 1997); studies examining the location of, and resistance to, HIV/AIDS facilities (Chiotti and Joseph 1995; Takahashi 1997); social theory approaches (Brown 1995; Kearns 1996); and, qualitative and multi-method studies of the geography of HIV/AIDS (Wilton 1996).

This paper will focus on the diffusion of AIDS in women in North Carolina. The male/female ratio in the state has gone from approximately 8:1 in the 1980s to about 2:1 in 1999 (Division of Epidemiology 2000). It is hypothesized that over time, increases in the number of cases of AIDS have diffused from North Carolina's urban centers to its rural areas. Another hypothesis is that HIV/AIDS in North Carolina has mainly impacted African American women, following a nation-wide trend.

The primary data source for this paper is the Centers for Disease Control and Prevention (CDC). AIDS cases are reported to the CDC by all 50 states and the District of Columbia. Every state has a statute requiring laboratories and physicians to report the names of newly diagnosed people with AIDS to health departments. The CDC is the source commonly used by medical geographers, epidemiologists and others researching HIV/AIDS in the United States (the World Health Organization collects global HIV/AIDS data). Due to the confidentiality issues surrounding HIV/AIDS, data are only released at a fairly macro-scale level, especially in more rural areas. For instance, in North Carolina, data are primarily available at the county level, with some data released for larger cities (e.g., Raleigh-Durham, Charlotte and Wilmington).

The analysis and discussion of the diffusion of AIDS among North Carolina women suggest that North Carolina is part of a larger HIV/AIDS picture in the United States. The pattern of the spatial diffusion of HIV/AIDS in North Carolina has mirrored a three stage national pattern of: (1) initial "seeding" within metropolitan areas that functioned as state diffusion centers; (2) the formation of a "HIV/AIDS corridor" in the Piedmont Urban Crescent; and, (3) a new pattern of AIDS diffusing to the rural eastern counties of North Carolina (Figure 1 provides a base map of North Carolina).

Background

The transfer of HIV occurs three ways: (1) through intimate sexual contact; (2) by contact with contaminated blood or blood products, including the sharing of needles, blood transfusions, health care needlesticks and organ transplants; and (3) perinatal means, that is, mother-to-child transfer during pregnancy or birth. In the US, homosexual males and

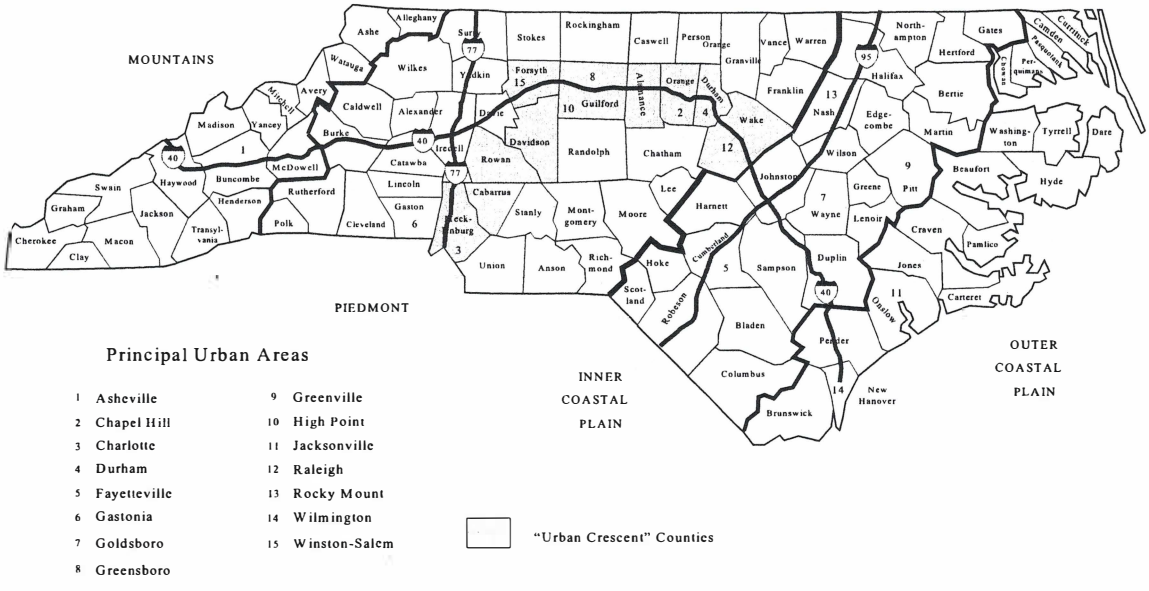

Figure 1. North Carolina Regions, Counties, Urban Areas, and Major Highways.

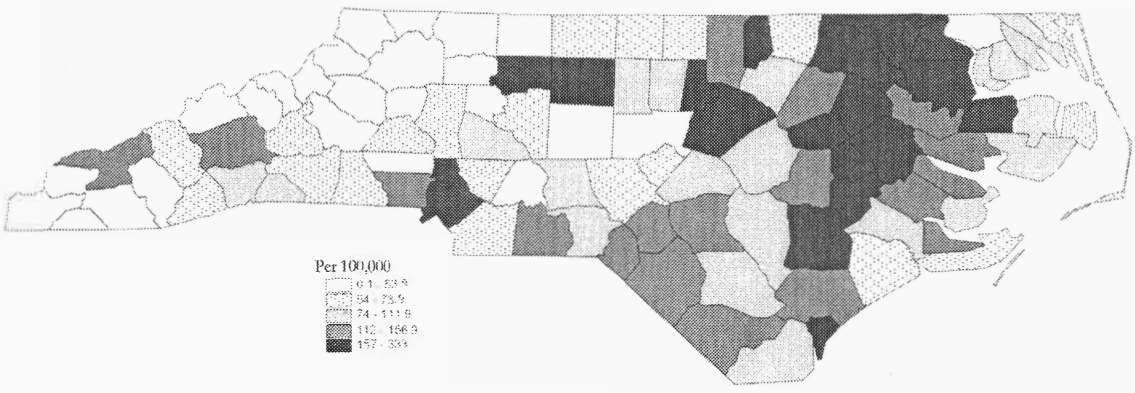

Figure 2. AIDS Rate in NC, 1987-1999
Source: HIV/STD Control Section

injecting drug users have been among the hardest hit populations. In recent years, however, the highest rates has been among women and minorities—and especially minority women.

The geography of the diffusion and distribution of HIV/AIDS in the United States can be represented fairly accurately. Data from the CDC have shown that in the earliest stages (in the beginning of the 1980s), AIDS was definitely a disease of major urban areas (Shannon and Pyle 1989). With HIV/AIDS, hierarchical diffusion between urban areas occurred initially, followed by contagious diffusion out from these centers. Hierarchical diffusion is the spread of a phenomena, in this case a disease, down the urban hierarchy. Prior to 1983, 67% of AIDS cases were in three metropolitan areas: New York City, San Francisco, and Los Angeles (three cities at the top of the urban hierarchy in the United States). Between 1981 and 1985, another focal point emerged in Miami, and by 1987 Denver and Houston entered the picture (Dutt, Monroe, Dutta and Prince 1987). This diffusion from New York City and Los Angeles to cities such as Miami and Denver illustrates the concept of hierarchical diffusion.

By the mid-1980s, as the disease spread further down the urban hierarchy, HIV/AIDS "corridors" could be identified (areas with high HIV/AIDS rates); they occurred in densely populated urban areas and were mostly coastal (Shannon and Pyle 1993). By the end of the 1980s, an HIV/AIDS "periphery" could be seen, consisting of urban areas of the interior western United States as well as sections of the southern United States (Shannon and Pyle 1993).

By the late 1980s to the early 1990s, however, the HIV/AIDS periphery collapsed and even rural areas were included in the scope of the HIV/AIDS epidemic (Verghese, Berk and Sarabbi 1989; National Commission on AIDS 1990; Lam and Liu 1994). This is the final stage of HIV/AIDS diffusion in the United States, that of contagious diffusion, wherein the disease has spread through adjacent areas and nearly everyone is affected.

Two trends have emerged from HIV/AIDS statistics: (1) the southeastern United States has the fastest growing incidence of HIV/AIDS in the country; and (2) there has been a "ruralization" of HIV/AIDS (Ellington, Brown, Gross, Katzin, Roth and Somerville 1994). The initial, major epicenters in New York, California, and Florida are contributing smaller

percentages of new cases as the epidemic spreads to other areas of the United States (Ricketts, Savitz, Gesler and Osborne 1994). HIV/AIDS is no longer confined to a few metropolitan areas or only to marginalized sub-populations of the United States, and thus the geographic component of our understanding of the AIDS epidemic increases in importance.

HIV/AIDS did not begin spreading through North Carolina until the mid-to-late 1980s. In 1985, within the context of the national diffusion of HIV/AIDS, North Carolina was still a peripheral area (Pyle and Furuseth 1992). The pattern at this time appeared random, suggesting that many people with HIV/AIDS had returned home to die. There were two distinct stages of the HIV/AIDS epidemic infusion into North Carolina. The first is referred to as the "infusion stage." From 1985 to 1987, HIV/AIDS became "seeded" within certain counties of the state. By the end of 1987, nodal areas had been established in the Triangle area as well as several coastal counties (Pyle and Furuseth 1992) (Figure 2). Most counties with larger cities were represented in early reporting (i.e., Charlotte in Mecklenburg and Winston-Salem in Forsyth), corresponding with the nationwide pattern of metropolitan areas functioning as the nodes for diffusion into surrounding rural areas.

The second stage, from 1988 to 1990, consisted of HIV/AIDS diffusion within North Carolina and included the "continued growth of AIDS reporting within major metropolitan areas as well as the formation of an AIDS corridor essentially mirroring the Piedmont Urban Crescent from Charlotte to Raleigh" (Pyle and Furuseth 1992, 3). In other words, this 'corridor', or urban crescent, included North Carolina cities such as Charlotte, Highpoint, Greensboro, Winston-Salem, Durham and Raleigh. Additionally, a new geographical pattern appeared in 1989. The most substantial increases in AIDS cases were being reported in both the inner city sections of the Piedmont Urban Crescent, but also in the poor rural counties of eastern North Carolina (i.e., Bladen, Halifax, and Hertford counties) (Pyle and Furuseth 1992). The high AIDS infection rate in these rural Eastern areas and in the cities of North Carolina is accentuated by the low rate of AIDS in the suburbs, small towns, and many of the mountain communities (Pyle and Furuseth 1992).

It is assumed that the initial infusion of HIV/AIDS in North Carolina was via homosexual and bisexual males as was true elsewhere in the United States (Pyle and Furuseth 1992). This explains the reports of early cases in counties such as New Hanover and Buncombe, since both Wilmington (New Hanover) and Asheville (Buncombe) contain sizable gay populations. Cities such as Charlotte and Raleigh were also reporting early cases of HIV/AIDS in North Carolina. More cases during the second wave could be attributed to needle-sharing and prostitution (Pyle and Furuseth 1992). These avenues led to the spread of the disease quickly in various poor, inner-city sections of some metropolitan areas of the state, especially Charlotte, but also Durham and Raleigh. This second wave is described by Pyle (1996, 143) as an "extension of a larger poverty syndrome... [including] poverty, crack, and HIV."

AIDS became reportable in North Carolina in 1984 and HIV infection was made reportable by name in North Carolina in 1990. There are two forms of HIV testing, anonymous and confidential. Anonymous allows the individual being tested to be recorded simply as a number, whereas confidential testing requires the individual's name. Stancil (2000) examined the elimination of anonymous testing in NC, which occurred in 1997. She found that those individuals at the highest risk for HIV were also those most affected by the change from anonymous and confidential testing to confidential testing only in NC. The CDC acknowledges the benefits of anonymous testing and encourages states that do not have anonymous testing available to reevaluate their programs.

Certain epidemiologic patterns can be seen in the spread of AIDS in North Carolina. First, the ethnicity has shifted from 48% African American among AIDS cases reported between 1984 and 1989 to 69% African American among cases reported between 1994 and 1996 (Division of Epidemiology 1997). This follows the national pattern in that, by 1996, African Americans accounted for more AIDS diagnoses than whites

Table1. Counties with the Highest Number of AIDS Cases Among Women in North Carolina and Cumulative Totals

County	'87	'88	'89	'90	'91	'92	'93
Mecklenburg	5	3	4	6	10	10	27
Wake	3	5	5	4	7	8	10
Guilford	1	1	3	8	11	10	10
Durham	3	4	5	8	15	9	14
Forsyth	1	1	0	3	7	7	5
Cumberland	3	1	3	1	3	3	12
Pitt	0	1	1	2	5	8	6

County	'94	'95	'96	'97	'98	'99	Total
Mecklenburg	10	40	20	20	29	20	204
Wake	17	20	20	24	19	26	168
Guilford	14	25	16	6	22	18	145
Durham	25	12	16	15	9	7	142
Forsyth	5	11	5	12	8	17	82
Cumberland	8	8	9	4	10	12	77
Pitt	9	11	9	8	2	6	68

Source: HIV/STD Control Section 1999

(CDC 2000b). Also, the proportion of male AIDS cases attributed to male to male sexual contact has decreased from 60% of cases reported between 1984 and 1989 to 41% of cases reported between 1994 and 1996. The proportion of male AIDS cases attributed to injecting drug use (IDU) has increased, while the proportion of female cases attributed to IDU has decreased. For females, the proportion attributed to heterosexual contact has increased slightly and the proportion of cases attributed to blood products among both sexes has decreased. The proportion of AIDS cases for which there is "no identified risk" for both sexes combined constituted 21% of cases from 1994 to 1996.

By the end of the 1990s, HIV/AIDS had impacted the majority of North Carolina's 100 counties. The highest rates continued to be in the urban counties with major metropolitan areas, such as Durham, Mecklenburg, Guilford, Wake and New Hanover. However, several rural counties in the coastal plain continued to have high rates also (e.g., Northampton, Duplin and Bertie). The pattern illustrates a concentration of cases in the urban crescent of North Carolina, with contagious diffusion to the surrounding counties, as well as high rates in the coastal plain. The mountain counties continue to contain the lowest HIV/AIDS rates.

Black women are 15 times more likely to have AIDS than white women, and their children 18 times more likely than white children (Rosin 1995). Minority women also have increased risks due to a higher incidence of injecting drug use by themselves and their sexual partners (Ickovics and Rodin 1992; Land 1994). Minority women may not perceive themselves to be at risk because they do not see themselves as having

anything in common with people in stereotypical high risk groups, especially white, gay males (Kalichman, Kelly, Hunter, Murphy and Tyler 1993; Land 1994). "Everyone knew AIDS was a disease of white boys...the community-board leaders in Harlem are saying 'AIDS is not a problem for us. AIDS is a white man's disease'" (Burkett 1995, 193).

Gould (1993) discusses the 'geography of the condom.' In the United States, using a condom for HIV-AIDS prevention is not acceptable for over 40% of Hispanic and Haitian women, and 20% of African American women, even if their partner is HIV-positive (Landau-Stanton and Clements 1993). One reason for this behavior is that minority women are fearful of driving away a person who may be the father of their children, as well as their only source of emotional and financial support (Land 1994; Osmond, Wambach, Harrison, Byers, Levine, Imershein and Quadagno 1994). Condoms are used by men, and women can only ask for their use. The female condom is technically an option for women, because it is similar to the male condom in that it prevents pregnancies and the transmission of sexually transmitted diseases. Much of the research, however, is still underway on the female condom's acceptability, affordability, and its consistent and correct use (CDC 1995). Thus, until heterosexual men become the focus of prevention efforts, AIDS cases among women will continue to rise.

The response of homosexual and bisexual men to the HIV-AIDS threat has been well documented, and there has been considerable behavior modification. On the other hand, risk reduction among women, especially minorities and others at high risk, is less common. Prevention efforts are aimed at women changing the behavior of men. This assumes that women have control over their health and bodies, but in many cases, this is not so. The lower level of literacy of women, especially among the urban poor, means that women are not easily reached by mass media campaigns and other forms of information about HIV-AIDS (Patton 1994).

Analysis

Analysis of new cases of AIDS among women in North Carolina from 1987 to 1999 is performed via assessment of the mapped patterns. For the most part (Figures 3 and 5-7), analysis is of the raw number of new cases reported; in other words, rates are not

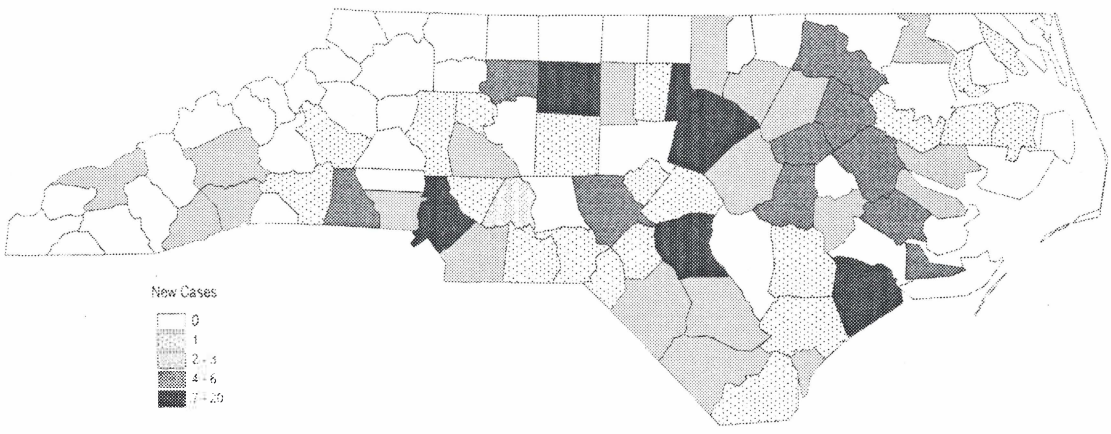

Figure 3. New AIDS Cases in NC Women, 1987-1990
Source: HIV/STD Control Section

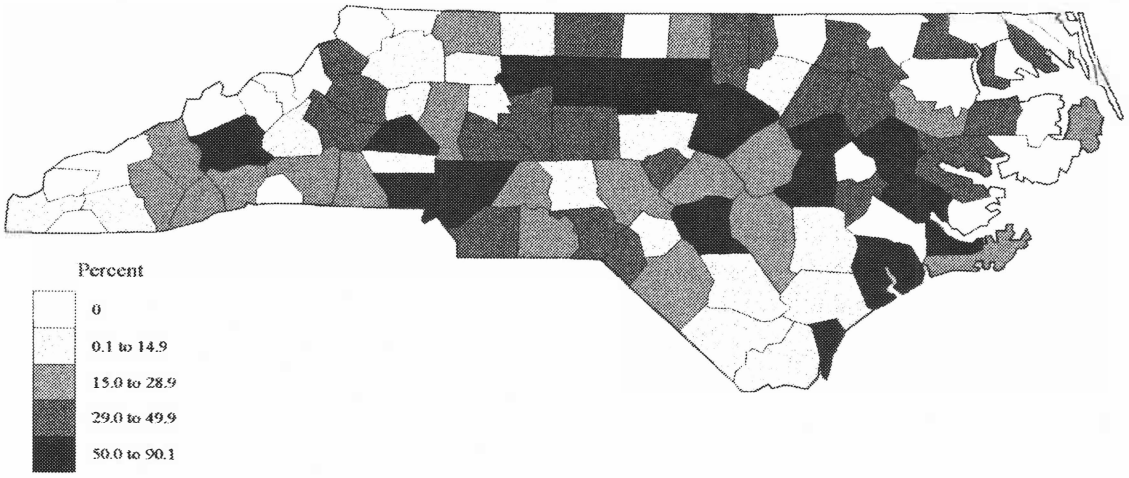

Figure 4. Population in Urban Areas.
Source: US Bureau of the Census 1990.

calculated due to low numbers. However, the final maps and analyses are of the entire time period, and both the total number and the rate per 100,000 women are calculated.

In 1987, Mecklenburg County reported five new cases of AIDS among women, and Cumberland, Durham, and Wake counties each reported three cases. At this time 50% of all women with AIDS in North Carolina were in these four counties (Table 1). This follows the United States-wide pattern of AIDS initially being a disease of major urban areas. In metropolitan areas such as Charlotte and Durham, many cases can be attributed to needle-sharing and prostitution (Pyle and Furuseth 1992).

Counties that only reported one new case of AIDS among women per year during the years from 1987 to 1990 are dispersed throughout the state, as are those with no new cases (approximately one-third of North Carolina counties). The counties with one new case are mainly located on the outskirts of the large urban areas. However, the counties with no new cases are primarily in the mountainous region of the state (Figure 3).

These initial years of the epidemic illustrate two clear patterns: the expansion of cases in the urban areas, especially in the Piedmont Urban Crescent, and a corresponding growth in the Coastal Plain regions. Durham (20 cases), Mecklenburg (18 cases), Wake (17 cases), and Guilford (13 cases) counties are the focus of AIDS among women in the Piedmont Urban Crescent. Of the 68 cases in these four metropolitan counties, 62 are black women. Also, along the Piedmont Urban Crescent, the counties adjacent to Mecklenburg, Guilford, Durham, and Wake counties show increased diffusion. This can be seen by examining the following counties: Gaston (3 cases), Union (2 cases), Rowan (3 cases), and Stanly (2 cases) counties from Mecklenburg County; Forsyth (5 cases) and Alamance (2 cases) counties from Guilford County; and Granville (2 cases), Franklin (2 cases), Nash (3 cases), and Johnston (2 cases) counties from Durham and Wake counties. At this time, many of the peripheral counties of the Piedmont reported no cases of AIDS among women.

There is a second pattern in the Coastal Plain Crescent, that now extends from Craven County on the coast, north to Halifax County, and then south to Onslow County on the coast. There was a total of 39 cases among women in these eight counties, 33 of them black women. Only five counties in the Inner

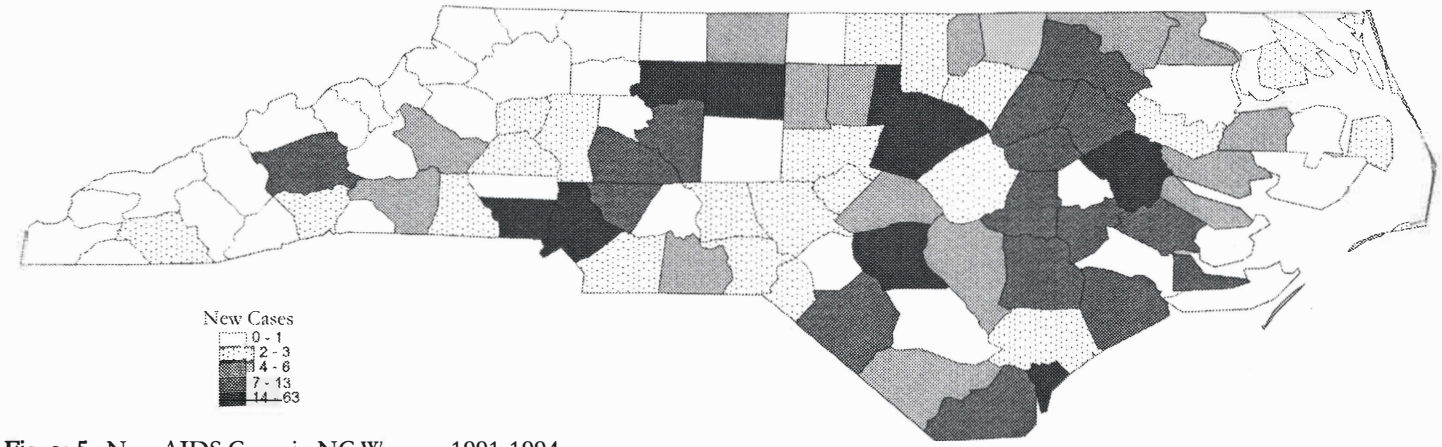

Figure 5. New AIDS Cases in NC Women, 1991-1994
Source: HIV/STD Control Section

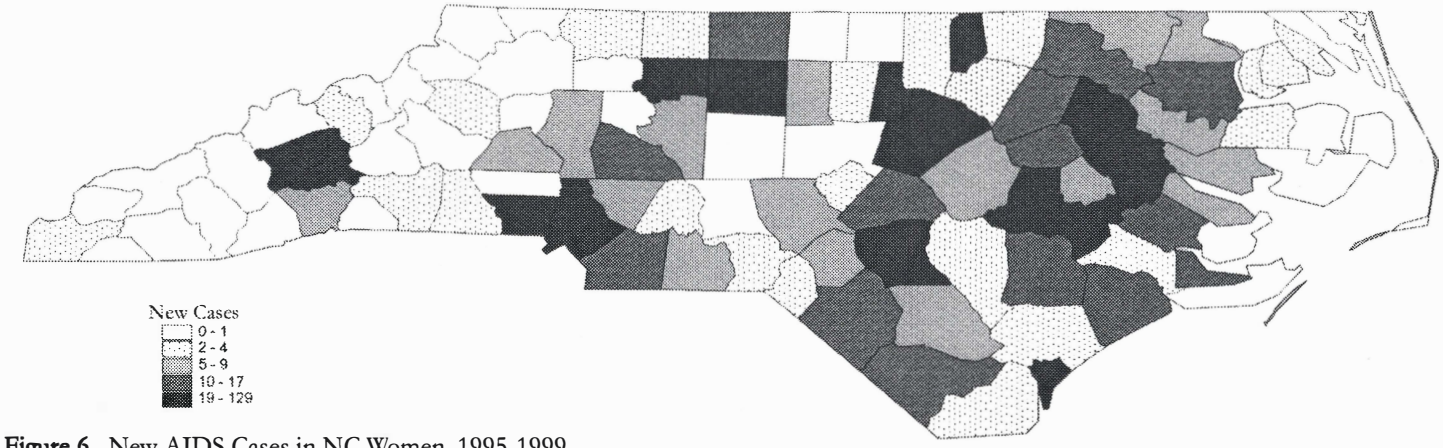

Figure 6. New AIDS Cases in NC Women, 1995-1999
Source: HIV/STD Control Section

Coastal Plain had not yet reported any cases, and eight of the Outer Coastal Plain counties had no cases from 1987 to 1990.

The mountainous region had the fewest total cases during these four years, only four of the counties having any reported cases. From 1987 to 1990, Swain reported two cases, Transylvania two cases, Henderson two cases, and Buncombe three cases; of these nine cases, four were black.

Statewide, during this time the majority of the counties with four or more AIDS cases among women were the counties that are more than 50% urban (Figure 4). Exceptions are Cleveland, Moore, Halifax, and Edgecombe counties. Edgecombe is 49.9% and Halifax is 38.5% urban. Cleveland and Moore, on the other hand, are only 26.8% and 28.7% urban, respectively.

In 1991, Durham County reported 15 new cases of AIDS among women. This was by far the peak incidence of cases, representing 13.6% of the state's 110 cases in 1991. The presence of Duke University's Medical Center may be attracting AIDS patients to the area. The Piedmont Urban Crescent counties showed an almost unbroken arc of concentration of new cases. Mecklenburg reported ten new cases, Forsyth seven, Guilford eleven, and Wake seven. The other counties forming the Urban Crescent reported two to three new cases. Several of the Coastal Plain counties were also reporting two to three new cases at this time, including Pitt County where there were five new cases in 1991. An explanation for this may be the presence of East Carolina University and its medical school. West of the Piedmont Urban Crescent, there were no new cases, with the exception of Macon and Avery counties with one case each.

Again in 1992, the metropolitan counties of Mecklenburg (with 10 new cases), Guilford (10), Durham (9), Wake (8), and Forsyth (7) had the highest number of new cases. Pitt (with 8), Duplin (7), and New Hanover (5) were added to this group; these counties all contain urban areas and/or are situated relatively close to the Interstate 95 and Interstate 40 corridors (Figure 1). Of the 64 cases reported by these eight counties, 55 were black women. Again in 1992, the western portion of the state primarily had counties with no new cases. Exceptions were the appearance of two new cases in Buncombe, Burke, and Catawba counties. Buncombe County contains a substantial gay population (in Asheville), so at this time, the disease had been spreading through the homosexual population for several years and now began to appear within the heterosexual community.

In 1993, Mecklenburg County had an increase of over two and one half times the number of new cases reported, with hierarchical diffusion appearing to take place as nearby counties of Union and Gaston begin to have increasing cases of women with AIDS. Durham and Cumberland were also reporting large numbers of new cases (14 and 12, respectively). Other focal points also began to appear (Figure 5). There is a definite concentration in the Coastal Plain, with many counties reporting at least two new cases. Five counties reported their first case of AIDS among women in 1993. Thus, by the end of 1993, AIDS has reached many of the rural, isolated areas of the state, such as Currituck County and Rockingham County.

One thing to keep in mind when examining AIDS statistics from this time period is that in 1993, after considerable controversy, the CDC further expanded its definition for an AIDS diagnosis to include all HIV-infected adults and adolescents who have less than 200 CD4 cells/øl, or who have been diagnosed with pulmonary tuberculosis, invasive cervical cancer, or recurrent pneumonia. This revision greatly increased the numbers of reported cases, primarily due to the addition of severe immunosuppression to the definition (CDC 1997).

From 1995 to 1999, Mecklenburg (129 new cases), Wake (109), Guilford (87) and Durham counties (59) reported the highest numbers of new cases (Figure 6). In 1995 alone, Mecklenburg County reported 40 new cases. By 1999, all of the coastal counties of North Carolina had reported at least one case of a woman with AIDS. During this time, the inner coastal plain had higher rates than the urban crescent (excluding the four peak counties mentioned previously).

Discussion: AIDS among North Carolina Women 1987 to 1999

One of the hypotheses of this paper is that over time, increases in the number of cases of AIDS have diffused from North Carolina's urban centers to its

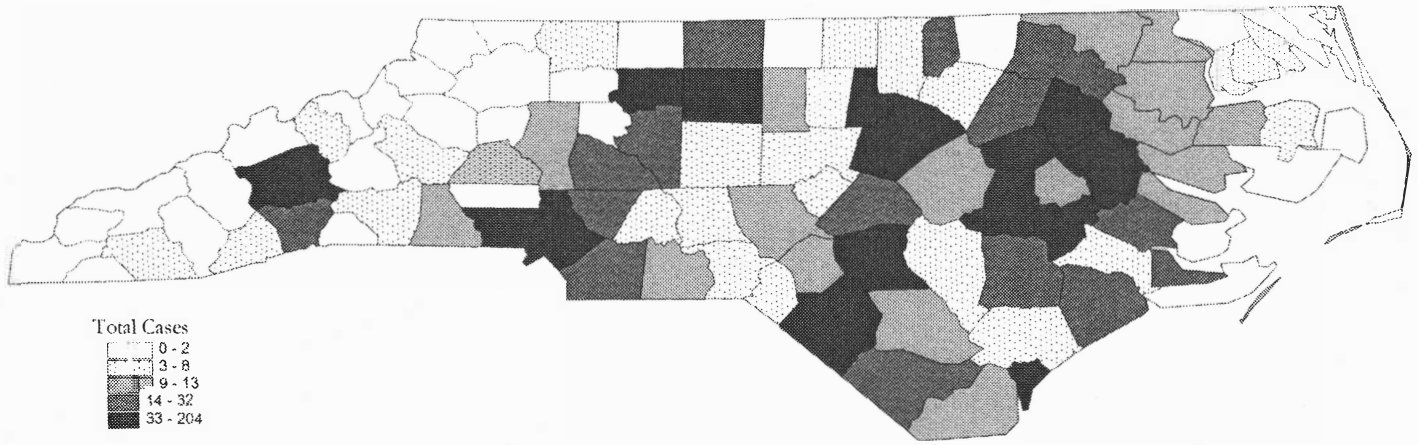

Figure 7. New AIDS Cases in NC Women, 1987-1999
Source: HIV/STD Control Section

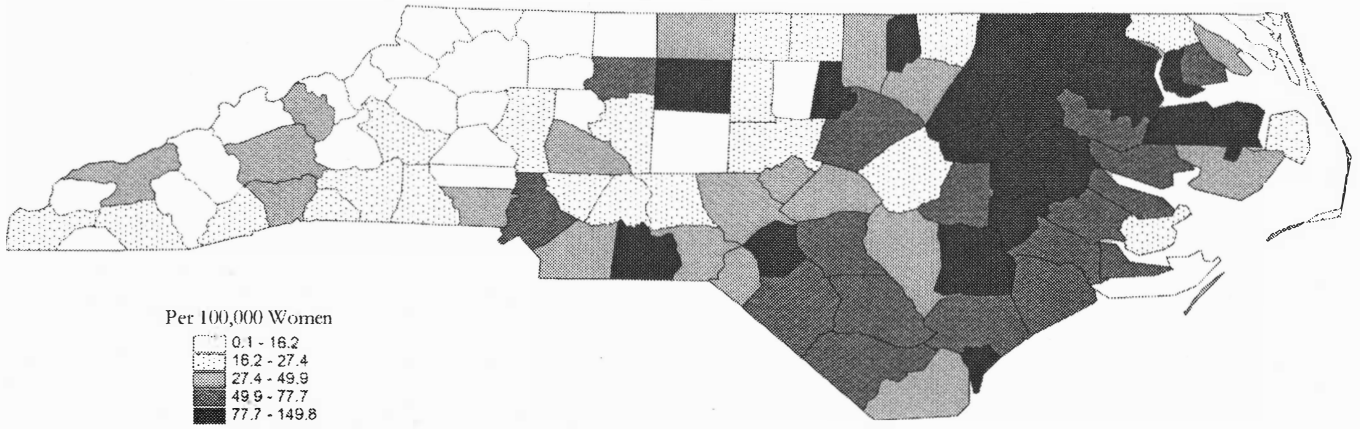

Figure 8. AIDS Rate in NC Women, 1987-1999
Source: HIV/STD Control Section

rural areas (Figures 3-5). The cumulative totals through 1999 show that only seven of North Carolina's 100 counties had yet to report a case of AIDS among women (Alleghany, Ashe, Camden, Clay, Graham, Mitchell and Watauga, Figure 7). As expected, the dominant urban areas of North Carolina have the highest AIDS totals: Mecklenburg with 204, Wake with 168, Guilford with 145 and Durham with 142 cases. Of these 659 cases, all but 74 are black women (89%). A similar rate is true for the rest of the state. Of almost 2000 total cases from 1987 to 1999, 1556 of these women with AIDS are African American (78%). This confirms a second hypothesis, that race is a factor in HIV/AIDS diffusion in North Carolina, the disease mainly impacts African American women.

During the late 1990s, other minority women in North Carolina also were contracting HIV/AIDS. For example, during 1998 and 1999, there were 9 new cases of AIDS among Hispanic women, 4 cases among Native American women and 2 cases among Asian women. Although these total numbers are low, the rates, particularly among Hispanic women, are higher than those for white women. Examining rates of HIV among different racial/ethnic groups, the rate of HIV disease among African Americans (65.1/100,000) is almost 10 times that of whites (6.8/100,000). Rates for Hispanics and Native Americans are almost three times that of whites (Division of Epidemiology 2000).

In North Carolina, minorities are disproportionately impacted by other diseases and by poverty, particularly in the coastal areas of the state; for example, infant mortality rates and tuberculosis rates are higher in eastern North Carolina than average state and national rates (Pyle 1996). Furthermore, "disadvantaged populations, living in urban ghettos or rural areas, have greater medical and health problems and less access to medical services than other Americans" (Pyle and Furuseth 1992, 1). Other important socio-economic variables impacting high HIV/AIDS rates in coastal North Carolina include high unemployment, high levels of drug and alcohol abuse and prostitution.

From 1988 to 1991, there was a statewide average annual increase in new cases of 34.3%. There was a sharp increase between 1992 and 1993, but this is probably due to the change in definition for AIDS. After 1993, however, the increase had leveled off to less than 5% annually and cases among North Carolina women even experienced a sight decline between 1996 and 1997.

When the rates are calculated per 100,000 women for each county, the resulting pattern is fairly similar to that for total cases (Figure 8). Looking back at Table 1, we can see that some of the counties with the highest numbers of AIDS cases also have the highest rates (i.e., Durham and Pitt counties). When rates/100,000

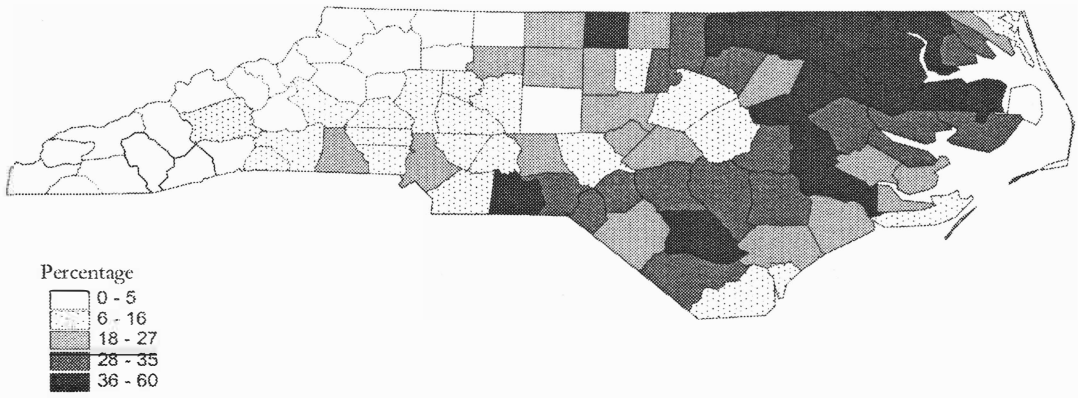

Figure 9. Percent of the Population African-American
Source: US Bureau of the Census, 1997

women are calculated, Tyrell County (along the coast) has the highest rate. Although it only had three total cases of AIDS among women, Tyrell has the lowest number of women of any of the counties (as well as the smallest overall population), causing this statistical anomaly.

AIDS cases among North Carolina women have occurred throughout the state, not only in the urban areas but also in the small, rural communities. This pattern of spread has also been observed in the United States as a whole. The Piedmont and Coastal Plain counties contain a higher incidence than the mountain counties, but with each passing year an added number of western counties are reporting AIDS cases.

Six of the nine counties that have reported no cases are in the mountains. Aside from Buncombe and Henderson counties, the area west of Mecklenburg County has low numbers of AIDS among women. This is a result of both the low levels of urbanization here, and also the high percentage of whites living in these counties (since AIDS in North Carolina is primarily affecting black women) (Figure 9). There is some speculation that a partial explanation of these low numbers may be the result of migration of these cases to other urban areas in North Carolina or even outside the state. However, HIV and AIDS cases are reported to the country of residence at time of diagnosis.

Conclusions

This paper builds upon work done by Pyle and Furuseth (1992), in which they discussed the diffusion of AIDS in North Carolina among both genders. The pattern of AIDS among women in North Carolina is similar to that of men in this state and this paper serves to continue that discussion through the late 1990s. For instance, whereas seven North Carolina counties have yet to report a case of AIDS among women, all but three have at least one case of AIDS among men (those being Alleghany, Clay and Tyrell). Furthermore, the AIDS data from 1999 show that the disease is spreading into the minority populations in both genders, not just African-Americans, but also Hispanics and to a lesser degree, Asians and Native Americans.

In summary, in North Carolina, HIV/AIDS first impacted women living in urban centers such as Charlotte, Raleigh and Durham in the mid- to late-1980s. Through the 1990s, HIV/AIDS diffused down the urban hierarchy and also intensified in the rural coastal plain. The counties in the coastal plain of North Carolina contain (relatively) high percentages of African-Americans, who are disproportionately infected with HIV in the United States and North Carolina. As mentioned previously, minorities in North Carolina are markedly impacted by other diseases (e.g., tuberculosis) and by poverty (e.g., high infant mortality rates), particularly in the coastal areas of the state.

Many people in the United States believe that AIDS is a disease of 'others.' White Americans believe AIDS is a disease of poor blacks, while African Americans think AIDS is a gay white man's disease. Rural residents think AIDS is a problem in "the city," and urban dwellers believe AIDS only afflicts the drug users. Because the public views AIDS as a disease of "others," AIDS victims become separated from their societies. People who are treated as outsiders from the mainstream of society may be denied vital life-saving information or public health tools. In this respect, a subgroup's marginalization may be a risk factor, just as much as a contaminated syringe or unprotected intercourse. As seen in this paper, AIDS has spread throughout North Carolina and is not a problem only affecting 'others.'

Much of the "geography of AIDS" research in the United States (including this paper) can be described as the geography of AIDS *diagnoses*. Since most AIDS funding is distributed based on the county of diagnosis, it is important to examine not only where people are living at the time of diagnosis, but to also investigate the subsequent movement of people with HIV/AIDS and the impact of this movement on the 'host' community. People with HIV are significantly mobile and health care needs may be underestimated in areas experiencing net increase in HIV/AIDS patients due to migration.

Other areas for future study include: the presence/absence/ strength/role of a 'gay community' in North Carolina's urban areas; the acceptance of or resistance to AIDS houses/hospices in North Carolina; rural vs. urban beliefs about HIV/AIDS; and, the

impact of southern culture on compliance with medication regimes. Many elements of HIV/AIDS are rapidly evolving, whether medical, social or educational; therefore, attitudes, lifestyles and knowledge of those infected, affected and uninfected are changing also. Consequently, conducting research on this disease is both challenging and rewarding.

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Sediment Storage and Drainage Ditch Excavation on the North Carolina Coastal Plain: A Case Study in Pitt County

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The storage component of a fluvial sediment budget is difficult to quantify, yet is critical to understanding the fate of soils eroded from agricultural lands. The drainage systems in eastern North Carolina are heavily modified by human activity and are presently dominated by maintained ditches. The periodic re-excavation of the drainage ditches provides a unique opportunity to investigate the accretion of stored alluvial sediments. This paper presents an initial evaluation of the effects of channel excavation with particular focus on adjustments in channel morphology and sediment characteristics. Sixteen cross-sectional profiles were monitored along a 40m ditch segment over a one year period following re-excavation. The depth and composition of stored bed sediments were measured. Ditch excavation produced a sediment sink that resulted in a significant positive net change in alluvial storage and relatively simple cross-sectional morphology. The stored sediments lacked a fine fraction, suggesting that fines are transported beyond the study reach. Beginning in spring, vegetation growth increased the hydraulic roughness within the ditches and resulted in a decrease in sediment transport and an increase in complexity of cross-sectional channel morphology. We tentatively conclude that sediment eroded from coastal plain agricultural land does not travel very far from its source.

Introduction

Most drainage systems on North Carolina's coastal plain have been heavily modified for agricultural use by channelization. The straightening and deepening of stream segments lowers seasonally high water tables and accelerates the movement of water off agricultural fields. Periodically, the channels are cleared of vegetation and accumulated sediment. This re-channelization provides an excellent opportunity to study sediment storage and the evolution of drainage ditches in coastal plain watersheds. Because the sediments removed from the ditches are spread over adjacent fields, re-channelization also provides an opportunity to investigate sediment recycling which has been suggested as a potential solution to coastal plain agricultural erosion (Phillips, 1985). The purpose of this paper is to present an initial evaluation of the short-term and longer-term effects of channel excavation on stored sediment volumes and channel morphology, and to examine the effectiveness of re-channelization as a mechanism for sediment recycling.

Study Site

The study site is located near the town of Littlefield on the southern edge of Pitt County on the North Carolina Coastal Plain (Fig. 1). This small watershed is part of the larger Neuse River drainage that flows into the Pamlico Sound on the Atlantic Coast. The site is surrounded by a mixture of woodland and cropland and is characterized by low slope gradients (< 0.02) and well drained sandy soils (Slattery et al., 1998). The channel reach investigated is part of a deep (1.5-2 m), straight, 450 m long channel with intermittent flow that drains into a larger ditch exhibiting base flow year round. The drainage basin has been heavily modified for agricultural use with row and furrow cropping patterns that have the effect of concentrating surface runoff down rows to the lower field edge in a pattern common in agricultural catchments (Souchere et al., 1998). Several small swales along the field edges develop ephemeral gullies that cut across furrows and have the potential to significantly increase sediment entrainment and delivery to the ditches (Thorne and Zevenbergen, 1990). The watershed is

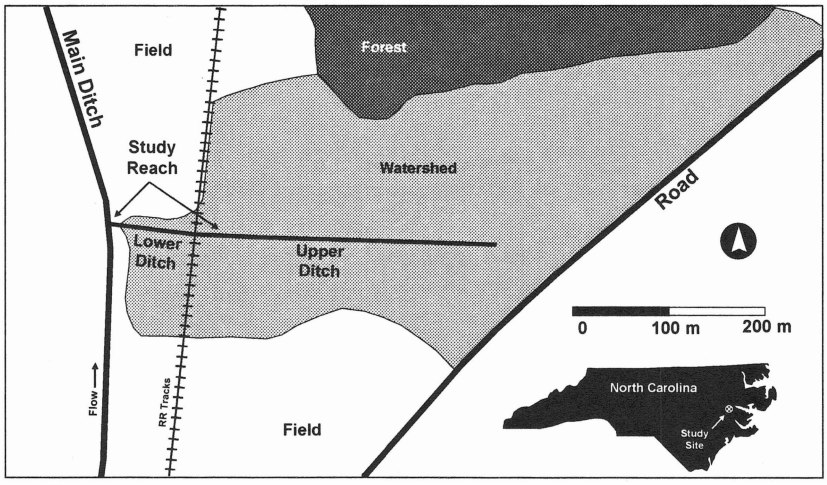

Figure 1. Study site location

truncated to the east by a county road (Fig. 1) and railroad tracks divide the upper and lower basin, further modifying the drainage pattern by forcing all upper basin surface runoff into the channel before passing under the railroad tracks via a 1 m diameter cement culvert. The railroad tracks also mark an abrupt decrease in channel gradient (from 0.04 to 0.009) and a downstream increase in the width (2 m) of the channel bottom (Fig. 2). The channel is re-excavated every 2-3 years and the alluvial sediments removed from the channel are spread on the adjacent field edges using heavy equipment.

Research Design

This study focused on the effects of channel excavation along the lower 40 m segment of the ditch downstream from where it emerges from under the railroad tracks (Fig. 2) to its outflow through a culvert leading to the larger, north-south flowing ditch. The decrease in channel gradient and channel widening below the railroad culvert leads to the deposition and storage of sediments transported from upstream. In March of 1999 a single cross-sectional profile was surveyed near the confluence with the main ditch shortly after the channel had been re-excavated (Fig. 3). In April and November of 1999 and March of 2000 sixteen cross-sectional profiles were surveyed every 2 m along the length of the lower ditch. A local datum was established for all the surveys using the elevation of the nearby railroad track. The depth of stored bed sediments was also measured at each cross-section by probing down through the softer channel-bed sediments until reaching the contact with poorly-sorted, coarser sediments. Particle-size analysis of these sediments confirm that this boundary marks the maximum depth of excavation by heavy equipment. Grab samples were collected from sediments in the channel bed, colluvium (at the base the channel banks), upper basin channel reach, and the sediment underlying the stored alluvial sediments. Finally, the bed sediments were trenched once at the upper end of the study reach and once at the lower end of the study reach and the sedimentary units measured and described. The purpose of the trenching was to measure and describe the depth and lateral extent of the sedimentary units.

Results

The study reach exhibited a positive net change in alluvial storage over the one year period between March 1999 and March 2000 (Fig. 3). Overall, 23.45 m^3 of sediment was stored along the lower ditch between re-excavation (shortly before the first survey) and the last survey in March 2000. Most of this deposition occurred before the first survey in March 1999 because the re-excavation of the ditch had lowered the

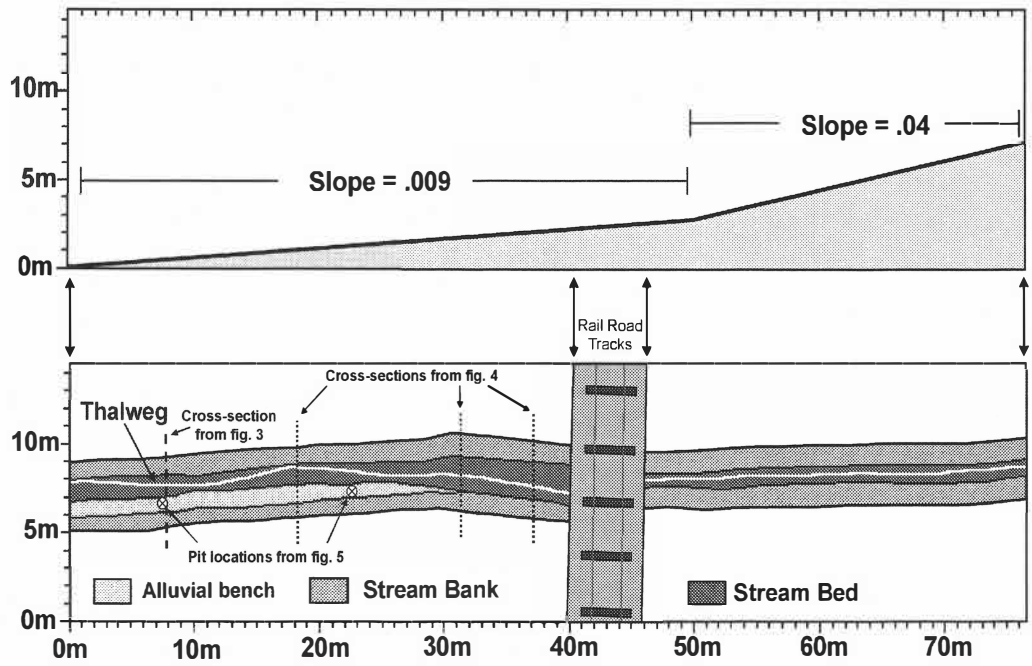

Figure 2. Enlarged view of the study reach, labeled on figure 1. The figure shows a linear profile (5x exaggeration) and a map view of study reach. The locations of cross-section and pits shown in figures 3-5 are shown.

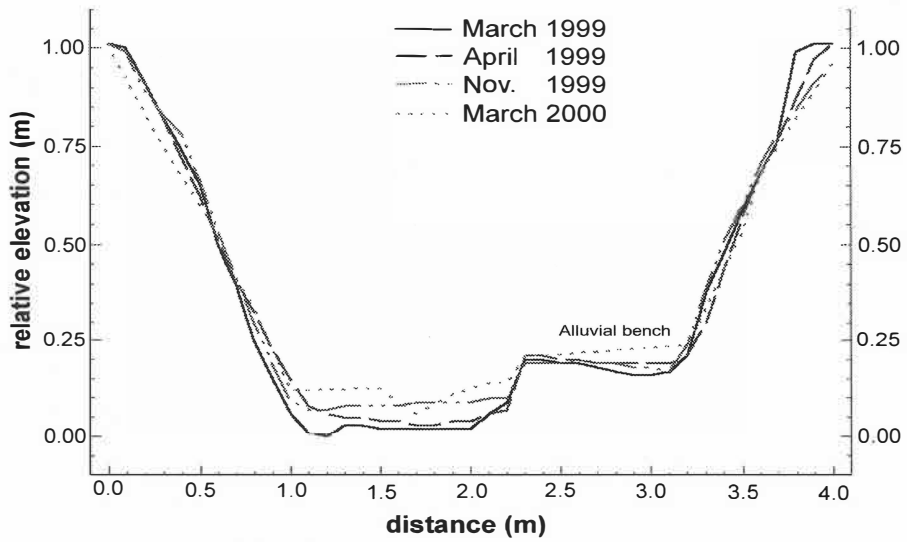

Figure 3. Profiles measured four times over a one year period for a cross-section at the lower end of the study reach, 8m upstream from a culvert pipe. The location is shown on figure 2.

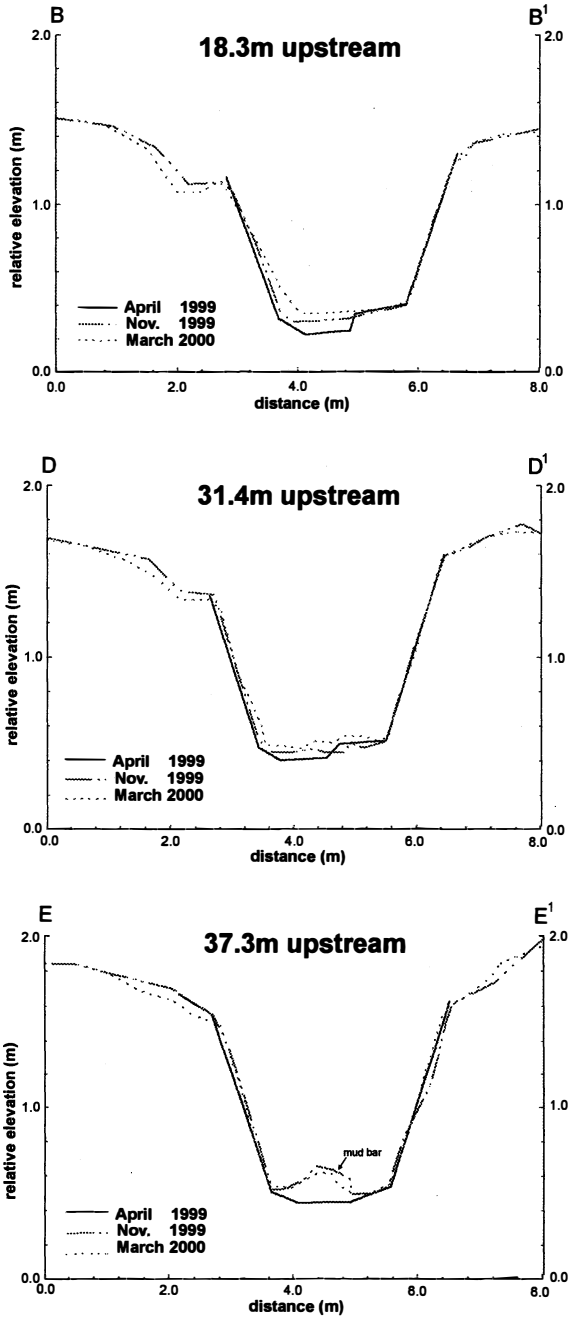

Figure 4. Selected cross-sections illustrating the influence of vegetation on bed morphology, particularly up channel, over a one year period. Locations are shown on figure 2.

level of the bed below the outflow culvert by about 25 cm. Whether this "over-trenching" was inadvertent or purposeful is unknown, but it created a large sediment sink that filled in rapidly until the channel bed was graded to the elevation of the outflow culvert. Nevertheless, the surveys identified significant sediment storage with the channel bottom aggrading by about 8 cm between March 1999 and November 1999, and by 4 cm between November 1999 and the last survey in March 2000.

The cross-sectional profiles also indicate the development of a small alluvial bench along the channel bed (Figs. 3 and 4). The height of the bench increased down-channel, indicating that it was produced by thalweg downcutting at low flow conditions. The bench alluvium was likely deposited as excess bed sediment during the first several high discharge events and the thalweg subsequently incised through this alluvium in an effort to reach equilibrium relative to base level, in this case the outflow culvert that discharges into the main ditch. Because sediment transport rates at low flows were not large enough to move significant quantities of sandy bedload, this downcutting was slow and an equilibrium profile was probably never fully formed before the next storm event. The difference between the slow rate of downcutting during low flow, and the higher frequency of large discharge events in the spring months that are capable of transporting large quantities of sand for deposition in the heavily vegetated channel bottom led to a net aggradation of the channel bed.

A distinction can be made between stored bed sediments derived from sources in the upper and lower basin (Fig. 5). Darker, organic-rich soils of the Bibb complex (Karnowski et al., 1974) were supplied by slumping and gullying of the channel banks in the lower basin downstream from the railroad tracks. The sediments supplied by the upper basin are eroded from lighter colored, sandier soils of the Wagram and Aycock series (Karnowski et al., 1974). The sediment profile in the channel bed in the lower end of the study reach (Fig. 5) reflects these two sediment sources, showing distinct units of darker soils that alternate with thicker, lighter colored units. These darker units were not visible in the sediment profile at the upper end of the reach. The upper basin area is considerably

larger than the lower basin and this is manifested by the comparatively large volume of upper basin alluvium in the profile. Several large slumps involving over 4 m of bank length were observed along the bank of the channel in the upper basin (above the railroad tracks) and certainly contributed lighter colored sediments for transport into the lower reach. Moreover, the channel profiles in the lower ditch all show evidence of smaller-scale bank slumping (Figs. 3 and 4).

Further evidence for the provenance of sediments can be found in the results of grain size analyses. A ternary plot of sediment sizes (Fig. 6) shows three distinct populations: the underlying coarse sediments, the sandy bed sediments, and the finer field and colluvium/alluvium sediments. The dark colored colluvium/alluvium was collected at the base of the channel bank in the lower ditch. The stored bed sediments are sandy and are missing the finer fractions present in the soils found up-basin (Wagram and Aycock series). The fines, although not abundant in these sandy soils, are probably carried away as suspended load, leaving the sand to be transported episodically as bedload.

Discussion

Although the data presented in this paper are limited, they provide some interesting insights that should be considered as speculative in nature. We suggest that the initial consequences of channel excavation are twofold. First, the erosion of sediment in the upper basin was probably enhanced by several factors: the removal of vegetation along the ditch, increasing the gradient of the ditch, oversteepening of the banks of the ditch, and the cultivation of fields that exposes soil for erosion during winter months. The concurrent cultivation of fields and ditching would lead to a sudden increase in sediment production and delivery to the study reach in the lower basin. Rather than generating higher sediment yields as might be expected under the assumption of a constant alluvium storage rate (Boardman et al., 1990), the increase in sediment production was countered by a second effect of re-channeling: the over-deepening and wid-

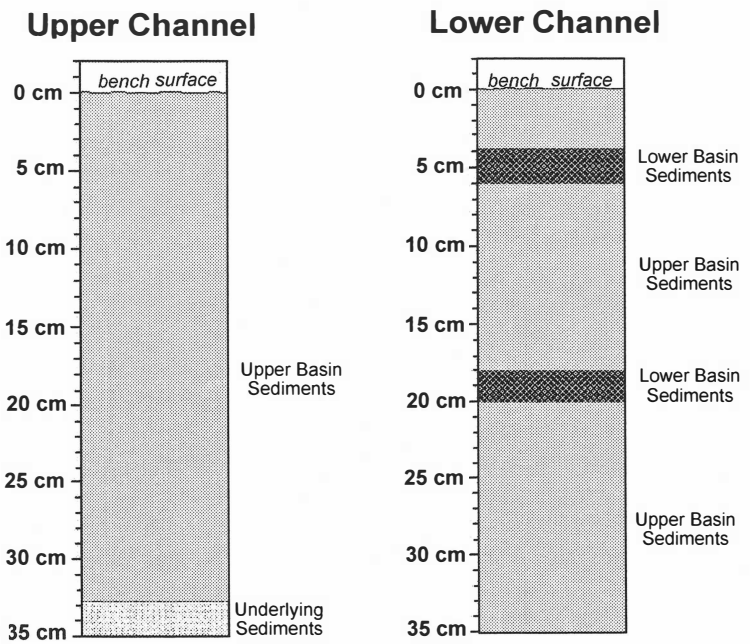

Figure 5. Channel sediment profiles from pits dug in the ditch bed. Locations are given on figure 2.

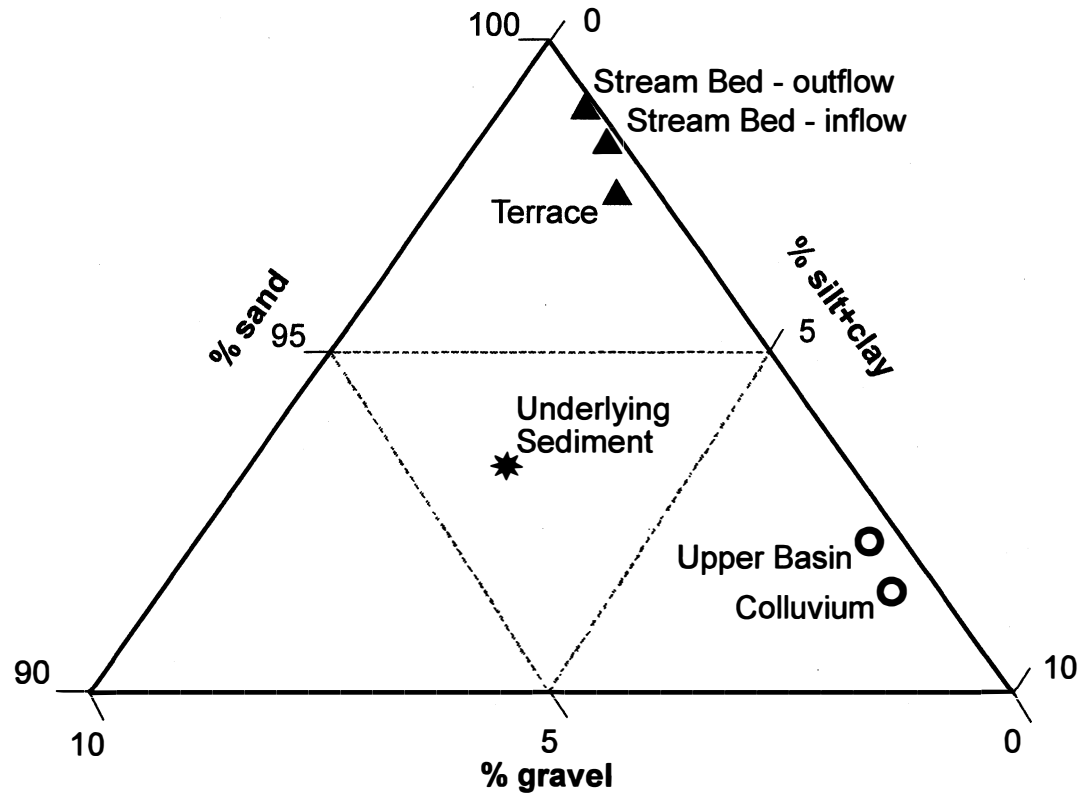

Figure 6. Ternary plot showing sediment grain size distribution.

ening of the lower basin channel. This, in combination with the low channel slope, created a sediment sink. The total effect was to quickly move large volumes of sediment from the upper basin and store it in the lower channel. It appears that the fine fraction is carried beyond the study channel leaving the sand fraction to be stored, if only temporarily, in the lower ditch.

Channel morphology appears to have been storm-controlled, with large storms resulting in high discharge events that aggraded the channel bed in the lower reach. Between storms, thalweg downcutting during low flows produced an alluvial bench that increased in height downstream. This is similar to the findings of Friedman et al. (1996) who identified stages of channel narrowing in a sandbed stream. They found that large discharge events produced an elevated bed due to the deposition of sands and small gravels. During periods of low flow the channel incised and a single thalweg developed. Over several seasons vegetation established a control over sub-areal portions of the bed, stabilizing most of the channel bottom around a well-defined, narrow channel. The Littlefield study site appears to follow a similar process of channel narrowing.

Field observations over the year-long study period suggest that the immediate effects of re-channelization are dampened through time by the re-establishment of vegetation. Each fall the farmers mow the vegetation growing in and along the ditches. During the winter and early spring, sediment transport is unimpeded by the hydraulic roughness introduced by vegetation (Fig. 7). Dense vegetation growth during the spring and summer, however, quickly chokes these drainage ditches. This is particularly true for the small ditches where baseflow is minimal or absent, and much growth occurs directly in the bed of the channel. Only the largest of flows (e.g., Hurricane

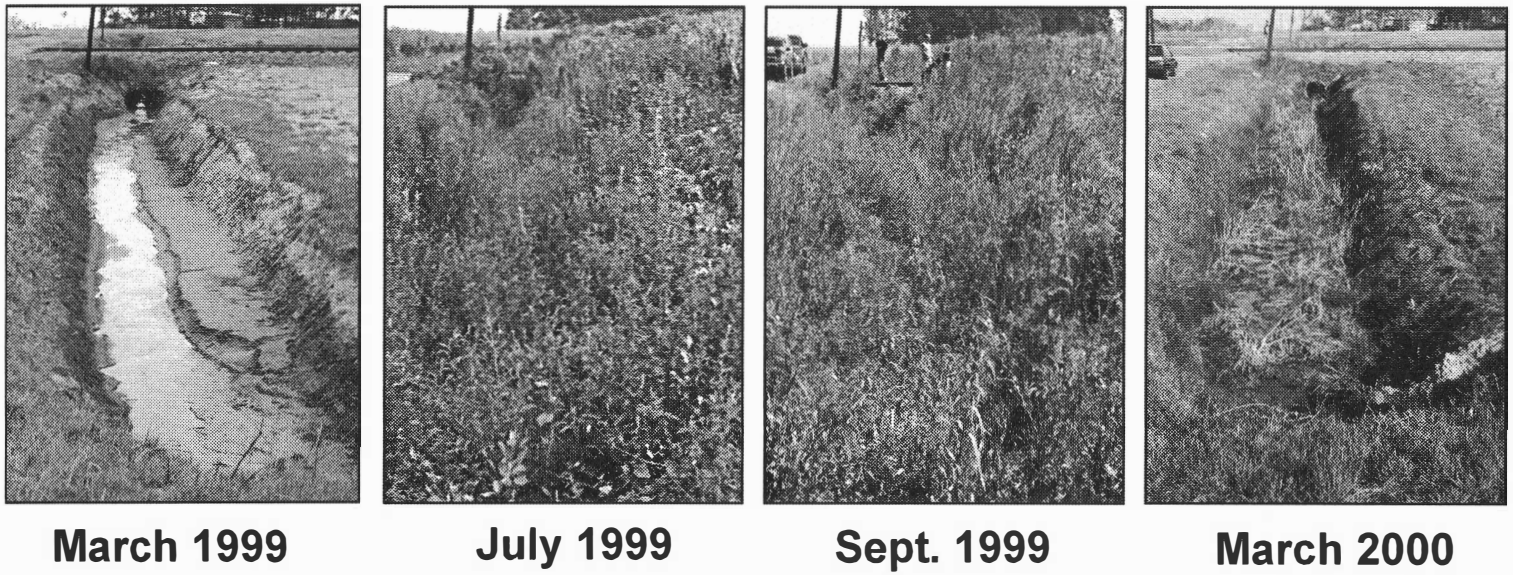

Figure 7. Photographs showing the evolution of channel vegetation over the study period. The photographs are facing to the east and show the Lower Ditch study reach up to the culvert pipe under the rail road tracks.

Floyd) are likely to disrupt the vegetation enough to allow significant amounts of sediment to be transported through these channels. Cross-sectional profiles indicate that channel morphology is influenced by vegetation that is effective in trapping sediment along the channel bed (Fig. 4). While the bed aggraded considerably in the lower channel section, vegetation trapped sediment in the upper channel section resulting in the accumulation of a large mid-channel bar. Although vegetation growth and sedimentation in the lower channel (reducing the channel gradient) favors the accumulation of sediments, the planting of crops and the stabilization of channel banks with vegetation reduces sediment production up-basin.

Assuming the rapid sedimentation of the small ditch examined in our study is generally representative of the region, the return of ditch sediments to the field would appear to be an effective mechanism for minimizing soil loss from agricultural fields. Indeed, the recycling of sediment has been suggested as a potential remedy to the coastal plains agricultural erosion problem (Phillips, 1985). However, even though a large part of the sand fraction is returned to the field, a significant portion of the fine fraction may be lost as suspended load. Thus, the net result may be to concentrate the sand fraction in sediment which is then recycled to fields.

Conclusion

The results of this study show that significant amounts of sediment can accumulate in drainage ditches during a relatively short period of time. Insofar as the construction of small ditches and the clearing of vegetation from these ditches is the consequence of human agency, the movement and storage of sediment in the coastal plain environment is highly modified from a "natural" condition. Previous studies have argued that soil erosion is significant, but that the fate of the eroded sediments is unclear (Phillips et al., 1993; Slattery et al., 1998). We maintain that, at least in some situations, the eroded sediment is not transported very far from its source. It is either deposited on the same field from which it was eroded (Phillips et al., 1999), or is deposited nearby in drainage ditches which must be re-excavated frequently. Indeed, this would seem to be confirmed by the relative lack of sedimentation on the Tar River floodplain during the 1999 flood which resulted from Hurricane Floyd (Lecce et al., in press).

Further study is needed to assess the recycling of sediments excavated from the ditches. Although the source area for the sediments involves a significant portion of the basin, the ditch sediments are returned only to the field edges so that soil erosion remains a significant problem on most of the field. This may lead to spatial variations in soil quality with the field edges becoming increasingly sandy as the alluvium is repeatedly spread on the field edges. Additional study is also required to quantify the loss of fines as suspended load and the rate with which sandy sediments are transported as bedload. An event-scale study of bed load and suspended load transport rates could further illuminate the processes by which eroded soil is moved and stored in drainage ditches in eastern North Carolina.

Acknowlegment

This paper is contribution number 52 to the Tobacco Road Research Team.

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Guest Analysis

The 2000 Presidential Election in the Many Souths of North Carolina

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While the nation's attention was riveted on Florida in the closest presidential election in history, North Carolina underscored the reality of Southern political geography. For the sixth time since 1976 the Republican Party carried the electoral votes of North Carolina. George W. Bush received 56 percent of the vote, whereas Al Gore garnered 43 percent (Ralph Nader was not on the ballot in the Tar Heel State). Bush won throughout the South and took the border states of West Virginia, Kentucky, and Missouri away from the Democrats and redeemed Arkansas, Louisiana, and Tennessee for the Grand Old Party (Figure 1). Tennessee proved especially heartbreaking for Gore, since it would have made Florida irrelevant. Florida, North Carolina, and the Greater South formed the bedrock of George W. Bush's electoral college strategy. Gore actively contested only the Southern states of Florida, Tennessee, and Arkansas and ceded North Carolina to Bush.

North Carolina, a microcosm of the South, is a geographically diverse state within the Southern context. The eastern Coastal Plain is part of the Deep South and houses substantial rural black populations with a history of white minority control. These counties constituted the heart of the Solid South and yellow-dog Democratic support among white voters. The Blue Ridge represents the Mountain South and its white Upland South culture. These counties have been Republican since the Civil War. Family farmers living in the area had no use for slaves on their small and hilly plots and have supported the GOP at local, state, and national levels since Reconstruction. The Piedmont consists of the urban/suburban South (Charlotte, Winston-Salem, and Greensboro), the rural hinterland, and the high-technology Sunbelt South (the Triangle of Raleigh, Durham, and Chapel Hill). The Piedmont is also home to black populations in urban areas and is increasingly attracting migrants from outside the South and the United States to its fast-growth cities. Republican success in North Carolina has been built on the votes of Mountain Republicans in the Blue Ridge and white voters in the Piedmont with some white support from the Coastal Plain. Democrats rely on black voters, remaining yellow-dog Democrats, and white moderates and liberals in the cities of the Piedmont.

A look at the Republican vote by county shows areas of Republican support in the Blue Ridge and the Piedmont (Figure 2). Bush received heavy support in the traditional mountain base of Cherokee, Clay, and Polk Counties. But, these counties are relatively small when compared to the larger urban/suburban Piedmont. The urban/suburban Piedmont and its rural hinterland provided George W. Bush with his winning statewide margin. Bush won a majority of the vote in the more populated Counties of Wake, Forsythe, Alamance, and Guilford. But, Bush's urban support was not uniform throughout the Piedmont. In Charlotte's Mecklenberg County, his margin was only 51 percent. Orange County, which is home to Chapel Hill, supported Gore handily as did Durham County, home to Duke. Areas of higher Democratic support included the northern and Southern edges of the Coastal Plain. Many of these counties represent North Carolina's rural black-belt. Robeson County's population is approximately 25 percent black and Gore won the county easily. Likewise, Edgecombe County in the northeastern portion of the Coastal Plain is over half African-American and supported Gore by a large margin. But as in the mountains most

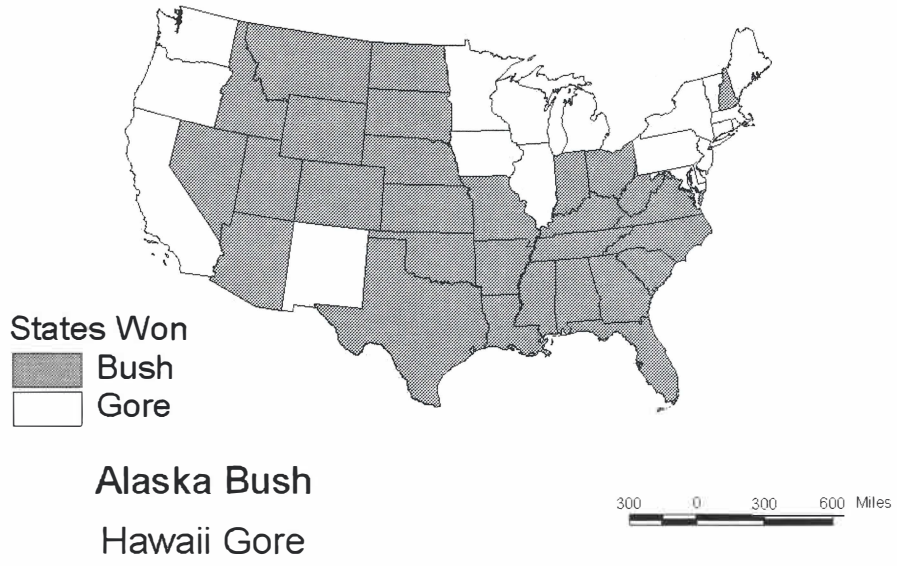

Figure 1. The 2000 Election

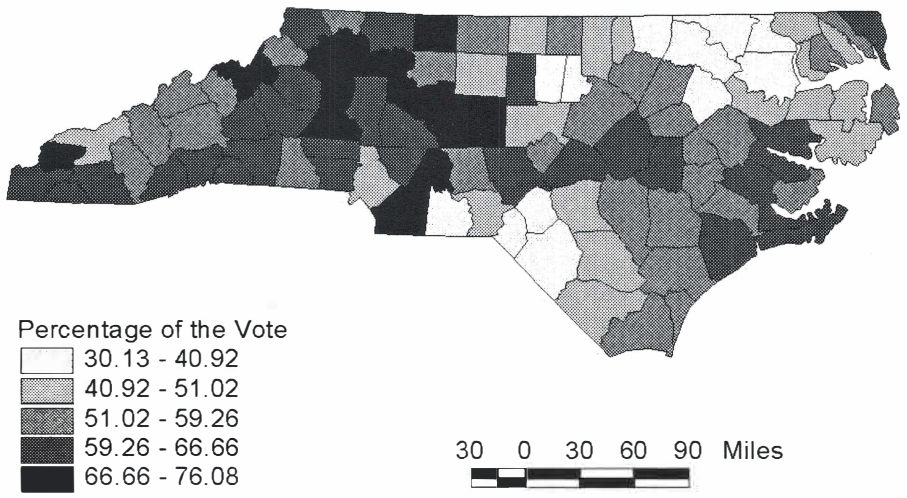

Figure 2. The George W. Bush Vote in North Carolina by County

of the counties of the Coastal Plain are not heavily populated and the urban/suburban Piedmont remains the key to taking the state. The GOP has had an advantage among white voters in that portion of the state since the 1960s.

But, the presence of loyal African-American voters and islands of Democratic strength in Orange and Durham Counties still makes the state competitive for Democrats. Democrat Mike Easley was elected governor while George W. Bush carried the state and Democrat John Edwards was previously elected to the Senate. They won based on a coalition similar to those built by former Democratic Governor Jim Hunt. A coalition based on blacks and white liberals led by a moderate, white Democrat can receive just enough white votes from the Piedmont and the Coastal Plain to carry the state. In the final analysis, both parties need a formula which includes the urban Piedmont, and future elections in the state will be dominated by appeals to these voters. North Carolina's political geography dictates that both parties must appeal to more than just one South.

Commentary

Kenaf: A New Farmer-Driven Solution to Eastern Carolina's Agricultural Crisis

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North Carolina agriculture, once leading the nation in returns per planted acre, and third only to California and Texas in net farm income (North Carolina Rural Economic Development Center 2000), has been hard hit in recent years. Tobacco allotments, which underpin the entire system, have been cut in half. Increasing globalization and significant US commodity market exposure to foreign producers have brought commodity grain prices to historically low levels — with no relief in sight. Massive consolidation of packaging and processing capacity has also siphoned poultry, livestock and vegetable revenues away from the grower to the benefit of the agri-business overlords. The family farm, in particular, has been caught in the middle of the squeeze. Increasingly, farmers acting on the stern advice of their bankers are following the only course of action available to them — getting out of farming while they still have some asset value left.

This paper examines the efforts of a small, yet determined group of Eastern North Carolina family farmers who have decided they wish to remain as farmers. It is a bleak landscape, US agriculture, from within which this group is searching for solutions. They know there are no easy answers nor simple solutions. Still, resolved to *be* farmers and not be "retrained" as something they wish not to become, they have determined that they *will* solve their own problems.

The Farmers' Dilemma

It is instructive to put some numbers to the farmers' dilemma. This year tobacco brought an average of 178 cents per lb at auction. Farmers pay an average of 50 cents per lb to lease allotments. With the increase in fuel, fertilizer, fumigant, pesticide and herbicide prices, the average cost of producing and curing a pound of tobacco leaf has risen to around 105 cents (including land rental) — up from just 65 cents six years ago (Farmer Interviews, 2000). That gives farmers a net return of 23 cents per lb on the average year 2000 production quota of 2,000 lbs per acre (Personal Communication, Farm Service Agency, 2000) — or $460 per acre, less than half their net return per acre just six years ago. With the average tobacco farmer now controlling approximately 40 acres of allotments, farm-derived income for a tobacco farmer averages around $18,400. This is around a quarter of the average income of a United Auto Workers Union member (United Auto Workers Union, 2000). Taking into account the effects of inflation and a 31% loss in the purchasing power of the dollar during the decade of the 1990s (US Bureau of Labor Statistics, 2000), it is also less than one fifth of the real income a tobacco farmer made less than a decade ago. While farmers rotate tobacco with corn and soybeans, those two crops are, this year, expected to net the farmer zero — even with government subsidy payments.

Farm acreage in Eastern North Carolina is now distributed, approximately, among the following crops: 6% tobacco, 28% cotton; 36% soybeans, 13% corn and 17% other crops — including wheat, hay and grass crops, fallow and vegetables (Farm Service Agency, 2000).[1] Cotton this year is enjoying its best

year in a decade — a "best case" year resulting from a favorable convergence of "somewhat" attractive world prices and excellent local weather. Farmers are expected to net between $100 and $125 on their cotton acreage this year. The hypothetical "average" 500-acre Eastern North Carolina family farm occupies land worth over $1 million, owns around $300,000 in equipment and borrows around $275,000 in working capital. The farmer can expect to net the following income on his statistically balanced acreage: tobacco (30 acres) $13,800; cotton (140 acres) $15,750; corn and soybeans (245 acres) $0; other crops and fallow (85 acres) $0. With his approximately $30,000 in pretax income, the statistical farmer makes 25% less than his wife who works as a school teacher (15 years seniority) for the county. If one combines the $25,000 the farmer pays as rent on his tillable acreage with his own $30,000 income and subtracts the tax assessment on land ($10,000) paid by the landlord we arrive at net annual "value derived" from farming 500 acres of $45,000. This is equal to a return of approximately 3.5% on asset value (Farmer Interviews, 2000). These returns, which are subject to significant weather and market-related risks, are effectively the worst of any sector of the US economy.

Figure 1. Kenaf Leaf- Everglades Strain

Poultry and swine were, at one time identified as an escape route for the average dirt farmer. Today, approximately 13% of Eastern North Carolina farmers own either poultry or swine finishing facilities (Farm Service Agency, 2000; Farmer Interviews, 2000). A turkey farmer who committed to a 6-house turkey farm seven years ago can today claim a partially depreciated, fully-paid-for $600,000 asset and expect to net around $80,000 finishing birds for his "integrator." Similarly, a swine farmer who committed to a new 4-house swine finishing facility seven years ago can claim a partially depreciated, fully-paid-for $400,000 asset and expect to net around $40,000 (Farmer Interviews, 2000). The rosy picture ends there, however. There is, effectively, zero growth in both the poultry and swine finishing businesses. The swine equation is particularly disturbing. Attractive 7-year "contracts" with integrators have been replaced by "agreements" that now pay only $9.50 per finished hog (with incentives), perhaps 5% less than they did seven years ago, with cost of inputs having increased by as much as 25%. This reduction in real income, combined with expectations of a requirement to spend between $100,000 and $250,000 on new waste treatment technology, promise to bring income from swine finishing to a par with other farm crops (Personal Communication, Department of Environment and Natural Resources, 2000; Farmer Interviews 2000). The circumstance in the swine industry, in particular, is governed by a massive consolidation at the integrator and processing levels. A single entity now controls over 50% of North Carolina's swine production and over 85% of its processing capacity. By "setting" the market price of finished hogs slightly below breakeven, this same company can bleed at will all the equity from its competing integrators. As integrators gradually succumb, the market value of affiliated farmer-owned finishing facilities will also decline. Farmers will eventually be faced with the choice of selling out to the

prevailing integrator-processor for a significant discount, or walking away from a worthless asset which that same integrator may, in any case, buy at auction (Farmer Interviews, 2000).

This dismal farming circumstance has, not unexpectedly, begun to attract significant attention from among North Carolina's politicians and its media. Governor Hunt convened a state Rural Prosperity Task Force with a mandate to develop solutions for generating in North Carolina's rural communities the extraordinary prosperity enjoyed by its urban residents during the last decade. The Task Force recommendations, while thoughtful and enlightened with respect to information technology, training, capital formation and infrastructure issues, were notable for their failure to provide any specific solutions for North Carolina agriculture beyond the obvious recommendations for investments in enhanced coordination, marketing, processing and research on "transgenic" crops. Perhaps more ominous for small, family farmers was the report's acknowledgment that "more and more small farmers are getting out [of agriculture]"; and "we've lost 150,000 farms." The report goes on to state that "the average size of farms has been increasing"; and "8% of North Carolina's farms produce 73% of the state's farm income." Indeed, accepting that ". . .this change is inevitable" the only real tangible assistance offered by the report's authors to the small farmer is "to help those farmers transitioning out of the business by using the retraining programs we are recommending in our education section." The report does not anticipate any developments in agriculture that might have a wide impact on the state's remaining farmers. It speaks vaguely of "bioceuticals" and "nutraceuticals" as products that "typically represent niche markets, but can be highly profitable in small quantities." (Rural Prosperity Task Force Report, 2000)

The Farmers' Approach to a Solution

A group of small, family farmers based in the 5-county area bordered by Greenville, Wilson, Goldsboro and Kinston in Eastern North Carolina having decided not to accept the "inevitable," took it upon themselves to change the prevalent paradigm — to develop a means by which they might not only remain in agriculture, but also to thrive. It is not their intention, as suggested by the Rural Prosperity Task Force Report, to submit themselves to "retraining" at the nearest Community College. They are farmers. They enjoy being farmers, and they intend to remain so.

In their analysis of the problem facing them, the farmer group arrived at some simple first round conclusions:

❖ No purpose was served spending any time on working to improve the circumstance with existing crops. No "new markets," "byproducts" or "bioceuticals" derived from those crops, nor any amount of transgenic engineering of those crops would or could favorably affect the farmer in the near term. The mechanisms to extract, away from farmers, all the residual value in those crops were already cast in stone. Discovery of a nutraceutical derived from corn or a new polymer from soybeans would, for instance, have absolutely no impact on local farmers' income. Any such development could have no practical impact on any aspect of the massive global market for corn. It would still be less expensive to import corn from Iowa. Any increase in value derived from the "discovery" would contribute entirely to the the scientist, the manufacturer and his agents.

❖ No purpose was served going after niche markets. It was their intention to deliver a solution that could benefit hundreds of farmers tending tens of thousands of acres. Niche markets might serve one, or perhaps a handful of farmers who separated themselves from the pack, but they were not a "general solution."

❖ They needed a crop for which a huge potential market existed. Further, they should have a natural comparative advantage in growing and/or marketing that crop — preferably both.

❖ Mindful of the "environmental bad boy" label applied to the swine and poultry industries, they wanted a crop that was "environmentally friendly."

❖ Finally, they needed a crop they could deploy immediately. They could not wait another decade while scientists engineered the perfect rhubarb or turnip. Their livelihoods — their lives were in the

balance *now*. The bankers had already delivered their verdict on local agriculture. "We were forgiving this year because of the flood and pressure of public opinion, but next year, if the numbers on your business/cropping plans don't add up, we're going to pull the plug." (Banker Interviews 2000)

❖ The farmers also recognized that introduction of a new crop allowed them the opportunity to control the crop from the outset — to ensure that they did not yet again become passive victims of the processors, reprocessors and marketers of the products they grew. The lesson of the penny worth of corn in a two dollar box of corn flakes was burned into their collective psyche. They must take this new crop all the way to the consumer. They wanted their share of the $1.99 added to their penny worth of corn.

Kenaf — A New Crop for Eastern North Carolina

The farmers found their crop — kenaf. Closely related to both cotton and okra, kenaf was ideally suited to Eastern North Carolina's unique soil and climatic conditions. As with cotton, Eastern North Carolina's greater rainfall and high humidity allowed the state a distinct advantage over Georgia, Mississippi, Arizona, south Texas, Oklahoma and Alabama — both for growing the crop and retting it — the first morning dew-dependant stage of processing. Better yet, demand for the unique "bast" and "core" fibers produced by the plant was exploding in Europe and on the verge of an explosion in the US. Timing for introducing kenaf into high volume production in North Carolina was excellent.

From a global perspective kenaf is not a new crop. It falls within a loose grouping of "bast fiber" crops known to the twine and textile industries as "jute-like" fibers. This group, which includes jute, roselle, sunnhemp, hemp and kenaf have historically been grown for the long fibers in the plants' outer bark. Before the plastics industry came along these competed with the cactus-derived henequen and sisal for supremacy in the twine and rope markets. A hibiscus species traced to Africa, kenaf, or "poor man's jute," was grown primarily in India as a jute-substitute more suited to dryer and less fertile soils. Jute always dominated kenaf in the Subcontinent, and it continues to do so today.

Disruption by German and Japanese U-boats of bast fiber shipments to the US during World War II prompted the US Department of Agriculture to launch a small kenaf R&D program in south Texas. Hemp was, at that time, selected as the fiber of choice to compensate for jute and manila (hemp) shipment losses. Production of that fiber, particularly in Kentucky, reached significant tonnage by the end of the war, with remarkable progress having been made in developing strains optimized to US climatic conditions. Following World War II, however, confusion of industrial hemp with its narcotic cousin, combined with strong competition from the plastics industry ultimately doomed the crop. Sadly, all the valuable germplasm of optimized strains was destroyed. Unaffected by the excitement surrounding hemp, research on kenaf, which never entered serious pro-

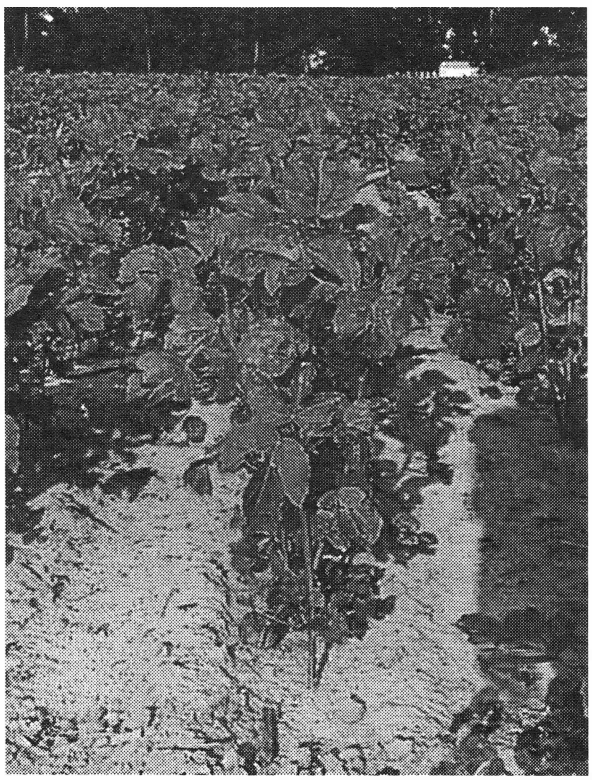

Figure 2. First Kenaf in North Carolina

duction in the US during World War II, continued forward, unnoticed, under the guidance of a small handful of dedicated USDA researchers.

Due in large part to the fifty years of research contributed by the USDA South Texas laboratory, and more recently by plant breeders at the Mississippi State University, Kenaf has suddenly gained prominence as a highly competitive fiber crop ideally suited to the southern US, and North Carolina in particular. New varieties and strains identified by these two research programs have been shown capable of producing, under ideal conditions, more than 10 tons per acre of total fiber — both bast and the lightweight core material. This high productivity exceeds, by a factor of 4, the highest productivity of the latest "synthetic forest" pine species. Further, kenaf has been shown to be an excellent — typically superior — substitute for tree-derived fiber in most applications such as paper, panelboard, plastic fillers and reinforcers, engineered lumbers, insulators and absorbents. The long bast fiber has 4 times the stiffness and tensile strength of wood fibers and the lightweight core fiber is at once lighter, more adsorbent (by a factor of 4), and a better insulator than comparable wood shavings.

Figure 3. Greene County Kenaf Harvest - October, 2000

In production of paper, kenaf holds two distinct advantages over wood fiber. A significantly lower lignin content makes pulping of the fiber less costly — with respect to energy (electricity and fuel), chemical use and time. A "37% cost advantage" in optimized pulping is typically cited by most kenaf advocates (Mardon and Lehmer 1997). Further, being a less pigmented fiber than wood, kenaf pulp can be brought to an acceptable color (bleached) without the need for expensive, environmentally hostile chemicals such as chlorine. Benign peroxide bleach produces an acceptable product.

The unique absorptive characteristics of kenaf bast have rendered it indispensable in the kenaf, hemp and flax blends now employed in manufacture of reinforced polypropylene automobile panels. Those same properties, combined with kenaf's vastly superior strength allow manufacture of a high strength panelboard and/or engineered lumber products having the added advantage of being rendered completely fire retardant (through rapid absorption of borates added during manufacturing).

Kenaf core fiber, typically between 60% and 70% of the total plant by weight, provides an excellent performance in the removal of oil from water.[2] These same absorptive characteristics render it a highly effective replacement for sphagnum moss in high-end potting soils and a superior substitute for wood shavings in animal and poultry bedding and clay in oil cleanup products. Kenaf core also provides an effective low cost replacement for synthetics in the manufacture of lightweight insulating and sound dampening panels and ceiling tiles. As a replacement for talc and calcium carbonate in injectable and extrudable plastic compounds it adds stiffness while also reducing weight and cost.

From the farmers' perspective, Kenaf provides a profitable fixed-price, contracted agricultural alternative to commodity crops in an era of historic low prices. It is a relatively low-input, robust annual crop

capable of producing more than 3-times the equivalent fiber yields of the latest generation of high yielding softwood "false forest" plantations. Kenaf provides exceedingly quick planting-to-payment turnaround for a fiber crop — less than 7 months in most instances, compared to 5 years for bamboo and more than 8 for the latest generation of conifers. Kenaf can be planted and cultivated with conventional equipment — allowing farmers to commence production without incurring a major capital investment.

In North Carolina, kenaf production is expected to average around 5 tons per acre per year. Production and harvesting costs, excluding land, should average between $250 and $350, depending on local conditions. With farmers receiving 4¢ — 6¢ per lb for whole fiber, net returns to the farmer should average between $250 and $350 per acre. This compares favorably with any of the commodity crops now being grown by Eastern North Carolina farmers and even begins to approach returns now being realized in local production of tobacco.

Most importantly, the markets in which kenaf can be sold transcend the typical limitations of "niche" markets. Kenaf holds potential to compete with cotton locally with respect to farmed acreage. Demand from the automotive market alone is expected to reach 100,000 acres within the next five years. A single large pulping plant would require more than 100,000 acres of kenaf. Were the kenaf industry to capture only 1% of the $40 billion US market for building materials it would take over 400,000 acres of farmed kenaf to satisfy that demand.

The principal environmental benefits conveyed by cultivation of kenaf derive from its replacement of wood. Assuming a 5-to-1 growth advantage (over conventional growth forests), five acres of farmed kenaf will, each year, protect an acre of trees that might otherwise be clear cut and then replaced with biologically sterile, rapid-growth "false forest" pine plantations.[3] This affords two distinct advantages: it preserves the state's biodiversity and it shifts the state's fiber burden from its fragile forests to the shoulders of its threatened farmers, who welcome that responsibility. A kenaf-fiber strategy at once sustains both forests and farmers, while also preserving threatened plant and animal species of North Carolina.

Having now selected their candidate for turning around agriculture in Eastern North Carolina, the "kenaf" farmer group is embarked on a mission to achieve their objective. In 9 discrete plots — 25 acres in total — positioned strategically throughout Greene County, the farmers have demonstrated the feasibility of growing kenaf in Eastern North Carolina. By varying key planting and harvesting parameters they have also demonstrated the full range of plant production and harvesting paradigms. Interest by local farmers has been intense. In the 2001 growing season, the group intends to demonstrate the feasibility of "significant" production of the crop in Eastern North Carolina. Approximately 50 farmers located in the 5-county project area will cultivate 6,000 acres of pre-sold kenaf. This kenaf will be "dew-retted" in the field, round-baled for centralized storage and decorticated (fibers separated) in a farmer-owned facility installed as the "flag ship" of a new Greene County industrial park. The resulting 9,000 tons of retted, cleaned and baled bast fiber will be employed by the automotive industry in production of automotive door panels, headliners, rear window shelving and trunk liners. Kenaf will, in most instances, be replacing glass fiber reinforcing which is conventionally employed in manufacture of these same interior panels. The 21,000 tons of core material produced by the kenaf farmers will be employed in bulk as horse bedding and potting soil additive and packaged in a variety of configurations as oil absorbent and animal litter.

Having thus demonstrated the viability of farming several thousand acres of kenaf in Eastern North Carolina, the farmers intend then to move on to the third and final phase of their plan — installation of a factory to manufacture engineered building materials employing varying percentages of both bast and core. These building materials would compete across the entire range of building products, but concentrate heavily on integrated products requiring high strength, stiffness, dimensional stability, and insulating properties. I-beams, joists and structural insulated panels would number among the most important applications. The factory would process kenaf grown by approximately 300 farmers on 20,000 acres and supply less than one twentieth of one percent of the US

demand for building materials. The manufacturing facility will provide between 200 and 300 rural jobs in economically depressed Greene County. Providing market acceptance of the kenaf-based building materials was satisfactory, the same 20,000 acre model could be replicated in a dozen or more locations throughout Eastern North Carolina.

The Farmers' Solution: Producer Controlled "Bottom-up" Vertically Integrated Farming

The kenaf farmers are guided in their pursuit by a number of self-imposed operating rules and guiding principles. Taken as a whole, these rules and principles become a unique "model" for reforming agriculture in Eastern North Carolina:

❖ For the farmer, "bottom-up," directly linked value-added processing and direct market access for finished products is essential — an absolute necessity.

❖ Achieving equity ownership and control over value-added processing and direct market access by farmers is feasible, but only for a new crop — preferably "new" in an absolute sense (such as kenaf), but certainly, at a minimum "new to the area."

❖ Farmers must coordinate with one another to achieve strict farmer-control over production acreage.

❖ Farmers must only deliver their commodity to the market place as a value-added product. They must eschew the "commodity business."

❖ Capturing the middle ground between the farmer and the final consumer — for absolutely any farm-grown product — is immensely profitable. Witness the 2 cents worth of farmer's grain that goes into a $2 box of Ritz crackers. Farmer's need not hand this 100%+ profitability over to intermediaries, corporate processors and investors. Investors need only receive a "comfortable" 20% to 30% return. As the true controlling interest, farmers may reserve most of the value-added profitability for themselves.

❖ Farmers have enormous political strength if they can: (a) agree on a common agenda; (b) stand up and be seen as a group; and (c) speak with strength and absolute conviction. They must not request solutions. They must "know" the solutions and mandate implementation of those solutions.

Figure 4. Kenaf Farmers Surveying First Crop, August 2000

❖ Public opinion strongly favors the family farmer. This goodwill is greatly enhanced if the farmer is allied with a popular environmental cause, such as, in the kenaf instance, *preservation of our precious forest resources.* Public opinion weighs heavily in the political equation.

❖ Massive state and federal resources are spent to assist and subsidize the income of the farmer. The true value of these public sector investments is all drained off by monopolists and farm-exploitation interests. The "system" as it now exists is powerless to prevent this. Logically, both state and federal politicians must, therefore, see the virtue of making modest (by total agricultural subsidy standards) investments directly with farmers — invest-

ments that will allow farmers, once and for all, to escape the trap in which they are now caught. Ultimately, liberating and empowering farmers in this manner will be much less expensive to state and federal coffers than continuing to pour billions of dollars directly into the pockets of prominent agri-business corporations in a largely fruitless effort to maintain farmers' heads above the waterline. A "health sector" analogue is instructive: It cost less to eliminate, completely, the smallpox virus than the sum total all the world's nations spent each year on their domestic vaccination programs.

❖ Achieving complete financing of a major, environmentally friendly, farmer-driven vertically-integrated agricultural enterprise from a combination of public and private sources, while also maintaining absolute control, is a feasible task.

Today, only 8 months after embarking on their odyssey, the kenaf farmers of Eastern North Carolina, have succeeded in attracting the interest and support of their state legislators, county-level officials, the state's major universities and — most importantly, their peers. They have also attracted the attention of the market place. In the coming year they are being asked to supply 6,000 tons of Carolina-grown pure bast fiber for the manufacture of automotive interior parts. This is a small, yet significant beginning for what can grow to become one of the most important crops in North Carolina while providing a solution to the fundamental problems now confronting Eastern North Carolina's farmers.

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[1] These cropping figures relate specifically to the 5-county Phase-I kenaf project area (Wayne, Greene, Lenoir, Pitt and Wilson counties) and should not be generalized to all of Eastern North Carolina.

[2] Where this is particularly useful is in cleaning up after large oil spills on open bodies of water. It can also be used to separate the oil from water at drilling sites, allowing subsequent conventional "treatment" of the water.

[3] Five acres of kenaf will produce approximately the same tonnage of ligno-cellulosic fiber in one year as one acre of felled, 25-year growth trees. One acre of kenaf will, therefore, produce five times the total tonnage (on an annual basis) of one acre planted with trees.

Book Review

The North Carolina Atlas: Portrait for a New Century.

Douglas M. Orr. Jr. and Alfred W. Start, eds. Chapel Hill: The University of North Carolina Press, 2000. 461pp., photos, maps, tables, figs, index. $45.00 (ISBN 0-8078-2507-7).

Reviewed by Ron Mitchelson. East Carolina University

This volume is large in information on North Carolina. There are 275 maps, 52 color photographs, and 48 tables. This volume is even larger in analysis. Twenty-eight different authors penned nearly a quarter million words of supportive and interpretive text. All of this information and knowledge is organized into 20 coherent chapters edited by an experienced North Carolina atlas team that has produced high quality urban, state, and regional atlas products over the past 25 years. After a short introductory chapter, the natural environment provides one of the largest chapters followed by a chapter detailing the history of human occupation of this environment. Accounts of contemporary demographic patterns and processes followed by an evaluation of North Carolina's record of urbanization provide the next chapters. A general chapter dealing with the state's rapidly changing economy is then followed by individual chapters documenting primary economic activities, secondary economic activities, transportation and utilities, and service sector activities. A large chapter detailing the state's government and politics is followed by a sequence of issue oriented or topically specific chapters. These include air quality, water resources, crime, public education, higher education, health, culture, and recreation. The closing chapter provides an insightful synthesis of North Carolina's past and future prospects.

The North Carolina atlas team must be commended for developing a handsome volume that is wonderfully illustrated and well written. Despite the fragmentation into many chapters by numerous authors, the editors have done an outstanding job of integrating and standardizing so that the flow of information is smooth and continuous. The very substantial commitment to portray environmental and social issues that are faced by the state sets this atlas project apart from previous state atlases. Additionally, the volume and the depth of narrative analysis are quite remarkable for an atlas project. Many of the authors are not geographers and it is clear that this source largely explains the significant variation in graphic density that distinguishes some chapters from others. For instance the atlas, in its entirety, is 25 percent graphic and 75 percent text (as measured by page area). This general narrative density is actually quite high compared to most atlas products.

In some chapters it is the graphics that supports the narrative instead of the reverse. More than 175 pages of chapter content contain no graphic illustration. For geographers' perusal, this is unusual and at times disconcerting, but the frequency of these pages is far greater in chapters authored by non-geographers. For instance, the transportation and utilities chapter (by Wayne Walcott and David Hartgen) is the most graphically intense at 37 percent of page area while the large chapter that deals with government and politics (authored by a political scientist) is only 17 percent graphic in content. In such a case, expected graphics are indeed missing. The government and politics chapter has no maps of voting behaviors or changes in that behavior, e.g., voter registration, voter turnout, party affiliation, etc. Although the prose is excellent, most geographers will wish to see more of such topics in graphic form. One of the graphic categories most amiss is photographs, especially those that portray the North Carolina rural and urban landscapes. Twelve of the 20 chapters contain only one or two photos and there are only 48 in total. An important opportunity to illustrate the real world of North Carolina has been missed.

Although geographers might take issue with the sparseness of graphics in some chapters, they should be unanimous in their admiration of graphic quality. The maps and graphs are well done, and their immediate legibility, aesthetic quality, and varied symbolization lure the reader from page to page in search of more. Arguable exceptions include several choropleth maps that break with the cartographic convention of employing data standardization, although since North Carolina has similarly sized counties as enumeration units, this break with tradition is understandable. Although five-class choropleth, county level maps dominate the thematic cartography, atlas readers are treated to dot maps, graduated circle maps, flow maps, and isarithmic maps. Bar graphs, pie charts, and line graphs are all well designed, and the photographs are nicely composed and seem to be uniformly interesting. Omitted from the maps are the uses of three dimensional or other techniques to portray the physical regions, or the incorporation of remotely sensed imagery. As a result, exciting advances in cartographic visualization and data representation are not represented in the work. Overall, however, given the quality of their production, most readers will want to see more maps and graphs after finishing the first read.

The editors are quite aware of the unique quality of their current atlas project. In fact they have labeled their product as an "analytic atlas" to set it apart from other atlases that are more graphically and perhaps descriptively oriented. Another issue that the editors are aware of is the awkward timing of the volume's release. With the atlas publication date corresponding to the execution of the 2000 census, much of the raw data that sets the current North Carolina demographic and socioeconomic scene will be viewed as dated by the majority of readers. Of course, this cannot defeat the desire to provide historical context or longer-term trends, which are generally handled very well.

The editors must be applauded for the effort to portray issues and significant challenges facing North Carolina. Not only do readers become intimate with North Carolina's natural environment but they are also informed with substantial depth about air quality problems, problems of water supply and water quality, increasing exposure to natural hazards, and the deterioration of the coastal environs. Readers become intimate with North Carolina's economic landscape, but they are also informed with substantial depth about rural poverty and development issues, suburban sprawl, unemployment, accessibility issues associated with gender and ethnicity, central city decay, and the effects of globalization. Readers become intimate with North Carolina's social and cultural landscapes, but they are also informed of issues associated with access to health care, educational attainment, crime, and historic preservation.

There can be no doubt that the editors and the 26 other contributors have provided a great service to the citizens of North Carolina. This atlas is a wonderful addition to important references about the state. The volume belongs in many places. It belongs in Raleigh with every elected official and every bureaucrat. It belongs in every library in the state. It belongs in every classroom in the state as a resource for every teacher and many students. It also belongs with those people and those agencies that must cope with the many issues that face North Carolina. And, since you're reading this review, it belongs on your bookshelf and your friends' coffee tables.

The North Carolina Atlas: Portrait for a New Century, like many other state atlases that precede it, illustrates the important role that geographers can play in the life of a place. The capacities for meaningful graphic portrayal, and for integration and synthesis, are rare, and most non-geographers are impressed when they witness them. This atlas emerges as a valuable marketing tool for geography and geographic thinking. North Carolina geographers should pause to express gratitude to the editors and the contributors for a job well done. North Carolina geographers are all encouraged to share this volume with colleagues and acquaintances. The atlas provides an opportunity to elevate our discipline within the state.

Exploring the World, United States, and North Carolina using the Internet: Resources for Geographic Education

Mark Leipnik and Don Albert
Department of Geography and Geology
Sam Houston State University

The Internet is an impressive conduit for the exchange of information and ideas. Comparisons have been made between the Internet and the Silk Road, an earlier and much slower diffusion route(s) among far-flung cultures and regions. Just like on the Silk Road, there are bandits on the Internet. These bandits materialize as computer viruses, questionable data, erroneous "facts," spelling and grammatical errors, poor analysis, passwords, closed-down sites, and the like. Nevertheless, there is a plethora of appropriate Internet resources (maps, digital boundary files, graphics, photographs, encyclopedias, newspapers, lesson plans, educational games, software, quizzes, and more!) that can illustrate the National Geography Standards.

The American Geographical Society, Association of American Geographers, National Council for Geographic Education, and the National Geographic Society were instrumental in developing the National Geography Standards. The standards define the scope (what) and sequence (when) of a geography curriculum. The National Geography Standards were published in *Geography for Life* (Geography Education Standards Project, 1994) and have become integral to students and teachers of geographic education. The eighteen standards are organized under the following six essential elements: The World in Spatial Terms, Places and Regions, Physical Systems, Human Systems, Environment and Society, and The Uses of Geography.

The entitled list "Exploring the World, United States, and North Carolina using the Internet: Resources for Geographic Education," includes Web sites that are useful to illustrate the National Geography Standards. Students and instructors, however, must use judgment in the selection of such on-line information. Sites were selected for inclusion in this list on the basis of meeting, if possible, the following criteria: a) free public access; b) sites representing organizations from the United States or North Carolina; c) government or educational sites; d) commercial sites promoting geographic education; e) sites updated on a real-time, daily, annual or periodic basis; and if available, f) animated or interactive sites (Albert, 2000a; 2000b). Please visit www.ncge.org for a national-level hyper-linked slide presentation version of this educational resource (Albert, forthcoming).

References

Albert, D. (2000a), "Selecting Internet Sites to Supplement Course Materials," *Perspective*, 28(6):9-10.

_____. (2000b), "Learning Activity: Web Sites to Reinforce Geography Standards," *Perspective*, 28(6): 13-14.

_____. (forthcoming), "Internet Resources for Geographic Education" [hyper-linked slide presentation on www.ncge.org.]. Indiana, PA: National Council for Geographic Education.

Geography Education Standards Project. (1994), *Geography for Life: The National Geography Standards.* Washington, DC: National Geographic Society.

I. The World in Spatial Terms

Standard 1. How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective

http://www.odci.gov/cia/publications/factbook/index.html
The World Factbook 2000
Country Listing, Reference Maps, Notes and Definitions, Appendixes

http://www-atlas.usgs.gov/
United States Geological Survey, *National Atlas of the United States*
Atlas Maps, National Maps Online, Interactive Map Browser, Multimedia Maps, Map Layers Warehouse, Printed Maps

http://www.mapquest.com/
MAPQUEST
Maps,Driving Directions, Live Traffic Reports, Yellow & White Pages, Travel Guide, City Guide

http://metalab.unc.edu/uncpress/features/orr/more_ncatlas.html
The North Carolina Atlas: Portrait for a New Century by Douglas M. Orr Jr. and Alfred W. Stuart (Table of Contents and Chapter 1)

http://www.dot.state.nc.us/
North Carolina Department of Transportation
Transportation: Highway, Rail, Public, Aviation, Ferry, Bicycle, Pedestrian
Real-Time Traffic (I-40 cameras)
Transportation Improvement Plan (TIP)
State Travel Map

Standard 2. How to use mental maps to organize information about people, places, and environments in a spatial context

http://geography.miningco.com/science/geography/library/weekly/aa121597.htm
About.com – Matt Rosenberg
Mental Maps
Cognitive Site Mapping: Placing Yourself in Context
Geography Standard One Sample Activities
Mental Mapping from the National Geographic Society
World Mental Maps

Standard 3. How to analyze the spatial organization of people, places, and environments on earth's surface

http://www.ncgia.ucsb.edu/
National Center for Geographic Information & Analysis
GIS

http://www.esri.com/
Environmental Systems Research Institute, Inc.
ESRI Library
Introduction to GIS
GIS Glossary

http://www.intergraph.com/
INTERGRAPH
Education
Intergraph Program for Schools
Introduction to GIS for Schools (FREE CD)

http://www.cgia.state.nc.us/
Geographic Information North Carolina
MAPNET
Geographic Data Clearinghouse
Center for Geographic Information and Analysis
Geographic Information Coordinating Council

II. Places and Regions

Standard 4. The physical and human characteristics of places

http://www.state.gov/www/background_notes/
Background Notes, U.S. State Department
Geographic Regions
Africa, Middle East and North Africa, East Asia and the Pacific, South Asia, Europe

http://www.topozone.com/
TopoZone
Interactive Topographic Maps (US)

http://terraserver.microsoft.com/
TerraSever (Air Photographs)
View Images, Application, TerraServer Imagery, Education, Tools

Standard 5. That people create regions to interpret earth's complexity

http://www.whitehouse.gov/OMB/inforeg/msa-bull99-04.html
OMB Bulletin No. 99-04: Revised Statistical Definitions of Metropolitan Areas (MAs) and Guidance on Uses of MA Definitions (June 30, 1999)

http://www.tjcog.dst.nc.us/nccogs.htm
North Carolina Councils of Government

Standard 6. How culture and experience influence people's perceptions of places and regions

http://www.unctv.org/onlinestore/places.html
UNC-TV Online Store
North Carolina Is My Home by Charles Kuralt and Loonis McGlohon (book and video)
Pinehurst (video narrated by Charles Kuralt)
To Be a North Carolinian *(video)*

III. Physical Systems

Standard 7. The physical processes that shape the patterns of earth's surface

http://www.usgs.gov/
United States Geological Survey
USGS Information by State (North Carolina), Earthquakes, Floods, Maps, Volcanoes, More Topics!!!!

http://www.geology.enr.state.nc.us/
North Carolina Geological Survey

http://www.nws.noaa.gov/
National Weather Service, National Oceanic and Atmospheric Administration

http://www.usatoday.com/weather/wfront.htm
USA Today Weather

http://www.usatoday.com/weather/basemaps/states/wfnc.htm
USA Today Weather – North Carolina

http://www.nc-climate.ncsu.edu/sco/welcome.html
State Climate Office of North Carolina

Standard 8. The characteristics and spatial distribution of ecosystems on earth's surface

http://www.worldwildlife.org/
World Wildlife Fund
Kids
Educators

http://www.nps.gov/parks.html
National Park Service

IV. Human Systems

Standard 9. The characteristics, distribution, and migration of human populations on earth's surface

http://www.prb.org/
Population Reference Bureau

http://www.census.gov/
United States Bureau of the Census

http://www.ospl.state.nc.us/
Office of State Planning
Strategic Planning & Analysis, State Data Center, State Demographics, Center for Geographic Information & Analysis, Community Resource Information System, Geodetic Survey

http://www.cdc.gov/nchs/products/pubs/pubd/other/atlas/atlas.htm
Atlas of United States Mortality

http://www.schs.state.nc.us/SCHS/
North Carolina Center for Health Statistics
Birth Certificates, Health Statistics, Publications, Related Links

http://www.chsrd.med.ecu.edu/atlas-2000-updates/ppframe.htm
Atlas 2000 Updates, Eastern North Carolina Health Care Atlas (Slide Presentation)

Standard 10. The characteristics, distribution, and complexity of earth's cultural mosaics

http://www.odci.gov/cia/publications/factbook/in.html
The World Factbook 2000
Geography, People, Government, Economy, and more!!!

http://people.morehead-st.edu/fs/t.pitts/mainmenu.htm
The Geography of Religion Website Menu
Basics, Buddhism, Confucianism, Hinduism, Jainism, Islam, Judaism, Orthodox Christianity, Protestantism, Catholicism, Rastafarianism, Shintoism, Sikhism, Taoism, Other Religions

Standard 11. The patterns and networks of economic interdependence on earth's surface

http://www.mac.doc.gov/nafta/nafta2.htm
The NAFTA Home Page

http://www.eurunion.org/
The European Union

http://www.census.gov/epcd/www/econ97.html
Economic Census 1997
National Figures
Industry, Subject, and Geographic Areas Series

http://www.commerce.state.nc.us/
North Carolina Department of Commerce
Business, Vacation, Entertainment Industries, Communities

http://www.usda.gov/nass/
United States Department of Agriculture, National Agriculture Statistics Service
Publications, Graphics, Historical Data, Search, State Information, Census of Agriculture

http://www.agr.state.nc.us/
North Carolina Department of Agriculture and Consumer Services

http://www.ces.ncsu.edu/
NC Cooperative Extension

Standard 12. The processes, patterns, and functions of human settlement

http://geography.about.com/education/geography/msub9.htm
About.com – Geography
Cities and Urban Geography
Edge Cities
Largest Cities
The Law of the Primate City and Rank-Size Rule
Levittown
Megalopolis
Metropolitan Areas Population Estimates
Sprawl
Urban Planning and the New Urbanism
The Von Thunen Models
And More!!!

Standard 13. How the forces of cooperation and conflict among people influence the division and control of earth's surface

http://www.odci.gov/cia/publications/factbook/index.html
The World Factbook 2000 – Appendixes
Abbreviations
United Nations System
International Organizations,
Selected International Environmental Agreements

http://www.nato.int/home.htm
North Atlantic Treaty Organization

V. Environment and Society

Standard 14. How human actions modify the physical environment

http://edcwww.cr.usgs.gov/earthshots/slow/tableofcontents
USGS, Earthshots: Satellite Images of Environmental Change (remote sensing images and supporting articles)

Standard 15. How physical systems affect human systems

http://www.fema.gov/maps/
Federal Emergency Management Agency
- Disaster Mapping and Analysis Center
- Interactive Hazard Mapping
- Flood Hazard Mapping
- Library Map Room

Standard 16. The changes that occur in the meaning, use, distribution, and importance of resources

http://www.eia.doe.gov/kids/
Energy Information Administration
- Welcome to the EIA Kid's Page
  - Energy Sources
    - Natural Gas, Coal, Electricity, Oil, Nuclear, Geothermal, Wind, Water, Biomass, Solar
  - Energy Users

http://www.energy.state.nc.us/
North Carolina Energy Division, Department of Commerce
- Business Recruitment, NC Visitors, Exporting, Recreation Industry, Employment & Training, Department Organization, Government Technology, Community Assistance, Economic Data

http://www.enr.state.nc.us/
North Carolina Department of Environment & Natural Resources

VI. The Uses of Geography

Standard 17. How to apply geography to interpret the past

http://memory.loc.gov/ammem/gmdhtml/gmdhome.html
American Memory – Library of Congress
- Map Collections: 1544-1999

Cities and Towns
Conservation and Environment
Discovery and Exploration
Immigration and Settlement
Military Battles and Campaigns
Transportation and Communication
General Maps

http://www.lib.unc.edu/maps/collection.html
UNC-Chapel Hill Libraries, Wilson Library – Maps Collection

Standard 18. How to apply geography to interpret the present and plan for the future

http://www.aag.org/
Association of American Geographers
Careers in Geography
Specialty Groups

http://agsg.freac.fsu.edu/
Applied Geography Specialty Group

Other Internet Sites of Geographic Interest

http://www.state.nc.us/
The Official Web Site of North Carolina

http://www.colorado.edu/geography/virtdept/contents.html
The Virtual Geography Department

http://www.ed.gov/pubs/parents/Geography/index.html
U.S. Department of Education, Office of Research and Improvement, *Helping Your Child Learn Geography*

http://www.ncge.org/tutorial/introduction.html
National Council for Geographic Education, *Geography for Life Tutorial*

http://geography.state.gov/htmls/statehome.html
Department of State, Geographic Learning Site
Where Do U.S. Diplomats Work?
Traveling with the Secretary
World Geographic News
Challenging World

http://www.fedstats.gov/kids.htm;
Federal Government Kids Pages

http://mapping.usgs.gov/www/html/1educate.html
United States Geological Survey, Educational Resources for Cartography, Geography, and Related Disciplines

http://magma.nationalgeographic.com/education/index.cfm
National Geographic Society
- Online Adventures
- Maps & Geography
- Lesson Plans
- Teacher Community

http://www.nytimes.com/learning/
The New York Times On THE WEB
- Learning Network, Grades 3-12
  - Student Connections
  - Teacher Connections
  - Parent Connections

http://geography.about.com/education/geography/mbody.htm
About.com – Matt Rosenberg
- Cartography, Census Population, Cities and Urban Geography, Climate and Weather, Coordinates, Countries, Cultural Geography, Disaster/Hazard, Finding Places, Games, Geographic Education, GPS and GIS, Historic Maps, Large Cities, Maps, Outline Maps, Photos, Physical Geography, Rivers and Streams, Streets and Road Maps, Time and Time Zones, Topographic Maps, U.S. Map, U.S. Population, World Map, World Population, Zip Codes

http://www.mercatormag.com/
Mercator's World Wide Web
"The Magazine of Maps, Exploration and Discovery"

http://school.discovery.com/
Discovery Channel School

http://www.geo.appstate.edu/ncga/home.html
North Carolina Geographic Alliance
- Newsletter
- Teaching Resources
- Lesson Plans
- Upcoming Events

EAST CAROLINA UNIVERSITY

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 cartogrphy 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.: (252) 328-6230. World Wide Web: http:/www.ecu.edu/geog
Graduate Catalog: Graduate School, East Carolina University, Greenville, North Carolina 27858-4353. Tel.: (252) 328-6230. Fax: (252) 328-6054.

APPALACHIAN STATE UNIVERSITY
Department of Geography and Planning
www.geo.appstate.edu

Degrees Offered: B.A. in Geography, B.S. in Geography (teaching or concentrations in general geography or geographic information systems), B.S. in Community and Regional Planning, M.A. in Geography with liberal arts option (thesis or applied).

Facilities: The Department maintains four computer laboratories for work in computer cartography, GIS, and image processing. These labs have both PC and SUN workstations which are networked to each other and to the campus mainframe cluster. Software includes ERDAS, ARC/INFO, ArcView, SPSS, Surfer, Atlas GIS, SAS, CorelDraw and Aldus Freehand.

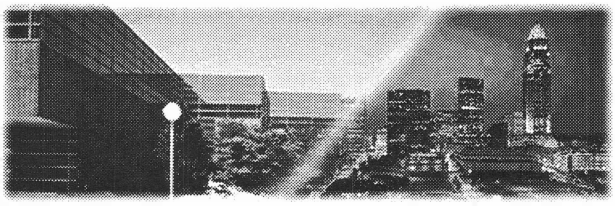
Graduate Program: The Masters program in geography is designed to provide students with a relatively broad range of academic and professional options, preparing them for Ph.D. work in geography and planning, professional applications in GIS, or opportunities in teaching at all educational levels. Accordingly, 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.

For a catalog and further information, please contact:
Undergraduate Geography: Dr. Roger Winsor {winsorra@appstate.edu}
Undergraduate Planning: Dr. Garry Cooper {coopergv@appstate.edu}
Graduate Program: Dr. Mike Mayfield {mayfldmw@appstate.edu}

Department of Geography and Planning
Appalachian State University
Boone, NC 28608
Phone (828) 262-3000
Fax (828) 262-3067

THE UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

Master of Arts in Geography



The MA in Geography at UNC Charlotte emphasizes the application of skills, methods, and theory to problem solving in contemporary society. Students are offered a solid foundation in research methods, problem formulation, quantitative methods and computer and GIS skills. Many UNCC graduates have gone directly into jobs working as professional geographers using skills acquired in their MA program. Jobs include research and/or marketing specialists, location analysts, planners, transportation specialists and private consultants. About 15% of the more than 100 graduates have gone on to study in Ph.D. programs.

CHARACTERISTICS

- About 55-60 students and 23 faculty are in residence
- Class sizes are small; student and faculty are in close contact; community involved in class projects
- Funding is available on a competitive basis; about half of all full-time, current students have funding
- Excellent Spatial Analysis Laboratory with ARC/INFO GIS (workstation and PC) and ERDAS (workstation)
- The Department manages the Center for Transportation Studies which contains a research laboratory

PROGRAM CONCENTRATIONS

Community Planning Track

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

Environmental Analysis and Assessment

The environmental concentration draws upon the expertise of practitioners and professionals and a diverse earth science and geography faculty. There are three main courses of study: hydrologic processes; atmospheric studies; and an interdisciplinary focus which includes environmental assessment and planning.

Urban-Regional Analysis and Planning

Students in the urban-regional analysis and planning concentration normally become planners in public sector planning agencies. Course work concentration is in one of the following areas:

Planning Theory	Public Facility Siting	Regional Development
Urban Theory	Environmental Planning	Site Feasibility Analysis
Urban Planning	Impact Analysis	

Location Analysis

The Location Analysis concentration prepares students for jobs in location research with retail companies, real estate developers, consulting firms, commercial banks, and economic development agencies or for continued academic training in economic geography and location analysis. Course work is offered in:

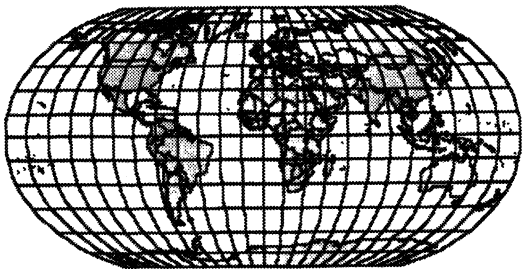
Retail Location	Trade Area Analysis	Facility Siting
Office and Industrial Location	Real Estate Development	Applied Population Analysis

Transportation Studies

Students in Transportation studies can pursue course work in transportation systems analysis, policy formulation, impact analysis, and planning. This concentration prepares students for jobs in the public sector as planners and in the private sector as analysts for transportation providers and private consulting firms.

THE INTERNSHIP As a program which emphasizes applied geography, the Internship is an especially important element and normally replaces the traditional thesis as the capstone project of a graduate program. Projects normally involve the students in the execution of a substative research task for private or public sector clients where the student is the primary investigator in a specific "real world" research task.

FOR FURTHER INFORMATION CONTACT: Dr. Gerald L. Ingalis, Graduate Coordinator
Department of Geography and Earth Sciences, UNCC, Charlotte, NC 28223 (704-547-4260)



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; 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 form 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 AT GREENSBORO



UNDERGRADUATE PROGRAM: The geography major can choose a concentration in Urban Planning or Earth Science/Environmental Studies. Currently, there are about 80 majors.

MASTERS IN APPLIED GEOGRAPHY: The program requires 30 hours in geography, including a thesis or internship, plus two courses in statistics or computer science. The program has nearly 30 students and offers several graduate assistantships.

FACILITIES: The Geograhy Department houses a state-of-the-art research and teaching lab for GIS, computer cartography, digital image processing, and air photo interpretation. There are 20 networked pentium pro machines on an NT operating system, plus several printers, scanners and digitizing boards, as well as GPS equipment. Software used in the lab includes Arc/Info, ArcView, ERDAS, Surfer, Atlas GIS, MapInfo, ERMapper, Adobe Illustrator, Adobe Photoshop and Corel Draw. There is also a climatology and SPSS computer lab, faculty/grad student research lab, geomorphology/geology lab, and a 100+ acre field camp to study geomorphology, meteorology, bio-geography, and GPS mapping.

SPECIAL ACTIVITIES: Students can become involved in the department, University, and community while becoming better aquainted with other students, faculty, employers and community leaders. The department hosts lectures bi-monthly at Geography Club meetings and sponcers several campus-wide events. Students can join the campus chapter of Gamma Thetsa Upsilon, the international geography honor society, and participate on UNCG's Geography Bowl Team in state competition. Many students take the summer field course to the West.

For Undergraduate Information:
Call: 336-334-3911
E-mail: KGDebbag@UNCG.EDU

For Graduate Information:
Call: 336-334-3895 or 3918
E-mail Hidore@UNCG.EDU or JCPatton@UNCG.EDU

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.

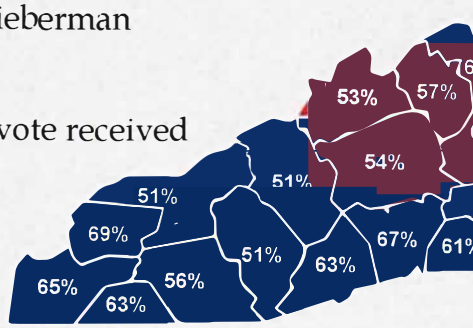
- Send one original and two copies of manuscripts. Only original, unpublished material will be accepted
- All manuscripts should be on 8 $^1/_2$" x 11" paper. Type on only one side of the page. Type should be 10 or 12 point font and double spaced. One inch margins should be used on all sides.
- References 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:
The North Carolina Geographer
Department of Geography
East Carolina University
Greenville, North Carolina 27858-4353
Telephone: (252) 328-6087 *or* (252) 328-6624
Fax: (252) 328-6054
E-mail: popkee@mail.ecu.edu *or* peasep@mail.ecu.edu

Counties won by Bush/Cheney

Counties won by Gore/Lieberman

56% Percentage of the county vote received by the winning candidate

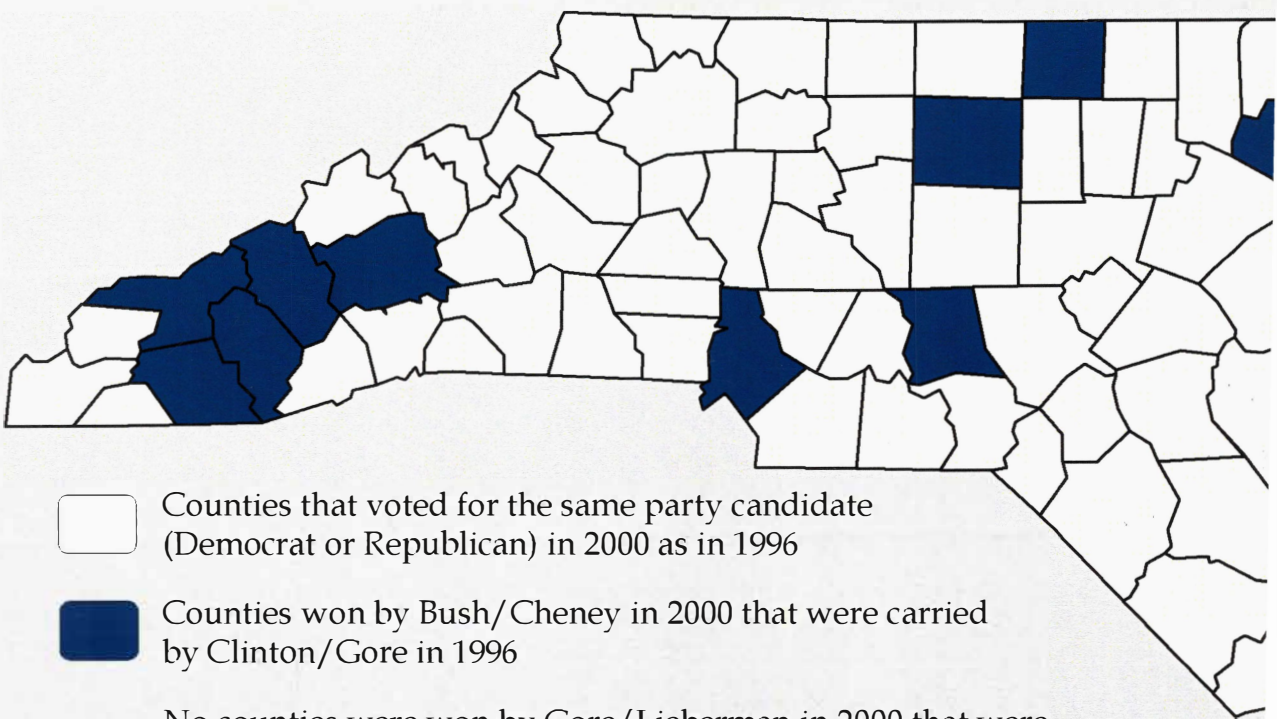


How North Carolina Voted

North Carolina Popular Vote of the 2000 Presidential Election

Bush / Cheney 56% **Gore / Lieberman 43%**

Data compiled from the NC State Board of Elections Web Page



Counties that voted for the same party candidate (Democrat or Republican) in 2000 as in 1996

Counties won by Bush/Cheney in 2000 that were carried by Clinton/Gore in 1996

No counties were won by Gore/Lieberman in 2000 that were carried by Dole/Kemp in 1996