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CONTENTS

Editorial Comment *ii*
Ole Gade

Articles

North Carolina: Natural Nidus for
Rocky Mountain Spotted Fever 1
Eugene J. Palka and Thomas W. Crawford

Merging Storm Water Management With Stream Habilitation:
Greensboro's Lake Daniel Pilot Project 17
Michael J. Lewis, John R. Jezorek and Parke Rublee

Physician Office Locations and Land Use Planning:
Asheville, North Carolina, 1948-1993 31
Donald P. Albert

Strange Worlds and Familiar Places: The National Geographic
Standards and Rethinking Geographic Education 47
Tyrel G. Moore and Donald L. Mitchell

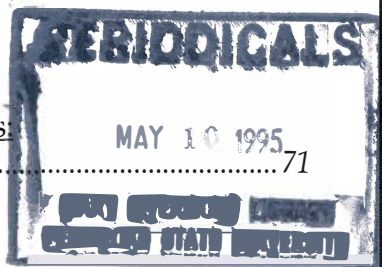
Reports

Recording Development and Change at the Shore 57
Simon Baker

About the Cover: Map Making Goes Digital 69
Art Rex

Book Review

Thomas E. Ross, One Land, Three Peoples:
A Geography of Robeson County 71
Reviewed by Frank Ainsley



EDITORIAL COMMENT

Ole Gade

A number of factors have combined to hinder the timely arrival of this the third volume of *The North Carolina Geographer*. We hope that these problems are now behind us and that future issues will arrive as anticipated. At this point, however, we are reminded that no issue has arrived during the summer promised. Accordingly, we will designate future issues with a fall publication date. Thus readers should expect volume four to arrive in November of this year.

On this note we would like to welcome the large number of North Carolina regional and educational institution libraries that recently have become subscribers to the *The North Carolina Geographer*, the annual journal of the North Carolina Geographical Society. As indicated by the content of this issue we publish geographic research articles, reports, and book reviews of interest to the general public of our state. The emphasis is emphatically on the current North Carolina scene as viewed by geographers with their fascination for regional, people-environment, and place location issues. As is well demonstrated by articles presented here geographers are especially interested in recording the dynamics of change as is evidenced by the use of our land, environmental problems, and shifts in our social, political, and economic activities. From these concerns emerge the needs of our people and our environments, whether measured locally, regionally, statewide, or globally. Our authors seek to identify these needs and frequently will point to possible ways of meeting them.

So, for example, you will see in our lead article the results of research by Gene Palka and Tom Crawford of the University of North Carolina at Chapel Hill on the incidence of Rocky Mountain Spotted Fever. How many North Carolinians realize that this, one of the most severe of infectious diseases, is a fairly recent entrant to the local scene? And it has so dramatically impacted our state that its populace is currently the worst afflicted in the nation! Explore with Palka and Crawford the options available to North Carolinians in the face of this plague.

Also from UNC-Chapel Hill is Don Albert, who looks at the dynamics of land use changes as these influence the location of physician offices. Albert chose to use Asheville over the past four decades as his case study. But the reality of these kinds of land use changes are near universal. MD's have been fleeing the central city, as have many other professional and personal services, with the result of a marked decrease in the availability of medical care to the indigent population. And while the zoning land use tool has been important in defining appropriate medical function land uses, these, in their newfound locations, have not benefitted the central city resident.

Mike Lewis, a geographer, John Jezorek, a chemist, and Parke Rublee, a biologist, have applied their multifaceted research expertise to the problems of constructing in watersheds, which may result in negatively affecting urban water quality and the incidence of local floods. They study here the Lake Daniel Project in Greensboro. Here they found that a local citizen group, with support of the local chapter of the National Audubon Society and representatives of the Greensboro Parks and Recreation Department, was able to institute a series of beneficial environmental changes for the watershed. And this was accomplished without incurring the otherwise frequent adversarial/litigious prone conditions engendered among city officials, developers, and environmental groups when their diverse interests spark into conflict over storm water management approaches.

With Tink Moore and Don Mitchell of the University of North Carolina at Charlotte we return to a theme that we as geographers seem to persist in addressing: How to teach the fundamentals of a complex discipline to a novice public, especially school children. Goaded on by persistent evidence of geographic illiteracy, we have devised various and sundry means to more effectively communicate the themes and relevance of our discipline. Moore and Mitchell address this issue through an example provided by Mitchell, a teacher in the Newton Conover Middle School, and find that the complexities of geography are best learned by beginning with a focus on places and activities of relevance to those to be taught. In this case the gym of the 'Red Devils' provides the place in question, and the basketball games, though more importantly, the great variety of other community activities, exemplify the themes of geography.

In our reports for this issue we include our traditional discussion of the multi-colored journal cover. In this case we are exemplifying some of the wall map products created at Appalachian State University's Department of Geography and Planning. Art Rex, of this department, looks at the evolution of the cartographer's art to its present geographic information systems' status. A more detailed account of geographers' interest in recording the changing conditions of land use on the earth's surface is provided by Simon Baker of East Carolina University. Baker, a long time pilot, demonstrates the application of aerial photography to changing conditions along the North Carolina coast. His primary objective here is to provide information on the basics in this type of aerial survey, and to show that this is not a task difficult to perform, nor is it particularly costly even when you will have to rent the plane and hire the pilot. He recommends that this technique be applied more frequently by those who have a serious interest in the shifting fortunes of our shorelines. But, of course, the basics are applicable to any part of our state. Anywhere and everywhere this is an excellent technique for getting 'on top' of land use change issues.

We are very pleased to have inaugurated with this issue, a book review section. Here we are evaluating Pembroke State University geographer Thomas Ross'

book on Robeson County's geography. As noted by the reviewer, Frank Ainsley of the University of North Carolina at Wilmington, this book provides an excellent example of what is needed for each of North Carolina's 100 counties. Well, county histories are quite popular. In fact, a goodly number of counties have more than one published history. It is time for more local level geography, a better way of getting at the intersect of people and environment as these relationships have evolved over time, and at a scale familiar to all of us.

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In this issue you will see a number of editorial and design changes, perhaps most notably the addition of the book review section. We will henceforth include reviews of recently published books that clearly focus on North Carolina's varied geography. For interested authors/publishers the procedure to follow is simply, contact the editor of the journal for preliminary approval and further information on the process to follow. As novices in the fine art of navigating the cutting edge of desk publishing technology we are still learning. Thus you will see a few new style wrinkles, designed to make the reading of the journal more enticing. With the support of Pat Pilchard and her crew, Beth Jacquot and Kerri Cox, of Appalachian State University's Media Center, we are now pleased that professionals are doing the Aldus TMPageMaker layout. And thanks go, as well, to Paul Maney for proofreading, to the faculty and chair of Appalachian State University's Department of Geography and Planning for unstinting encouragement and support, and the support generously provided in the form of advertisement fees by various geography departments in the state. For the general reader their ads provide additional information on the status and activities of geography departments in the state of North Carolina. Please look for them on the last pages of this issue.

Please be reminded that a subscription to *The North Carolina Geographer* is a mere \$10.00 (including postage and handling), per year and volume. Individual subscribers automatically become members of the North Carolina Geographical Society, and will receive its newsletter and annual meeting information, in addition to getting the journal. Feel free to contact the Editor on any concern relating to *The North Carolina Geographer*.



THE UNIVERSITY OF NORTH CAROLINA
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Is proud and pleased to support the continued publication of
The North Carolina Geographer

NORTH CAROLINA: NATURAL NIDUS FOR ROCKY MOUNTAIN SPOTTED FEVER

Eugene J. Palka and Thomas W. Crawford

Introduction

Eugene J. Palka and Thomas W. Crawford are doctoral candidates at University of North Carolina at Chapel Hill

Most people would correctly guess that Rocky Mountain Spotted Fever (RMSF) originated somewhere in the Rocky Mountain Region of the American West. Even geographers, however, might be surprised to learn that the disease has long been insignificant in its region of origin, yet, is increasingly prevalent in the Southeast, particularly in North Carolina.

It is ironic that this spatially-concentrated, regionally-relevant, innately-geographic problem has received so little attention from geographers beyond Pyle's (1979) account. In a relatively recent study, Newhouse et al. (1986) analyzed the social and environmental factors affecting the occurrence of RMSF in Georgia from 1961-75. Among the ten variables selected to predict the occurrence of RMSF, the authors

note that "the most important variables were those of climate and geography" (Newhouse et al., 1986). They also note that "of secondary, but still major importance, were those variables associated with humans and their environmental alterations" (Newhouse et al., 1986). Their well informed and conclusive study is typical of the literature on RMSF, which is dominated by contributions from medical and public health officials, whose findings often rely on a superficial understanding of the geographic variables involved. Moreover, cutting-edge spatial analytical techniques are rarely employed.

This paper examines RMSF from a geographic perspective. Following a brief history, we explain the cultural ecology of the disease, describe its prevalence in North Carolina, and identify potential points for intervention. We conclude by calling for greater efforts by geographers to better understand and even predict the occurrence of this spatially-concentrated and regionally-relevant problem.

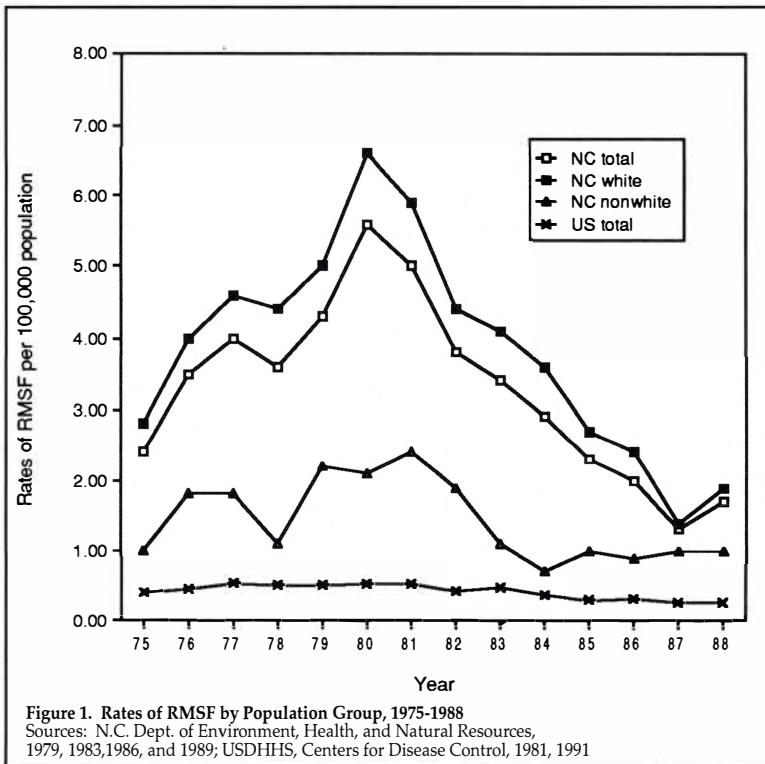
Historical Background

RMSF was first described in eastern Idaho during the late 19th century (Raoult and Walker, 1990), although the disease probably existed among Indians in the valleys of the Rocky Mountains long before the arrival of white settlers (Stuart-Harris, 1967). The first published report of the malady was made in 1896 by Major Marshall Wood, a US Army physician stationed in Boise, Idaho (Harden, 1990).

Most people might me surprised to learn that Rocky Mountain Spotted Fever is increasingly prevalent in North Carolina

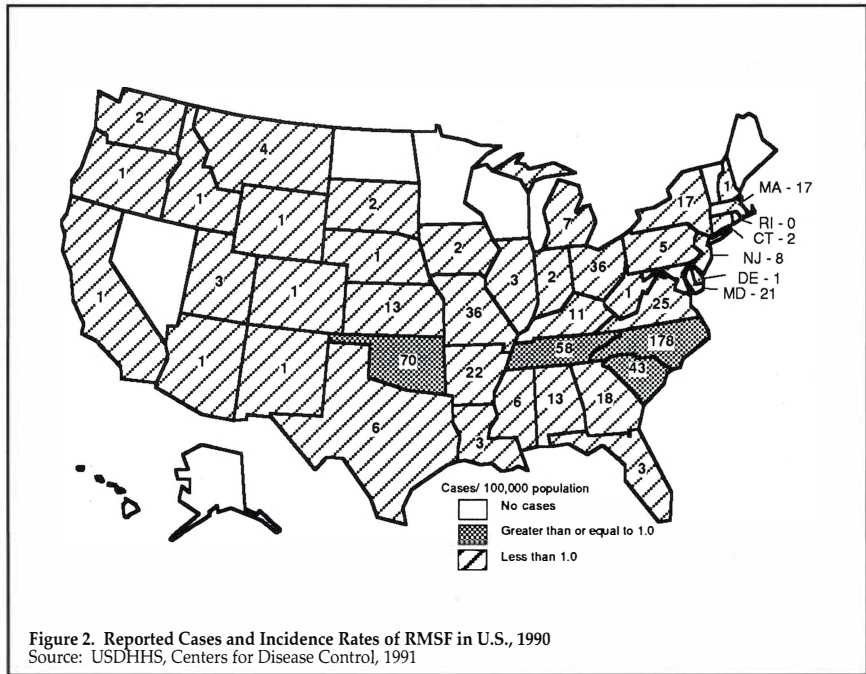
Incidence throughout the Bitterroot Valley of western Montana prompted subsequent research before the turn of the century. By 1906, Dr. Howard Ricketts established the infectious nature of the illness and demonstrated the role of ticks as vectors in western Montana (Raoult and Walker, 1990). Shortly thereafter, his associates identified the specific disease-causing agent.

Prior to the 1920s, RMSF was virtually unknown outside of the Rocky Mountain States. The first case east of the Mississippi River was reported in Indiana in 1925 (Horsfall, 1949), and by the 1930s, the disease had become well established in the East, accounting for almost half of the reported cases (Riley, 1977). By the mid 1970s, the disease had become prevalent in the East, Southeast, and South Central US, accounting for almost 97 percent of all reported cases (Riley, 1977). This trend continued through the mid 1980s, with highest incidence rates consistently occurring in North Carolina (Figure 1).



Although the causative organism, its vector, and route of transmission have been known for more than 85 years, RMSF remains the most prevalent rickettsial disease in the US, and one of the country's most severe of all infectious diseases (Weber and Walker, 1991). Currently, the disease is most prevalent in a core region

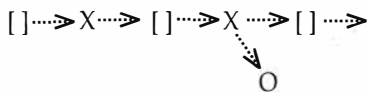
extending from the Piedmont of the Southeast, westward through the Mid-South and into Oklahoma (Figure 2). Based on reported figures, North Carolina far exceeds any other state in the number of cases annually.



A Cultural Ecology of Rocky Mountain Spotted Fever

RMSF is caused by one of a group of organisms known as rickettsiae. These microorganisms are structurally related to bacteria, but in other characteristics they resemble viruses. The specific agent of RMSF is *Rickettsia rickettsii* (named in honor of Dr. Ricketts) and is transmitted by the bite of an infective tick. Unlike most arthropod-borne pathogens, the causative organism can be passed directly from one generation of ticks to the next (Riley, 1977). RMSF is a vectored "zoonosis" (i.e., a disease which primarily infects animals), and is communicable between vertebrate animals and humans, and between various species of animals.

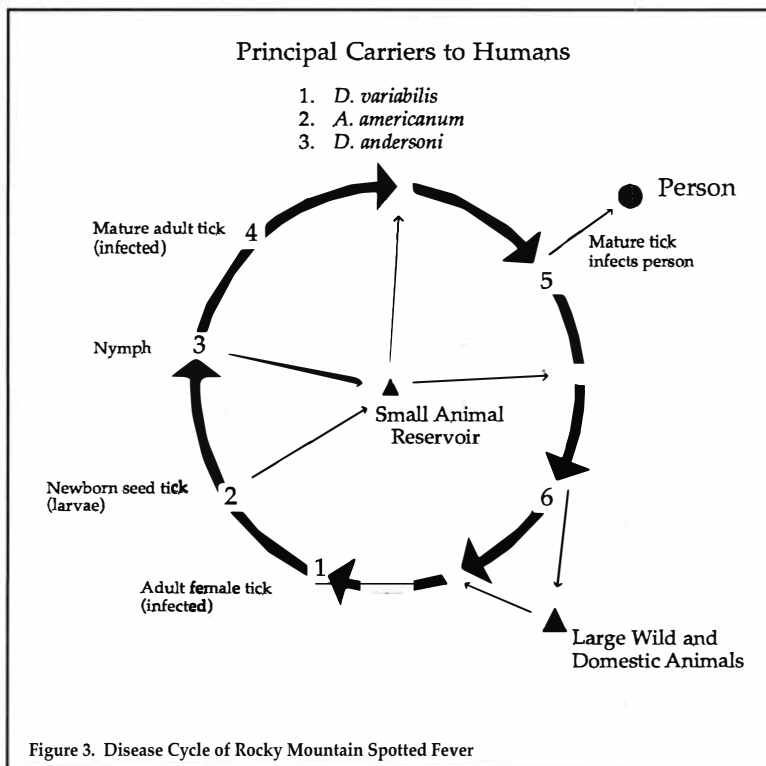
The chain of disease transmission for RMSF is simplified as follows:



where: [] = animal host
 X = vector
 O = human
 $\cdots \rightarrow$ = cycle of transmission

The animal host ranges from a variety of rodents to dogs and large hoofed mammals. Among the more common rodent hosts are the meadow and pine vole, chipmunk, white-footed mouse, cotton rat, cottontail rabbit, opossum, and snowshoe hare (Burgdorfer, 1980). The vector is the hard shell (ixodid) tick, which also serves as the main reservoir (Raoult and Walker, 1990). People serve as "dead end" hosts in the transmission chain, in that they cannot transmit the agent to a vector for transmission to another host (Meade et al., 1988).

A more detailed portrayal of the disease cycle is provided by Figure 3. A complete cycle is approximately two years, based on the lifespan of the tick. One can begin to analyze the cycle at the point where an infected, female adult tick has completed her third of three "blood meals" from a large wild or domestic animal, such as a horse, cow, deer, goat, or dog. The tick then falls to the ground and lays up to 10,000 eggs (many of which are transovarially infected) and subsequently dies. Within about 36 days the eggs hatch into larvae. These "seed ticks" subsequently cling to vegetation during their quest for small rodent hosts, in order to consume the first of three blood meals during their lives. After feeding for approximately one week, each larva falls back to the ground and enters the nymph phase. After finding another small animal host, each nymph consumes the



second of its blood meals, after which it falls to the ground and develops into an adult tick. At this point in time, the infected ticks are capable of transmitting the infectious agent of RMSF to a human host.

The infection cycle in humans commences when *R. rickettsia* is inoculated into the skin from the saliva of a feeding tick, a process which can only occur after several hours of feeding (Weber and Walker, 1991). After being bitten by the infected tick, an incubation period ensues for a period of 3-10 days. During this time, the rickettsiae produce an inflammation of the inner linings of the blood vessels (USDHHS, 1985). The inflammation eventually becomes visible in the form of a rash, comprised of many red spots under the skin and often concentrated around the wrists and ankles (although it later spreads to the trunk and limbs). The rash often appears on the palms of the hands and the soles of the feet, a symptom that is unique to RMSF and consequently provides a definitive diagnostic sign (Harden, 1990). Unfortunately, many people never become "clinical" (i.e., they never develop symptoms).

It normally takes six hours of feeding before R. rickettsia is inoculated into the skin through the saliva of the feeding tick

The rash may be preceded by several days of chills, high fever, headache, and bone pain (USDHHS, 1985). Other symptoms may include spinal and muscle stiffness, nausea, loss of appetite, and vomiting. Fever may range from 104° to 107° F, and if left untreated, may persist for several weeks, adversely affecting the central nervous system and resulting in delirium, convulsions or coma by the end of the first week (Blank and Rake, 1955). Critical circulatory and pulmonary complications can occur by the end of the second week (USDHHS, 1985). From the portal of entry in the skin, rickettsiae spread via lymphatics and the bloodstream to all body organs, including the heart, liver, kidneys, lungs, pancreas, gastrointestinal tract and the brain (Weber and Walker, 1991).

In worst-case scenarios, death can result from toxemia, vasomotor weakness, shock, renal failure, or respiratory or cardiac arrest (McDonald et al, 1987). In the US, case mortality has significantly declined, in part due to increased public awareness and early recognition of symptoms, but also because of the introduction of antibiotic treatments in the early 1950s. Whereas mortality resulted from 73 percent of the cases between 1895-1902 (Harden, 1990), by 1983 the case fatality rate of people who received antibiotic treatment had been reduced to 4 percent (McDonald et al., 1987).

As one might expect, neither incidence nor case fatality rates are uniform across the US population. Rates vary by age, sex, and race. Generally, the highest incidence of disease occurs in persons younger than 20 years of age (primarily 5-9 year olds), with the largest occurrence among white males (USDHHS, 1981; CDC, 1991). Mortality rates are highest among persons age 40 and older, particularly among

black males (USDHHS, 1981; CDC, 1991). The former trend may be related to increased suburbanization and exposure to ticks within wooded recreational areas, and/or a close association with exposed household pets, specifically dogs (Pyle, 1979; Newhouse et al., 1986). We hypothesize that the latter trend may be attributed to the difficulty in detecting a rash during the early stages of the disease, and/or more limited access to health care. It must be emphasized, however, that the data upon which the above generalizations are based are far from being complete. Since the majority of people infected never develop symptoms, the above statistics are based only on clinical reports.

Inadequate reporting may contribute to the uneven rate of incidence among white and non-white populations. Data for North Carolina from 1975 to 1988 reveal the persistent pattern of higher incidence rates among the state's white population (review Figure 1). The researchers hypothesize that 1) the "activity space" of white residents is more apt to intrude into the "natural nidus" (i.e., the microscale region comprised of a living community among whose members a disease agent continually circulates, and the habitat required to maintain the disease (Meade et al, 1988)) of RMSF, and 2) more limited access to health care may result in under-reporting the incidence among non-whites. Closer examinations of recreational and leisure location preferences, residential location, and access to health care for whites versus non-whites could yield greater insight into the causes of these trends.

Biocenose

RMSF exists in nature, independent of human activity. The disease agent occupies a specific environment (referred to as its "biocenose") that enables it to co-exist with its vector (which in the case of RMSF, also forms the reservoir) and hosts. Since the three factors of agent, vector and host coincide independent of human activity, "silent zones" (conceptualized by May (1958) as places where the disease thrives, yet it remains undetected because people are not present) occur throughout the hemisphere, making it historically difficult to precisely distinguish between the potential and actual nidus of the disease.

The causative organism of RMSF is only found in the western hemisphere, and prevails throughout North, South, and Central America (Harden, 1990). The disease is transmitted by a variety of different ticks that flourish in specific ecological niches throughout the hemisphere.

In the US, the two primary vectors are the wood tick (*Dermacentor andersoni*) in the Rocky Mountain and western states, and the dog tick (*Dermacentor variabilis*) in the eastern and southern states. The wood tick is the "original" vector identified by Ricketts in 1906 and continues to be found on many species of animals throughout the Rockies. Of much greater concern, however, is the dog tick, so named because it primarily infests dogs and other domestic animals. More importantly, the

dog tick is the principal vector in the Piedmont region of the Southeast, which has accounted for a disproportionate number of cases of RMSF over the past fifty years.

Data from multiple sources show that the "tick season" runs from early spring through summer (USDHHS, 1979; USDHHS, 1984; USDHHS, 1987; Raoult and Walker, 1990; Riley 1977). Despite the significant decline in the number of reported cases between 1980 and 1990, the pattern of monthly onset remains virtually unchanged (Figure 4). This seasonality of the incidence of RMSF reflects the seasonal

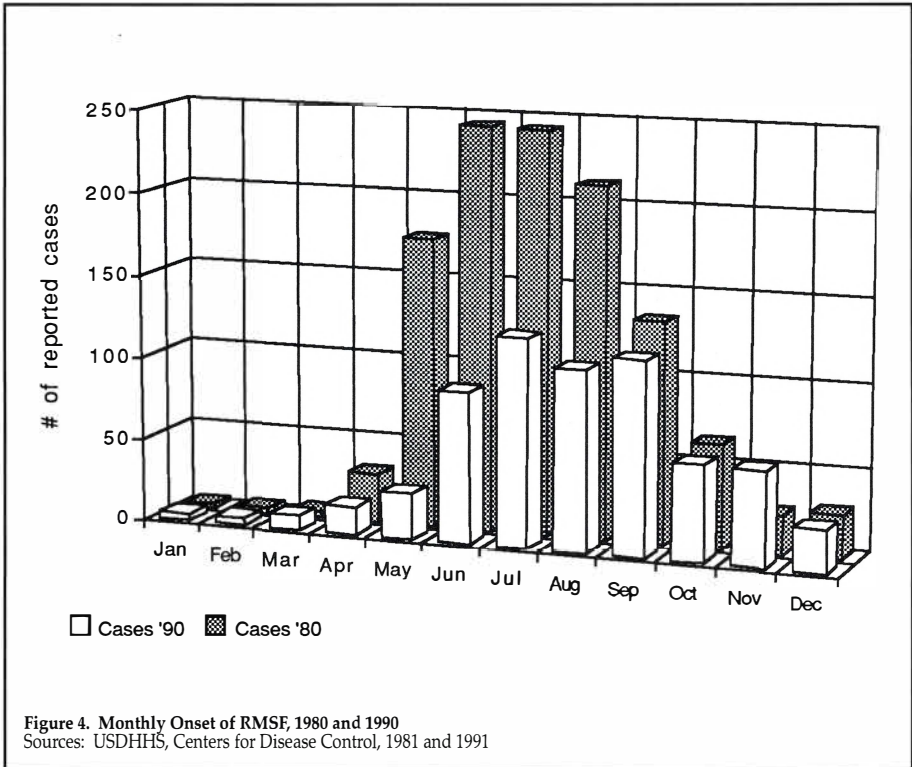


Figure 4. Monthly Onset of RMSF, 1980 and 1990
Sources: USDHHS, Centers for Disease Control, 1981 and 1991

activity of adult ticks (since immature forms seldom transmit the disease to humans), which actively feed during the spring and summer (Riley, 1977).

Generally, ticks are found in heavily wooded, mountainous, or sagebrush areas of the US (USDHHS, 1987; USDHHS, 1985; USDHHS, 1984). Open or patchy woodland, brushy areas, and abandoned overgrown fields and pastures also provide ideal habitat for wood and dog ticks alike (Riley, 1977; Pyle, 1979). Sonenshine et al. (1972) concluded that the range of the dog tick coincides with that of the eastern deciduous biome, and is largely confined within an area receiving at least 102 centimeters of average annual rainfall and experiencing a daily relative humidity of 70 percent or greater. The range is delimited by a latitudinal line beyond

which temperatures may dip below 0° C for extended periods of time to the north, and a longitudinal line of precipitation stress to the west, while including all of the southeastern mixed forest (Sonenshine et al., 1966; 1972). McEnroe and McEnroe (1973) also recognized the importance of the climatic variables of temperature and

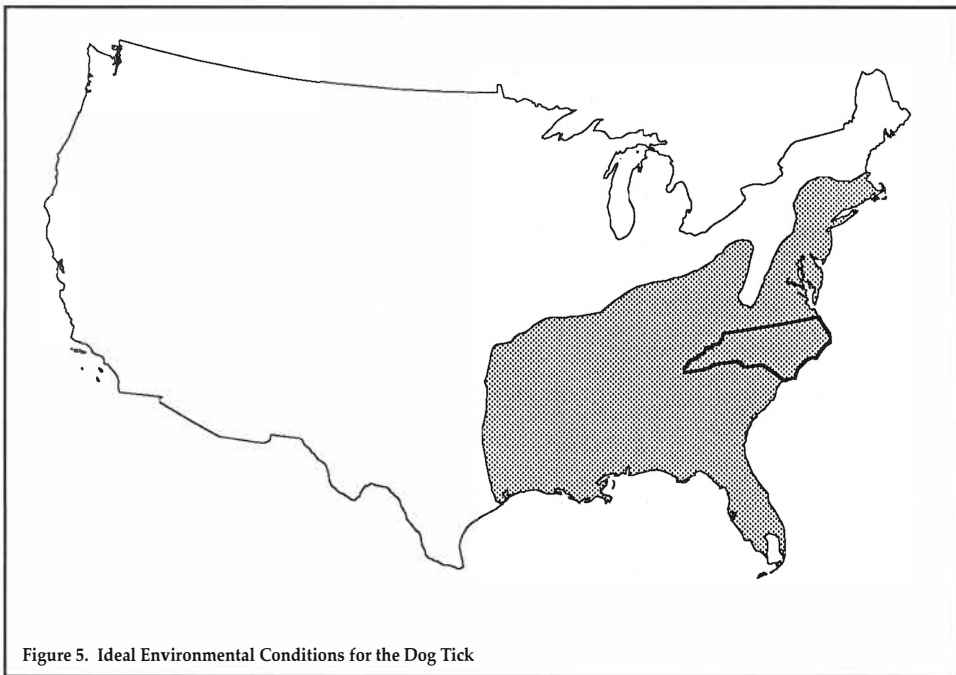


Figure 5. Ideal Environmental Conditions for the Dog Tick

relative humidity, noting that temperature and humidity significantly affect the questing behavior of ticks. More specifically, they concluded that the optimum questing temperature was 20° C, with an upper threshold of 40° C and a lower limit of 5° C (McEnroe and McEnroe, 1973). As relative humidity declines, ticks retreat to the soil surface in search of increased moisture, and return to questing only once the minimum required saturation level (about 60 percent) returns (McEnroe and McEnroe, 1973).

Humans are incidental hosts, yet they may enhance or reduce the spread of the disease. Exposure through interaction with pets, for example, should not be underestimated.

The environmental factors and conditions identified above by Sonenshine and others enable one to geographically delimit the territory of the dog tick (Figure 5). Unfortunately for its residents, North Carolina provides an ideal habitat, and hence the potential for RMSF. Pavlovsky (1966) referred to this "natural focus" of a disease as its "natural nidus," within which the infection is maintained among wild animals and arthropod vectors. As explained by Meade et al.

(1988), scientists can subsequently use the landscape to identify disease hazards once they understand the specific environmental conditions required for a particu-

lar disease. It is significant to note, however, that human behavior can significantly alter disease cycles (such as RMSF) that ordinarily exist independently in nature (Meade, 1977).

The Impact of Cultural Behavior

Because RMSF has a natural nidus, by definition, humans cannot "create" the disease. People are merely incidental hosts. Nevertheless, through various beliefs and activities, humans may enhance or reduce the spread of the disease, become exposed to it, or establish a variety of cultural buffers as means of controlling the disease cycle.

Pyle (1979) notes that there are differing theories which explain the shift in geographic foci of the disease from the Rocky Mountain region to the eastern US. It is doubtful that the causative organism diffused from the original source region in the West to a new core in the East. Better disease control and a sparse, yet stable population after the initial outbreaks of RMSF may account for the decline in incidence of the disease in the West. In the East, it appears that human activities such as migration, changing settlement patterns, suburbanization, and increased outdoor recreation in wooded areas have resulted in significant intrusion into "silent zones," prompting a dramatic increase in exposure to ticks. Other explanatory factors in the East might include greater awareness and improved reporting, insofar as the latter contributes to better statistics. These explanations are consistent with Roundy's (1980) contention that humans, through cultural or individual behavior, play roles in the success or mitigation of communicable disease agent life cycles. Roundy noted that people, through environmental foci, present themselves at sites where a disease agent can be transmitted to them. He specifically highlighted the influence of human-induced vegetational changes on disease patterns (Roundy, 1980).

Burgdorfer (1977) explained that RMSF was an "occupational disease among people settling in enzootic areas" in the West, and once the land was cleared and cultivated, incidence of RMSF declined as a function of decreased tick infestation. In the East, the highest incidence rates occurred among children and women because the dog tick primarily infected household pets, with which they constantly maintained contact (Burgdorfer, 1977). When populations began to shift into the natural foci of RMSF via suburbanization or recreational activities within previously cleared agricultural lands, alarming rates of incidence ensued. Raoult and Walker (1990) reached the same conclusion as Burgdorfer, lending support to the contention that current incidence patterns are largely related to cultural behavior and intrusions into the natural nidus of the dog tick by both humans and their pets. Exposure through interaction with pets should not be underestimated, since recent surveys have found that sharing homes with pets is a way of life for more than 60 percent of Americans (Folkenberg, 1990).

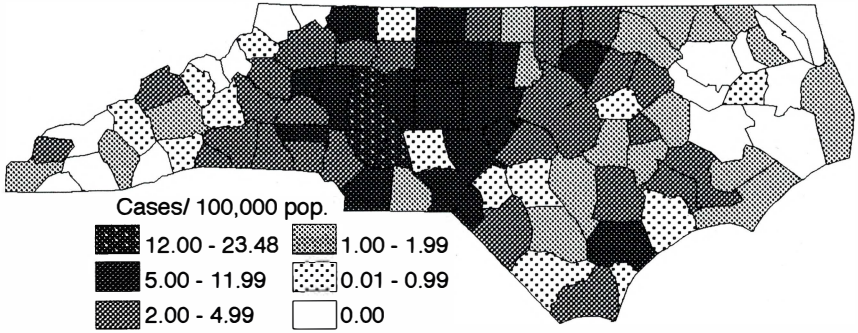


Figure 6a. Seven Year Average Incidence Rates of RMSF in NC, 1975-81
 Sources: N.C. Dept. of Environment, Health, and Natural Resources, 1989;
 N.C. Dept. of Human Resources, 1980, 1985, 1989

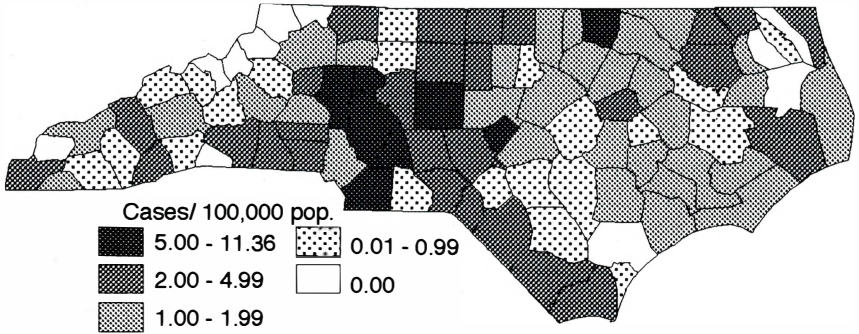


Figure 6b. Seven Year Average Incidence rates of RMSF in NC, 1982-1988
 Sources: N.C. Dept. of Environment, Health, and Natural Resources, 1989;
 N.C. Dept. of Human Resources, 1980, 1985, 1989

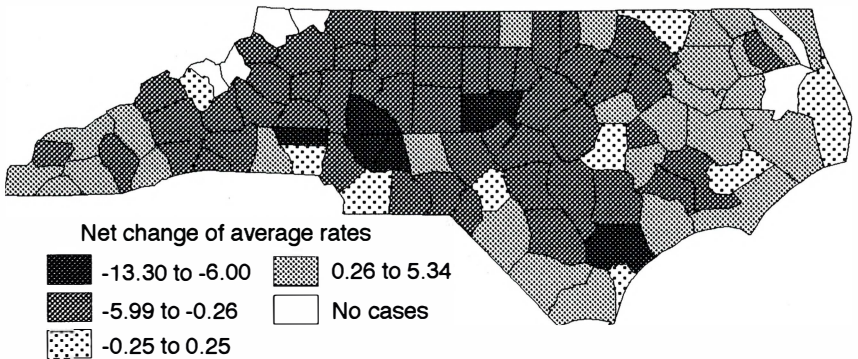


Figure 6c. Net Change in Average Incidence Rates of RMSF in NC; Net Change = (1982-1988 rate) - (1975-1981 rate)
 Sources: N.C. Dept. of Environment, Health, and Natural Resources, 1989;
 N.C. Dept. of Human Resources, 1980, 1985, 1989

A closer examination of the incidence rates in North Carolina reveals the dynamic nature of the pattern (Figures 6a, 6b and 6c). Figures 6a and 6b provide a comparison of average incidence rates per 100,000 population for two seven-year periods, 1975-1981 and 1982-1988.

Figure 6c indicates the resulting net changes in average incidence rates for each county in North Carolina. One can make the following inferences from these comparative maps: 1) incidence rates remain significantly higher in North Carolina than in other states despite a significant decline in the state's incidence rate in recent years; 2) highest incidence rates within North Carolina remain concentrated in the Piedmont section of the state, despite significant declines in incidence rates within this region; and 3) although still not as significant as in the Piedmont, increased incidence rates have occurred in both the Coastal Plain and the Mountain regions during recent years. Further research and resolution at a finer spatial scale are required to determine whether the high rates of incidence within the Piedmont region can be attributed to physical geographical factors or more widespread changes in population and land-use.

Intervention Points

A strategy for effectively intervening in the disease cycle of RMSF includes alternatives selected from the following general areas: eradication, behavior modification, medical treatment, and preventative measures. These are not new alternatives; rather, they represent the general options from which culture groups have historically selected an appropriate means to combat a disease.

Eradication would be geared towards eliminating tick-infested areas, best accomplished through the use of chemical pesticides. This alternative would be extremely expensive (if at all possible) and would subject people and the environment to the harmful side effects of pesticides. Perhaps more problematic would be the effort to target actual carriers of the disease. As Roueche (1988) noted, the vector tick is ubiquitous in range, and even in the most heavily infested areas, only 5 percent of the vector ticks are carriers.

Behavior modification would focus on the choice of recreational activities and the location of those activities, as well as owning and caring for pets (especially dogs). Partial solutions to the problem of avoiding tick-infested areas might be to forego certain outdoor recreational activities in wooded areas, such as hiking, camping, hunting, or fishing. This is not a realistic alternative nor are people likely to relinquish their pets or restrict the latter from going outside the house. Exposure can be minimized, however, by understanding a basic aspect of tick behavior. As Houle (1991) concluded, ticks climb vegetation early in the day to engage in "questing" (i.e., search behavior to find a suitable

The most effective prevention measure for avoiding Rocky Mountain Spotted Fever is to physically check one's body and to promptly and carefully remove any discovered

blood meal) for several hours. As the mid-day sun becomes extremely hot, the ticks retreat back to the ground and take refuge in cooler, moist areas. Thus, individuals can minimize their exposure and that of their pets by engaging in some activities later in the day.

Intervention via medical treatment is based on the use of antibiotics once the disease is diagnosed. This intervention strategy has proved extremely effective since the 1950s, especially when symptoms are identified early in the case. Antibiotics do not, of course, prevent people from contracting the disease (although they probably do decrease the number of "reported cases"); they merely provide a means of combatting the disease once a person becomes infected.

Preventative measures include a variety of means to help avoid contact with infected ticks. Although vaccines are common preventative measures, a commercially available vaccine does not exist for RMSF. Other preventative measures include wearing protective clothing (such as long trousers, long sleeve shirts, boots, and hats), using insect repellent, and purchasing "tick collars" for household pets. Each of these options however has its drawbacks. Protective clothing might not be practical during the hot, humid spring and summer "tick season" throughout the Southeast. Insect repellent is not always available each time one ventures into a tick-infested area (even if one could recognize such areas), nor is it convenient to continuously apply it, especially if one lives in a rural area. Tick collars are designed to prevent infected ticks from being brought into the house or yard and subsequently falling off and establishing a foci from which infected ticks may eventually evolve and infect the residents. Although tick collars are widely sold for household pets, they are rarely 100% effective, they fall off at inopportune times, and although they afford some protection to the pet, they do little to safeguard the owner.

The most effective preventative measure is to physically check one's body for ticks and to promptly and carefully remove ticks that are discovered. Because ticks usually require up to six hours of feeding before they can transmit *R. rickettsia* into the human body, checking one's body two or three times a day can enhance detection and avoid infection. Using the "buddy system" is especially important to helping children avoid infection.

Conclusion

Despite a variety of options for intervening into the disease cycle, RMSF remains an important infectious disease because of its prevalence, the difficulty in correctly diagnosing the illness in a timely manner, and the potentially fatal outcome (Weber and Walker, 1991). Moreover, because the ticks themselves can act as the reservoir (infection can be transmitted transovarially from the adult female tick

We argue that the tools and techniques of the geographer are well suited to integrate the complex combinations of physical and human factors which account for the prevalence of this disease

to her eggs) and can survive for long periods of time (over a year) without feeding, the possibility of eradicating the disease appears remote.

It has been established that North Carolina provides an ideal environmental habitat for the dog tick (*Dermacentor variabilis*). Given the rapidly changing cultural landscape of the Southeast and the Mid-South, especially in North Carolina, it appears that humans throughout the region will continue to play the role of incidental hosts in the foreseeable future. Consequently, public awareness programs should be appropriately designed to help residents and travellers recognize the natural nidus of RMSF, recognize its early symptoms, and understand various intervention options in order to combat (or hopefully avoid) the disease.

A major purpose of this paper is to provide a stimulus for more geographic inquiry on the topic of RMSF in North Carolina. Geographers can make a significant contribution in defining the natural nidus of RMSF within the Southeastern US and predicting the occurrence of the disease through the use of Geographic Information Systems (GIS).

We recognize that the problem of RMSF has two components: 1) a physical geographical factor, which defines the natural nidus of the disease; and 2) a human geographical factor, which accounts for how and where people come into contact with infected ticks and subsequently contract RMSF. GIS can be employed to generate and integrate layers of both physical and human information. The physical variables might include: temperature, relative humidity, soil temperatures, vegetative cover, precipitation, and frost-free days. Human variables could incorporate changing land use patterns such as suburbanization, farm land abandonment, and recreational use of wooded and forested areas. These combinations of variables could be overlaid with data on RMSF, which is currently available at the county level from the Centers for Disease Control.

The brief discussion above is only one example of how a geographic perspective may enhance better understanding of this problem. We argue that the tools and techniques of the geographer are well suited to integrate the complex combination of physical and human factors which account for the prevalence of RMSF in the Southeastern US, and particularly in North Carolina.

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MERGING STORM WATER MANAGEMENT WITH STREAM HABILITATION: GREENSBORO'S LAKE DANIEL PILOT PROJECT

Michael E. Lewis, John R. Jezorek and Parke Rublee

Introduction

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In spite of progress controlling discharges of industrial pollutants from discrete points, many urban drainage basins continue to suffer from heavy loads of sediment and pollutants in the form of storm water runoff from lawns, streets, driveways, parking lots, and other dispersed sources (Arnold et al., 1993; Riley, 1992; Ferguson 1991; Horak, 1988). Altered geomorphic and soil conditions, leaking or broken sewer lines, and structural responses to flooding also contribute to the degraded natural condition of many urban streams. City governments and local environmental groups are attempting to restore natural vitality to such streams and wetlands through cooperative, integrated efforts to reduce storm water borne pollution (DeWitt, 1994).

Stream rehabilitation efforts can be merged with the National Pollutant Discharge Elimination System (NPDES). Under authority of the Water Quality Act of 1987 NPDES requires local governments to devise plans for reducing sediment and pollutants carried by storm water runoff directly to streams or water treatment plants. State and local governments are also providing grants to fund community-based stream restoration projects that serve multiple goals, including storm water management (Riley, 1992). Greensboro, North Carolina, exemplifies the process of meeting the NPDES requirements to plan for storm water management with local public involvement. This article reviews the parallel histories of stream greenway rehabilitation and storm water management and describes the ongoing process of merging the two goals in a Southern Piedmont context.

Past Approaches

Urban landscape planners have long recognized the amenity value of clean running water, and also the practical reduction in flood hazards that comes from reserving floodplains within parks and greenways. Olmstead's emerald necklace around Boston in the 1880's was one of the earliest examples of a system of riparian public parks. Greenway corridors along streams

Volunteer citizens and cooperating city departments are involved in restoring vitality to stream and wetland environments suffering from heavy loads of sediments and pollution from lawns, driveways, streets, and parking areas

and rivers have subsequently emerged in cities around the country. The National Capital Park System along Rock Creek in Washington D.C., Denver's Platte River Greenway, Oregon's Willamette River Greenway through Portland, and the Chattahoochee River Corridor near Atlanta, are a few national examples. The Capital City Greenway in Raleigh, North Carolina, dating from the early 1970s, is one of the earliest greenways acquired through public acquisition of private floodplain land. In addition to directing development away from some 1,000 acres of active floodplains, the greenway is traversed by 30 miles of multipurpose trails within the Raleigh metropolitan area. The city of Charlotte, in cooperation with Mecklenburg County, has set aside the McAlpine floodplain greenway, while Guilford County links the City of Greensboro's water supply lakes with a series of greenway corridors and public recreational trails (Field, 1981; Ferguson, 1991; Flink and Stearns, 1993).

An ongoing problem has been that the amenities sought after in greenway reserves — a vigorous growth of riparian trees and shrubs, aesthetically pleasing stream morphology with meandering sequences of pools and riffles, including pockets of wetlands — have been at odds with engineered solutions to the flooding problems that also come with urban development. Hydraulic engineers recognize that land use changes associated with urban development produce forceful changes in stream hydrology and basin morphology. Total runoff and peak flows, bank erosion, and sedimentation all increase as houses, commercial buildings, parking lots, and roads replace natural vegetation and soil covers with a more impervious and environmentally toxic surface. Groundwater regimes are also altered as more water runs off surfaces rather than moving as soil through flow or infiltrating into subsoil levels (Leopold, 1968).

Stream channelization became a common solution to problems of accelerated storm water runoff and local flooding as housing projects proliferated around urban centers following the end of World War II. From the perspective of individual developers, straightening channels, clearing vegetation, and encasing banks in concrete or rip-rap to produce uniform trapezoidal cross-sections provided an efficient means of moving both water and pollutants out of local areas. More recently, the impaired natural environment of such streams, along with collective downstream increases in flooding and pollutant loading, has prompted efforts to identify alternatives to channelized streams (Nunnally and Shields, 1985; Nunnally and Keller, 1979; Nunnally, 1978).

Contemporary storm water management plans are replacing earlier designs emphasizing rapid discharge of floodwater through dredged channels with techniques for delaying its movement and spreading peak flows over longer time periods. Detention ponds, infiltration trenches, and porous parking lots, all designed to detain sediment and pollutants associated with storm water, have emerged as a

avored set of “best management practices” recommended in hydrologic engineering and planning literature (Whipple, 1991; Schueler, 1987). Such “pipe and pond” structures are a common response to sedimentation control ordinances in plans for new residential and commercial developments. While they can be effective as sediment traps, they do little to correct the unsightly legacy of channelized streams in established neighborhoods.

Flood stage detention ponds also give little attention to storm water that reaches streams during non-flood precipitation events. Pollutant conveyance is especially significant when a storm follows a period of dry weather. A flush of motor oils, grease, and other petroleum based pollutants are moved directly into streams from streets, parking lots, and driveways in heavy concentrations during such events, producing a severe strain on riparian and aquatic habitats (Silverman and Stenstrom, 1982). Rapid discharge of runoff from low intensity rainfall, and reduced bank storage when culverts are piped directly to streams, also limits the establishment and growth of riparian vegetation and aquatic life. That is a serious limitation because under favorable conditions of topography and soil character, riparian vegetation buffers aid the break down of organic pollutants and increase bank storage of storm water, which can consequently augment stream flow during low water periods (Holder and Mayfield, 1993; Phillips, 1989). In summary, there is a need for stream rehabilitation plans designed to soften the relic imprint of channelization, reduce or assimilate the flush of storm water pollutants during frequent, low intensity storm events, and improve natural stream habitat for aquatic and riparian plants and animals.

Engineering solutions to urban flooding problems are found to be at odds with amenities provided by aesthetically pleasing greenway environments

The Federal Mandate

The catalyst for bringing storm water management to the urban environmental planning agenda was a new interpretation of the scope of the National Pollutant Discharge Elimination System (NPDES). Discharge permits have been a federal tool for controlling and cleaning up water pollution since passage of the Federal Water Pollution Control Act Amendments of 1972, which was refined by adding the specific goals found in the Clean Water Act of 1977. Section 401 of the Clean Water Act created NPDES to meet the goal of controlling the discharge of effluent containing specific pollutants from discrete point sources.

When the Clean Water Act of 1977 was reauthorized by the Water Quality Act of 1987 a new goal was added. That goal was directed at reducing the introduction of pollutants to rivers and streams from dispersed, non point sources. Motivated by the new non point source pollution goal, the EPA successfully argued before

Municipal urban quality assessments have shown that diffuse source pollution is the leading cause of water impairment in the United States

Congress that though urban storm water runoff originated from dispersed sources, its conveyance through urban gutters, culverts, and storm sewer pipes fell under the legal definition of point source pollution, and was therefore subject to NPDES. The strongest evidence for the need for action was taken from biennial assessments of water quality submitted by the states to EPA under rules of the Clean Water Act of 1972. Those assessments concluded that the effects of pollutants from diffuse sources, primarily urban storm water and non point agricultural runoff, were the leading causes of water quality impairment in the United States (EPA, 1990).

With the broadened authority of NPDES, EPA requires municipalities with separate storm water and sanitary sewer systems to submit plans for management of urban storm water runoff as a condition for renewal of waste water discharge permits. The purpose of the EPA rules is to encourage cities to develop individual approaches that allow for variations in physical settings, and also greater public involvement in identifying and implementing effective planning for storm water management. EPA's policy differs from large scale flood control and multi-purpose water projects of the past in that it encourages preventative and source reduction methods in combination with built structures, and seeks to foster joint efforts between citizen based environmental advocacy groups and governmental agencies. It relies less on the federal government for design, funding, and implementation, finding earlier federally directed water projects plagued with long delays, rising construction and maintenance costs, and unacceptable demands on local property owners (EPA, 1990).

The EPA delegated authority to administer NPDES to the state of North Carolina in 1975. North Carolina's Department of Environment, Health, and Natural Resources is the primary agency responsible for statewide oversight of the storm water planning mandate, while city governments in urban areas exceeding 100,000 residents are responsible for drafting their own storm water discharge permit applications. Six North Carolina municipalities are currently required to develop storm water management plans to qualify for NPDES permits: Charlotte, Durham, Raleigh, Greensboro, Winston-Salem, and Fayetteville. At the beginning of 1994 only Charlotte had completed the application process and been granted a permit, while the other cities' applications were in various stages of development. Other federal and state legislation and regulations affect storm water management programs in other parts of North Carolina. They include floodplain management ordinances required under the National Flood Insurance Program administered by the Federal Emergency Management Agency and the North Carolina Coastal Area Management Act of 1974, which applies in 20 coastal counties (Eaker, 1994).

Paying the cost of implementing and maintaining storm water management plans without heavy federal subsidies has led some 60 cities across the U. S., including Raleigh, Charlotte, and Greensboro to adopt a public utility approach to storm water management. The justification used to create storm water utilities is that provision of storm water drainage facilities and their repair and maintenance are a public service provided to property owners. Property owners are assessed the fee based on a property's potential for producing runoff, including such criteria as the size and use of the tract, the roof area of buildings, extent of guttering, and the area of impervious surfaces. Fee collection is typically administered through a public works utility working in conjunction with water and sewer systems (Eaker, 1994; Lindsey, 1990).

Greensboro Case Study

Situated near the head of the Cape Fear River on the rolling dissected topography of the Southern Piedmont, Greensboro, North Carolina is approaching 200,000 urban residents. Local annual precipitation averages 43 inches and is distributed throughout all seasons of the year. Approximately 90 percent of precipitation events produce surface runoff and through flow to streams. Heavy clay textured soils in many areas, combined with the various impervious surfaces of built-up areas, provide generally poor subsurface drainage and slow infiltration to ground water. Greensboro streams also have small local catchment areas and receive small amounts of ground water base flow. As a result, city streams experience generally low flow levels, except for short periods after storms when rapid runoff can produce localized flooding. Repeated channel dredging and straightening in response to small floods has increased scouring and bank collapse with associated sediment loading. Greensboro streams also carry heavy loads of salts, fertilizers, pesticides, and petroleum based chemicals, conveyed to them from streets, landscaping, and commercial/ industrial areas (City of Greensboro, 1993).

The city took the first step in preparing its NPDES permit application by hiring a consulting firm, which divided the urban drainage network into 12 watersheds, each covering approximately six square miles or less (Figure 1, Table 1). Public meetings revealed a predisposition among city councilmen towards a structurally engineered approach to storm water controls, but also a political sensitivity to the cost that would be borne by city taxpayers. The local chapter of the National Audubon Society saw the situation as an opportunity to demonstrate the fiscal attractiveness of stream restoration and rehabilitation. They responded by establishing the Streamgreen Committee composed of interested Audubon members and local academicians with professional expertise in water resources, aquatic ecology, water chemistry, and public relations. Streamgreen's mission is to encourage city officials to take an integrative approach to storm water management, one that includes restoring the amenity, recreational, and natural habitat functions of urban

Watershed	Area (acres)	Composite Imperviousness	Runoff Coefficient	Runoff (acre-ft/year)
East Fork Deep River	2912	45.8	0.46	4297
Bull Run Creek	982	15.6	0.19	596
Horsepen Creek	5169	26.2	0.29	4721
South Buffalo Creek 1	5271	36.9	0.38	6435
South Buffalo Creek 2	4998	36.1	0.38	5986
South Buffalo Creek 3	5317	42.2	0.43	7298
South Buffalo Creek 4	3659	33.6	0.35	4118
Lake Jeanette	3861	21.4	0.24	2986
North Buffalo Creek 1	6122	37.0	0.38	7481
North Buffalo Creek 2	3578	50.2	0.50	5730
North Buffalo Creek 3	3790	33.5	0.35	4252
North Buffalo Creek 4	6400	35.4	0.37	7529
Citywide	52059	35.5	0.37	61,429

Table 1. Major Characteristics of Greensboro Watersheds
 Source: City of Greensboro NC, Stormwater permit Application, Part 2

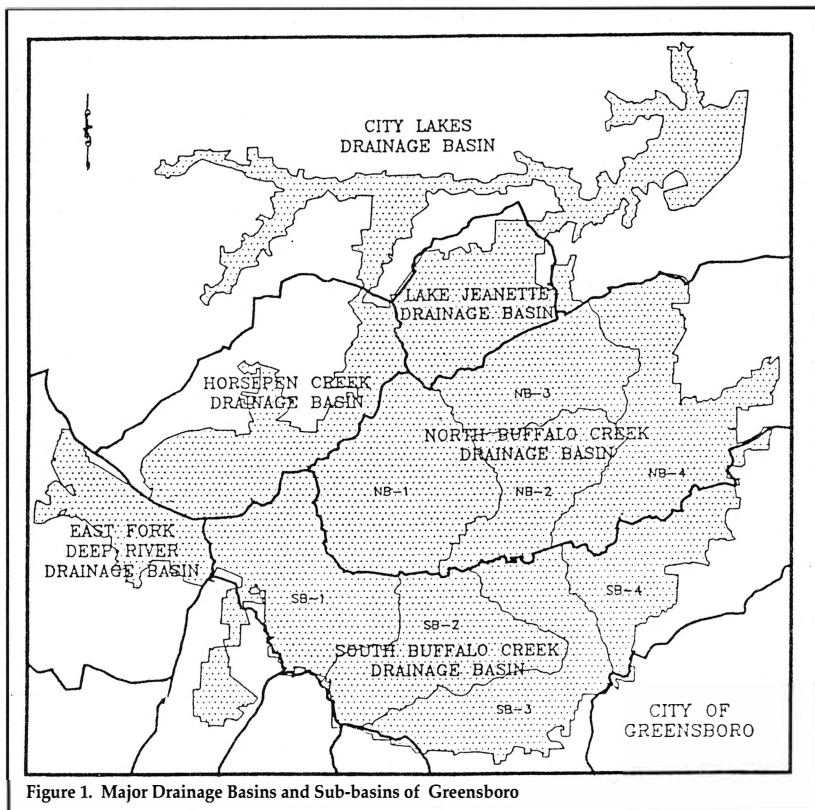


Figure 1. Major Drainage Basins and Sub-basins of Greensboro

streams, in addition to their storm water conveyance function. The initial working goals were to provide public educational information about the benefits of naturally flowing streams, establish linkages to city government officials with responsibility for streams, and involve local neighborhood groups in stream monitoring and restoring riparian vegetation.

The committee first produced a slide/lecture program describing the ecological functions and amenity values of natural stream greenways and wetlands, including their ability to break down some pollutants and absorb small floods. The program was shown to school classes and civic groups in targeted neighborhoods with local streams. Neighborhood outreach also took the form of "adopt-a-stream" projects involving churches, civic groups, and neighborhood associations in regular clean-up of trash and debris washed into streams. Adopt-a-stream was able to generate television and newspaper coverage of conditions at local streams and also the broader issue of storm water management.

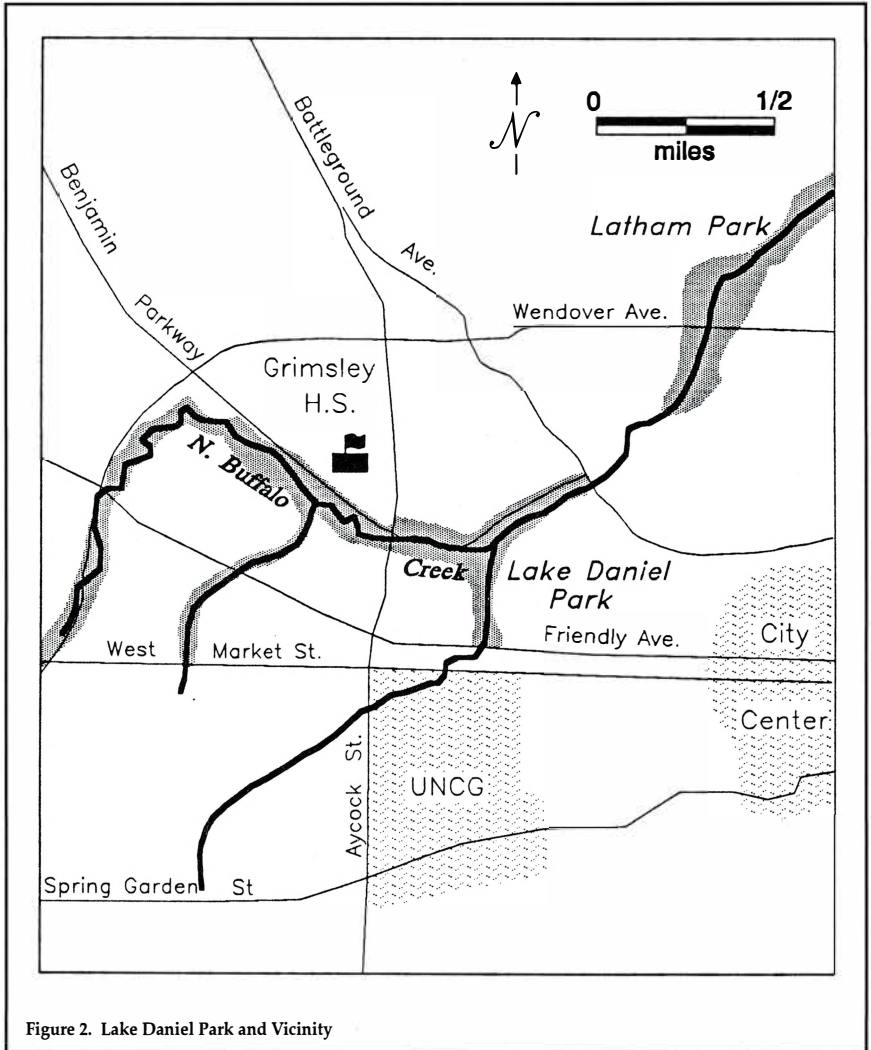
While neighborhood outreach and educational efforts proceeded, Streamgreen worked to establish linkages with Greensboro Beautiful, a private-public consortium primarily concerned with landscaping in the city's public parks and natural areas, but increasingly interested in restoring more natural landscapes. Obtaining the support of Greensboro Beautiful was a crucial step in Streamgreen's effort to identify and reach key city officials in departments involved with streams. Responsibility for planting and bank mowing, as well as ditching, piping, and bank grading, all with major effects on riparian vegetation and stream morphology, fall to different city departments. The Greensboro Parks and Recreation Department is responsible for mowing and planting vegetation within stream corridors, and provides part of the funding for Greensboro Beautiful. The Department of Transportation handles channel dredging, repair of drainage culverts and piping, and grading collapsed or eroded banks. Furthermore, any proposals to change the flow or morphology of streams on floodplains mapped by the Federal Emergency Management Agency requires approval from the Environmental Programs department (formerly Greensboro's Public Works department). Meetings were held to explain Streamgreen's mission with staff from each of those departments. The consulting firm contracted by the city to draft the NPDES permit application and design a set of best management practices was also kept informed of Streamgreen activities and made written comments on Streamgreen proposals.

Streamgreen is a committee of local citizens interested in restoring the more natural landscapes to the city's stream and wetland environments

The Lake Daniel Pilot Project

After two years of educational neighborhood outreach, political advocacy, and informal stream surveys, Streamgreen approached the city of Greensboro with a

proposal to begin a demonstration project in Lake Daniel park (Figure 2). The park's name is actually a misnomer, because the reservoir once called Lake Daniel was drained over fifty years ago. Since then North Buffalo Creek and its unnamed tributary flowing through the former reservoir site have been channelized several times, with the banks kept graded at a steep 1:1 slope gradient that encourages accelerated bank collapse.



The city agreed to allow a cooperative group composed of Audubon (Streamgreen) and the Lake Daniel Neighborhood Association to propose changes along the streams of Lake Daniel Park. A long term goal is to have the park serve as a model of low cost stream rehabilitation and preservation practices that the city

can implement on other streams within the city. Two elements defined the work carried out in Lake Daniel, each of these addressed by a subcommittee: restoration of native vegetation, and modifications of local drainage and channel morphology.

During channelization episodes in the 1980s the park's riparian zone had been cleared of all shrubs and trees, with the cleared channel banks initially allowed to grow up in volunteer vegetation. A single citizen complaint about "weeds in the park" prompted the Parks and Recreation Department to begin a biweekly regimen of mowing both the inside and upper channel banks. The mowing program prevented the growth of trees or shrubs, and left the stream channel exposed to the summer sun, prompting frequent algal blooms as runoff from local lawns brought in nutrients. Streamgreen lobbied the Parks and Recreation Department to end the mowing program and shade the stream with native shrubs and trees for both aesthetic and practical reasons. Empirical research has shown that vegetation serves to uptake excess fertilizer runoff in storm water as well as providing a measure of bank stabilization, while shading provides lower water temperatures and improves oxygenation for fish and aquatic organisms (Smith and Hellmund, 1993; Dawson and Haslam, 1983). Vegetative buffer zones along streams also provide substantial natural filtering of storm water borne pollutants and retard storm water movement so that contaminants can be decomposed by micro-organisms, or settle out into temporary storage on the primary floodplain (Phillips, 1989).

Given past complaints about the unkempt appearance of unmowed grassy stream banks in the park, Streamgreen and the Lake Daniel Neighborhood Association produced a brochure and posted signboards outlining the reasons for the revegetation project. Neighborhood Association members also sponsored morning and evening stream side walks to discuss the potential appearance of the vegetation over the long term while dampening fears that a lack of mowing would encourage rats and other "vermin" to invade the park. Reassured of public acceptance from the Lake Daniel Neighborhood Association, Greensboro Parks and Recreation agreed to suspend its mowing program along a riparian strip 20 - 100 feet wide along North Buffalo Creek and its tributary within the park.

A grant of \$5,000 from Greensboro Beautiful allowed the Lake Daniel Neighborhood Association to purchase some 200 native shrubs and trees for planting in the unmowed riparian buffer. Several planting days were held, and 40-50 neighborhood and Audubon volunteers assisted with the work. In the three growing seasons since the mowing program was suspended, suppressed willows have sprouted along the narrow primary floodplain within the channelized banks. Red maples, sycamores, and mulberry trees are reestablished on the upper banks, and along with a profusion of wildflowers are adding to the stock planted by the neighborhood association. The growth of this emerging vegetation has noticeably improved wildlife habitat. Long time Audubon birders have sighted several songbirds not documented in the park while the mowing program was in effect. Fully

documenting the effects of the planting program will require several years, but early signs of improvement are clearly encouraging.

In addition to planting native shrubs and trees in the riparian zone, Streamgreen sought to slow the discharge of storm water runoff into and from the park streams and reduce bank slumping and erosion. Producing an idealized meandering stream would involve an expensive reconfiguration of the existing channel using heavy earth-moving equipment inside a popular city park. Instead, the committee attempted to identify less invasive alterations with moderate or low financial costs, that when implemented collectively across the city could produce significant improvements in rates of storm water runoff and stream flow.

The modifications finally accepted by the city had several components. First, the city agreed to grade the stream banks back to a more gentle 2:1 slope ratio, augmented by plantings of willows to stabilize the bank and transpire some surplus moisture. Revegetating and reshaping the banks also provides a safety benefit in that people are less likely to slip off a steep bank and find themselves trapped in an entrenched rain-swollen stream channel.

Several years of volunteer work in cooperation with the Parks and Recreation Department has provided an excellent example of stream environment rehabilitation

Modifications were also made to the channel morphology through additions of rock. The city provided several truck loads of rough native granite stones ranging between 6-24 inches in greatest dimension. Neighborhood residents and Audubon volunteers placed as rock steps across the channel, or built rock flow deflectors upstream from several undercut and collapsed banks along straightened stream segments. Pools created behind the rock steps are intended to provide a refuge for fish during low water conditions, and delay movement of sediments and trash until clean-up crews can remove it. Stepped pools and rock deflectors also dissipate or redirect the hydraulic energy of stream flow, thus reducing bank erosion and channel scouring, and promoting development of meanders in the primary floodway of North Buffalo Creek. Turbulence created as water flows over the rock steps also improves aeration, which increases dissolved oxygen levels so that microorganisms can break down organic pollutants detained in sediments (Nunnally and Shields, 1985; Riley, 1992; Smith and Hellmund, 1993).

One severely collapsed and eroded bank threatened to cut into a popular walking path. Because of the imminent loss of the walkway, the city decided to construct a gabion wall along the affected bank. Gabions consist of a porous set of rock baskets made from wire fencing fabric. The baskets are wired together and embedded into the eroding bank. Under favorable conditions, soil and sediment collect in the open spaces within the baskets, allowing naturally propagated plants to become established. Construction of the gabion by city workers proved to be the most

expensive element of what was otherwise a very inexpensive volunteer labor project.

Phase three of the Lake Daniel Park plan calls for direct intervention in the movement of storm water from street curb drains and piped culverts. Streamgreen is urging the city to remove sections of cut stone street curbing along lightly traveled residential streets bordering gently sloping grassy areas of the park. Excavation of shallow pocket marshes at the outfalls of larger piped culverts are also being proposed. The intent of the curb cuts is to reduce the flow of storm water into drainage culverts and allow sheet flow across grassed areas and the unmowed buffer zone to provide temporary storage of storm water. In a similar fashion, small pockets of wetlands located at cut backs near culvert outfalls are intended to absorb and slow the movement of pollutants from frequent small magnitude storm events. At this time, city engineers in the Department of Transportation have cut back the banks along culvert outfalls on the tributary in the park. Construction of pocket marshes has been delayed on the main stem of North Buffalo Creek because of the need for approval from the Federal Emergency Management Agency for a permitted floodplain modification of the kind involved in the pocket marsh. The Department of Transportation has also committed to further study and public comment on the use of curb cuts to redirect storm water from residential streets.

Concluding Remarks

The Lake Daniel project is not a true empirical experiment given the lack of baseline data on stream flow, water chemistry, or plant and animal surveys on North Buffalo Creek. It is instead an attempt to apply the general results of empirical geomorphological research in a specific demonstration of stream rehabilitation. Audubon has encouraged the city to extend the modifications to Lake Daniel park to other city streams. When applied throughout the Greensboro urban area and integrated with storm water detention ponds and repair work on broken or leaking sewer and storm water lines, we believe the techniques demonstrated in this urban greenway park can contribute to a reduction in stream pollution loading while improving an important urban amenity. Not all of our recommendations were accepted and some remain under consideration, however the experience gained in Greensboro illustrates an alternative to the litigation and adversarial relationship that often characterizes relationships among city officials, development interests, and environmental groups. A locally designed set of practices for managing storm water can serve the best interests of all three groups by providing low cost, low impact, and attractive solutions to a federal mandate for improved water quality in urban areas.

The techniques shown here can contribute to reduction in urban stream pollution when applied throughout the Greensboro region

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THE MASTER OF ARTS IN GEOGRAPHY THE UNIVERSITY OF NORTH CAROLINA CHARLOTTE

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.

CHARACTERISTICS OF THE PROGRAM.

- There are 23 faculty and about 55-60 students in the Department.
- Class are small; student and faculty contact is close.
- The 36 hour program normally requires 2 years for a full-time student.
- About one-half of all full-time, current students have funding.
- Excellent Spatial Analysis Lab with ARC/INFO GIS (workstation and PC).
- The program emphasizes applied geography.
- An Internship, involving a specific "real world" research task, normally replaces the traditional thesis as the capstone of a student's program.

PROGRAM CONCENTRATIONS

ENVIRONMENTAL ANALYSIS AND ASSESSMENT

The environmental concentration draws upon the expertise of practitioners and professionals and a diverse earth science and geography faculty and focuses on 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 pursue course work in planning theory, public facility siting, regional development, impact analysis and/or urban planning or environmental planning.

LOCATION ANALYSIS

The location analysis concentration offers course work in: retail location, trade area analysis, facility siting, office and industrial location, real estate development and applied population analysis. This concentration prepares students for jobs in location research with retail companies, real estate developers, consulting firms, commercial banks, and economic development agencies.

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, usually as analysts for transportation providers and private consulting companies.

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1972), Pittsburgh (Kaplan and Leinhardt, 1973), Manhattan (Guzick and Jahiel, 1976), and Portland (Knaap and Blohowiak, 1989).

Study Area and Methodology

Asheville (Buncombe County) is the transportation, economic, and health care center for fifteen mountain counties of western North Carolina. Asheville is a remote urban enclave, though extra-regional access is excellent owing to its juncture with Interstates 40 and 26 (Figure 1). The leading industries are manufacturing and tourism, although retail trade and health care services are increasing in significance (Asheville City Planning Department, 1987; Western North Carolina Guides and Printing, 1992).

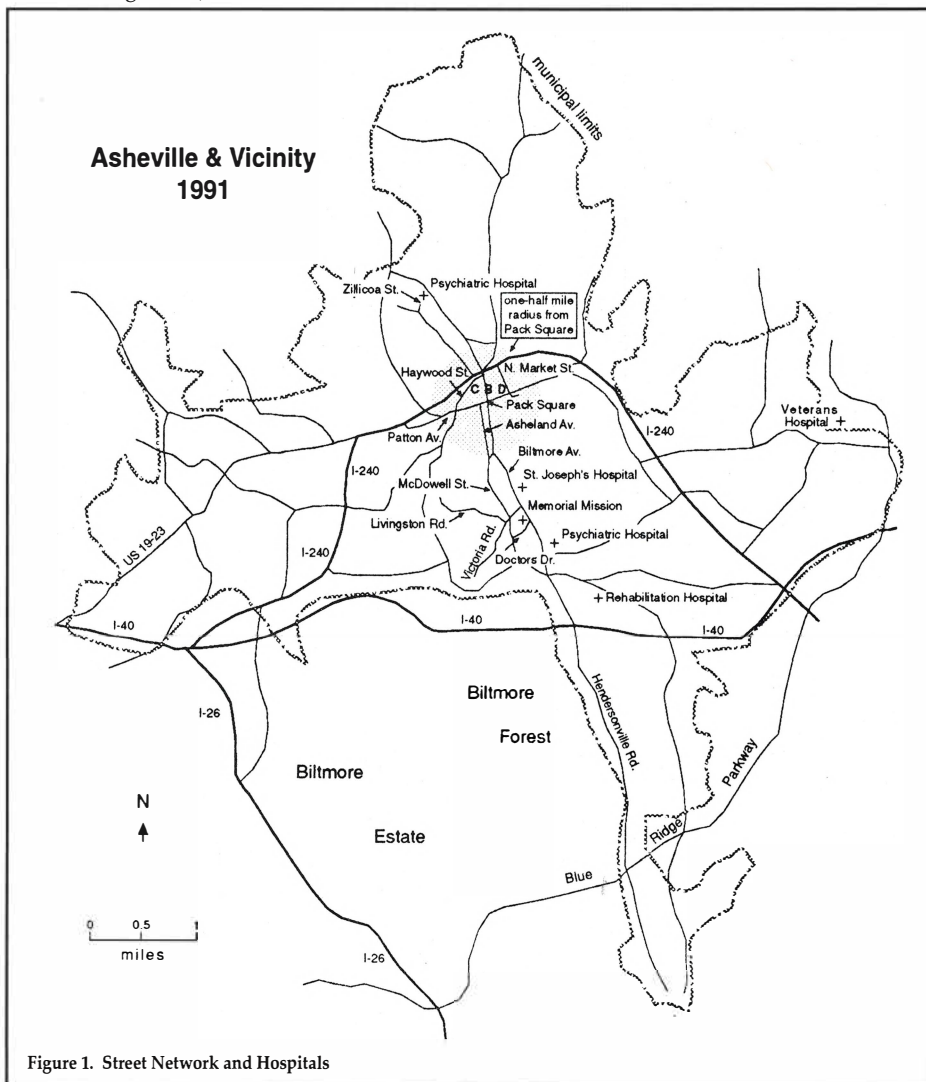


Figure 1. Street Network and Hospitals

Physician offices and hospitals were mapped for four select years that reflect four time periods: 1) 1948, reflecting the processes developing until 1948; 2) 1960, reflecting changes from 1948-1960; 3) 1975, reflecting changes from 1960-1975; and 4) 1991, reflecting changes from 1975-1991. The Asheville municipal limits at the four dates (1948, 1960, 1975, and 1991) define the study areas respectively, as well as parallel significant periods in the development of general hospitals from 1885 (Asheville Citizen-Times, 1990; Asheville Veterans Administration Medical Center, no date; Memorial Mission Hospital Centennial Research Committee, 1985), and land use controls from 1948. The 1948 data coincide with the enactment of Ordinance 322 "providing provisions for zoning of the City of Asheville" (City of Asheville, 1948), while the 1960 data correspond to the construction of facilities in the 1950s by St. Joseph's Hospital and Memorial Mission Hospital. By 1975 there had been a decade of expansion by Memorial Mission Hospital, the St. Joseph's Hospital and the Veterans Administration Medical Center. By 1991 we have experienced the expansion for both Memorial Mission and St. Joseph's Hospitals. The four time periods lag the expansion and construction of hospitals from one to six years and serve to provide physicians time to relocate to more advantageous situations.

Office addresses were compiled from city directories for 1948 and 1960 and from telephone directories for 1975 and 1991 under the listing "physicians and surgeons" (Miller's Asheville City Directory, 1948; Hill's Asheville City Directory, 1959; Yellow Pages, 1975; The Real Yellow Pages, 1991). They represent physicians in private practice, excluding MDs on full-time staff of hospitals or federal government medical facilities. It was felt that the 1975 and 1991 city directories, not included above, were inadequate due to incomplete and inaccurate physician listings. With the rise of group practices in the 70s, city directories often listed group practices without naming each physician in the group. For these reasons the "Yellow Pages" were more useful for developing data sets on physician office addresses over the last 25 to 30 years.

Asheville's zoning ordinances from 1948, 1977-1986, and zoning maps from 1948 and 1991 were used to determine the dominant zoning status of the five leading streets with physician offices during the four time periods (City of Asheville, 1948; 1977; 1991). These sources were supplemented with comprehensive plans and miscellaneous reports from the Asheville City Planning Department (U. S. Bureau of the Census, 1992; Metropolitan Planning Board of the City of Asheville and Buncombe County, 1966; Asheville City Planning Department, 1989). In addition, demographic, economic, and hospital utilization data were drawn from the Asheville Planning Department, the North Carolina Department of Human Resources, and the U.S. Bureau of the Census to provide an environmental context.

The reader is cautioned on the meaning of the word "district" in the remainder of this text. We normally refer to "central business district" (CBD) when we

mean a city's downtown commercial area, but in a few instances it is used to refer to a zoning district. Either, as in the former case, this refers to de facto land use or, as in the latter case, to a de jure designation. The spatial extent of the CBD as downtown and as zoning district are often the same, but it is important to distinguish the difference between the two definitions. Finally, the term "medical district" is based on common usage and refers to a concentration of medical facilities, while the term "medical institutional district" refers to a zoning district with legally defined boundaries and regulations.

Physician Office Locations: Asheville, North Carolina

In 1948 physicians were almost exclusively within a one-half mile radius of Pack Square, the historic focal point of Asheville's CBD (Figure 2). Of 124 physicians, 61% were concentrated in four buildings within the CBD. In 1960 there were 123 physicians, but the number within the CBD declined dramatically (Figure 3). Only 46% of physicians were within a one-half mile radius of Pack Square, while a

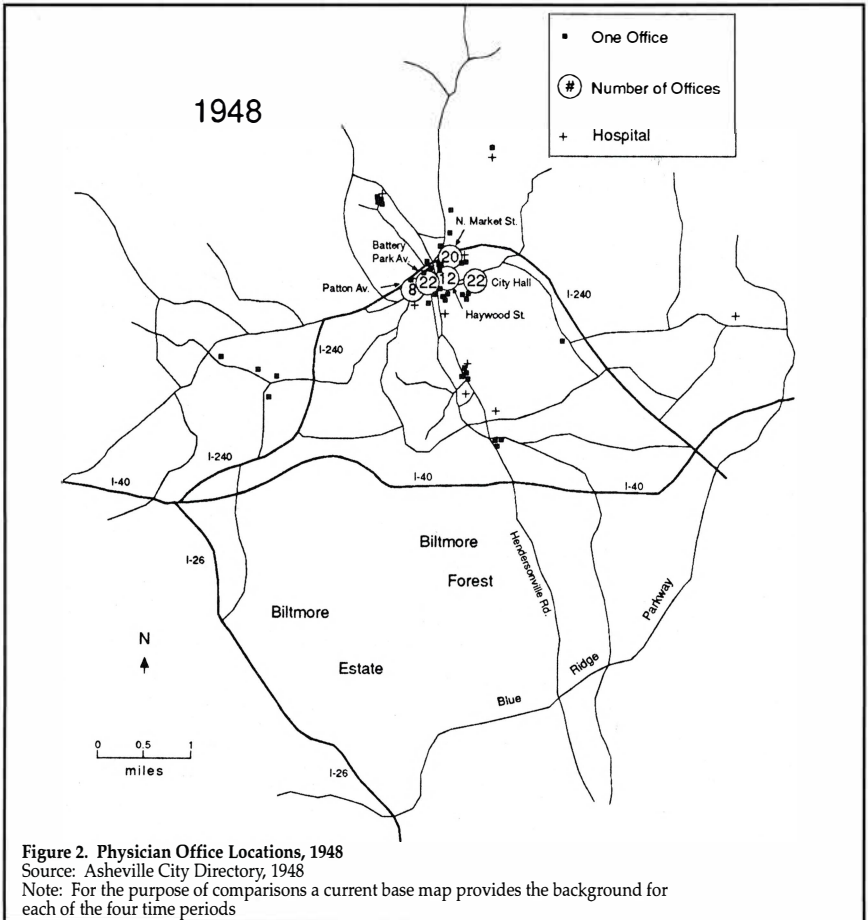


Figure 2. Physician Office Locations, 1948

Source: Asheville City Directory, 1948

Note: For the purpose of comparisons a current base map provides the background for each of the four time periods

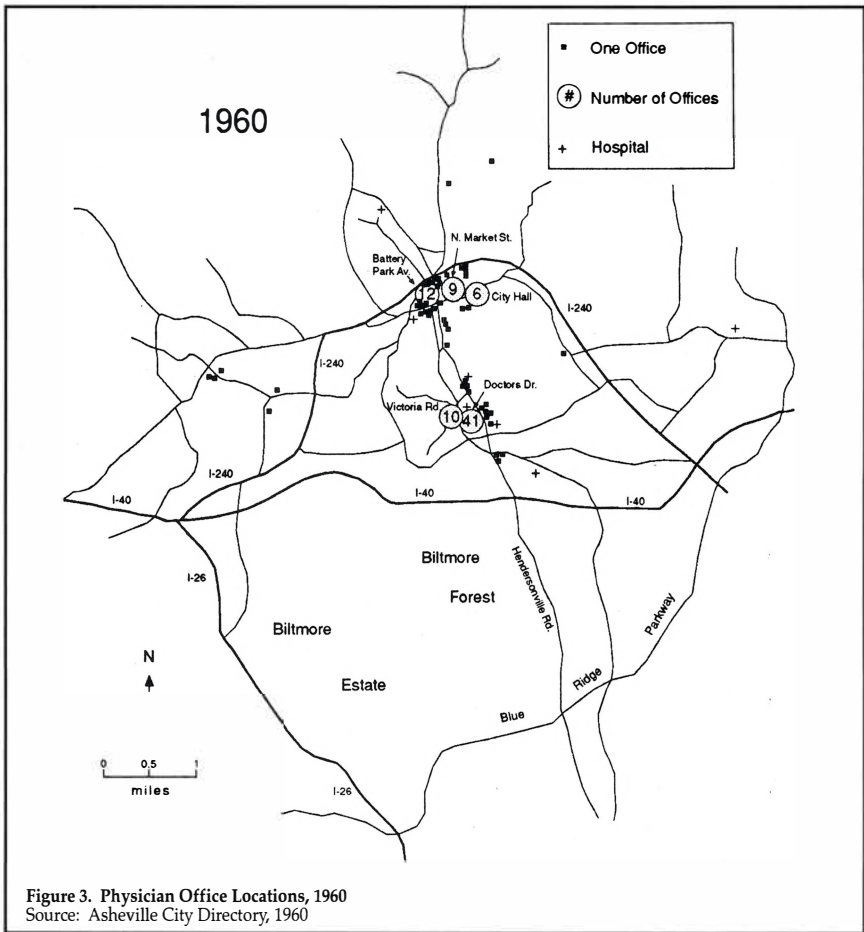
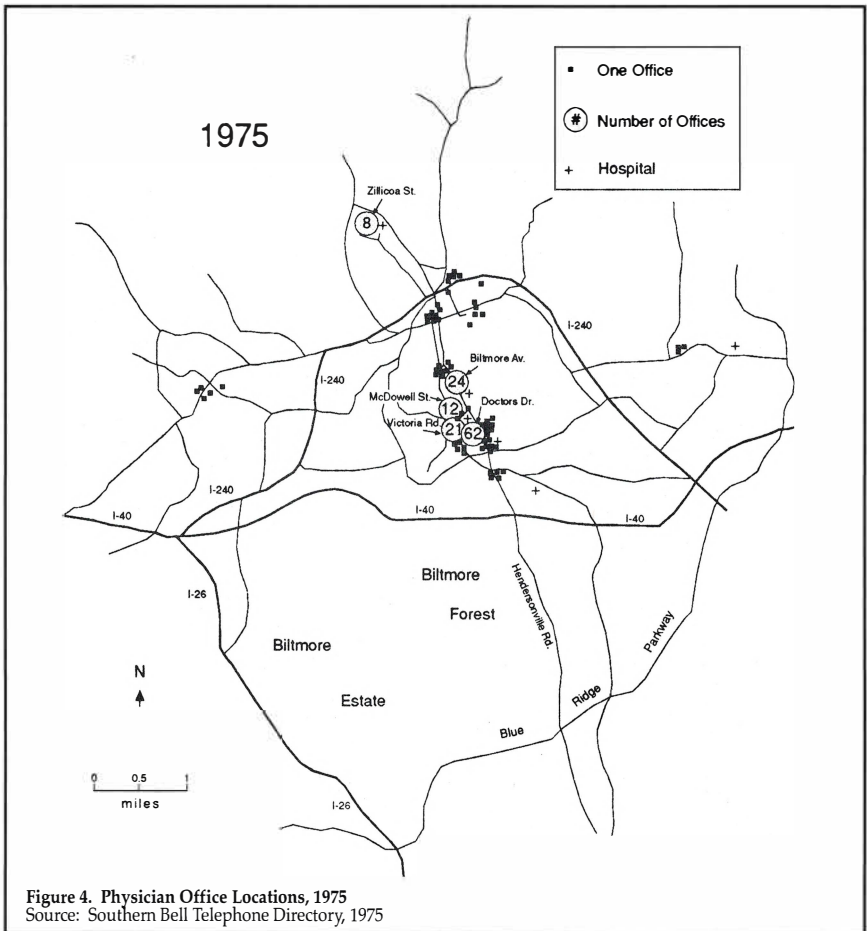


Figure 3. Physician Office Locations, 1960
 Source: Asheville City Directory, 1960

competing medical district with 52% of the town's physicians emerged one and one-quarter miles south of the CBD in the vicinity of St. Joseph's and Memorial Mission Hospitals.

In 1975 there were 191 physicians, but only a remnant 12% of their offices was within the CBD. Meanwhile, 79% of Asheville's physicians were located in the contemporary medical district (Figure 4). By 1991, there were 369 physicians, but only 3 in the CBD (Figure 5). The 11% within a one-half mile radius of Pack Square represented a northern expansion from the contemporary medical district where 79% of the physician offices were located. So, four stages are identified in the spatial changes in physician office locations and medical districts in Asheville, North Carolina, from concentration in the CBD in 1948 to concentration in the contemporary medical district in 1991.

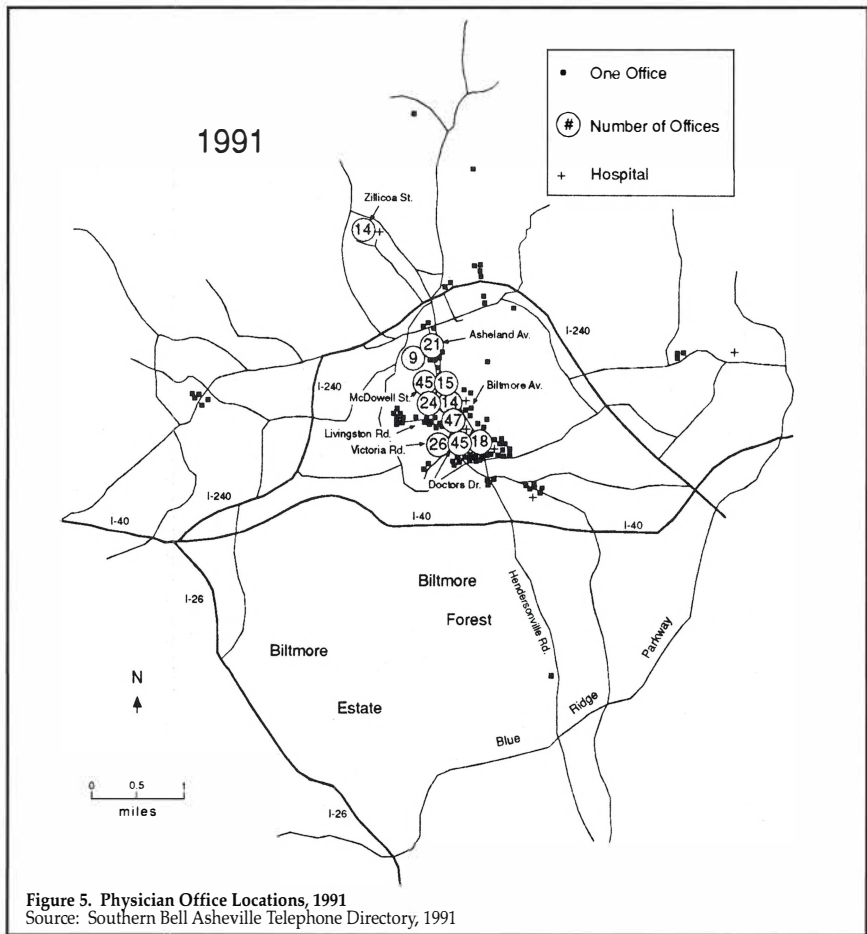
The sequential shifts of physician office locations and medical districts within Asheville during the twentieth century are in line with similar studies of



Bloomington (Indiana), Normal (Mattingly, 1991), and Charlotte (Pyle, 1989). During the first five decades of the 1900s physician offices were clustered within the CBD of each of these three cities. However, the decline of office clusters within CBDs began in the 40s for Charlotte and in the 60s and 70s for Bloomington-Normal and Asheville. Subsequently, physicians began to concentrate near hospitals outside the CBD in the 50s for Charlotte, and since the 60s for Bloomington-Normal and Asheville. In the case of Charlotte, the 70s and 80s brought a southward extension out of the medical district along a thoroughfare referred to as "Doctors' Alley." Charlotte is also experiencing a possible trend in the emergence of medical offices and facilities along major highways radiating outward from the urban core and at peripheral suburban locations.

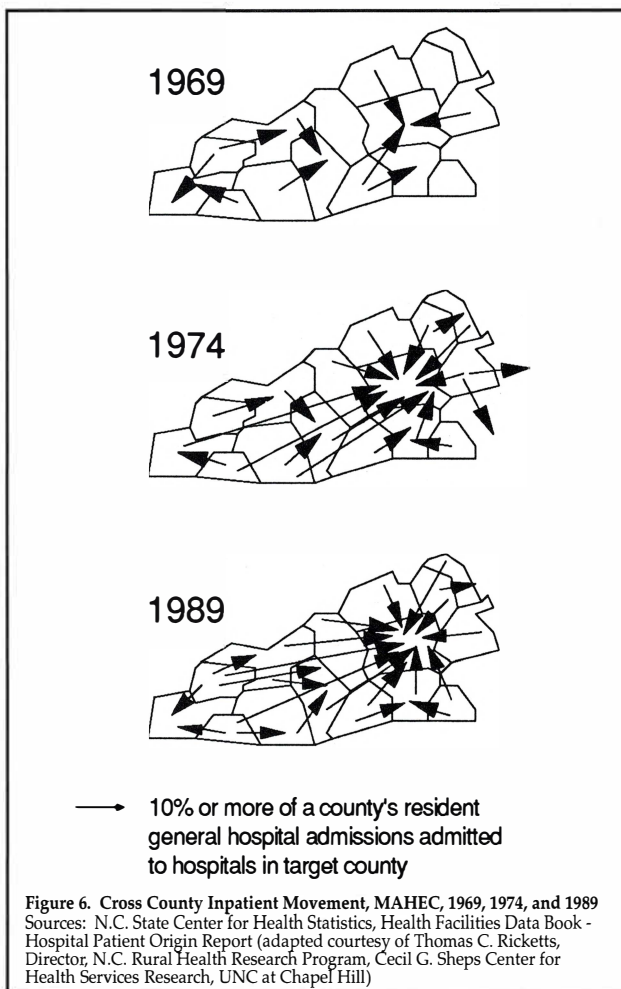
Demographics, Economics, and Utilization

During the last five decades Asheville's population increased 20% from 51,310 in 1940 to 61,607 in 1990 (U.S. Bureau of the Census, 1953, 1992), and Buncombe



County's population increased 61% from 108,755 in 1940 to 174,821 in 1990. In contrast to Asheville and Buncombe County, the Southwest North Carolina Mountain Area Health Education Center (MAHEC) region (Figure 6) has shown a much higher rate of population change, 104% or over 250,000 persons from 1950 to 1990 (U.S. Bureau of the Census, 1953, 1973, 1992).

Patient origins maps illustrate the increasing dependence on Asheville as a focus of health care services within the MAHEC region (Figure 6). MAHEC's mission is to improve the quality, geographic distribution, and retention of health professionals in a fifteen county region of western North Carolina. Arrows represent 10% or more of a county's inpatients admitted for acute care to a hospital(s) in another county. In 1969, a focus began to emerge with three adjacent counties showing flow arrows to Buncombe County. Just five years later, in 1974, this focus became dominant with flow arrows originating from ten counties. This pattern strengthened in 1989 with patient flow arrows originating from twelve counties.



The increase of inpatients from peripheral counties to a core focused on Buncombe County supports the growth in physician offices and the rise of the contemporary medical district in Asheville in the 1970s and 1980s.

The increasing number and percent of persons aged ≥ 65 in the MAHEC region correspond with dramatic growth in physician offices from 1975 to 1991 in Asheville. Further, employment projections for Buncombe County indicate an increase of 15.5% or 15,316 employees from 1990 to 2010. Given an aging population regionally and a growing workforce locally, physicians will continue to be drawn toward Asheville's contemporary medical district, especially along its burgeoning fringes. Future growth of the contemporary medical district will surely displace residential districts and revitalize older commercial sections (Asheville City Planning Department, 1987).

Land Use Controls

Asheville's first zoning (1945) ordinance was designed to maintain the racial status quo "within any one block or between street intersections" (City of Asheville, 1945). Fortunately, in 1948 a more equitable zoning ordinance became effective "to promote the health, safety, morals and general welfare of the inhabitants of the City of Asheville, North Carolina" (City of Asheville, 1948). The purpose being to lessen congestion in the streets; to secure safety from fire, panic and other dangers; to promote health and the general welfare; to provide adequate light and air; to prevent the overcrowding of the land; to avoid undue concentration of population; to facilitate the adequate provisions of transportation, water, sewage, schools, parks and other public requirements; to conserve the value of buildings and encourage the most appropriate use of the land throughout the area of jurisdiction. (City of Asheville, 1986).

For 1948 the zoning ordinance had provisions for six zoning districts, including three residential districts, a neighborhood trading area, a business district, and an industrial district (City of Asheville, 1948). Around 1960 areas adjacent to Biltmore Avenue and McDowell Street in the vicinity of St. Joseph's and Memorial Mission Hospitals were rezoned from residential to business. Current zoning ordinances (City of Asheville, 1991) includes five residential, five commercial, one office and institutional, and two industrial districts (Table 1). Individual doctors are permitted to maintain a home office "provided that no merchandise or commodity is sold ..."

District		Permitted Uses	Conditional Uses
R-1	single-family residential	N	N
R-2	low density residential	N	N
R-3	medium density residential	N	P
R-4	high density residential	P	N
R-5	residential	N	N
OI	office & institutional	P,L,H	N
CR	commercial regional	P	N
CS	commercial service	P, L, H	N
CG	commercial general	P	N
CH	commercial highway	P	N
CBD	central business district	P,L	N
LI	light industrial	P,L,H	N
HI	heavy industrial	P,L,H	N

P = Physician Office	L = Laboratory
H = Hospital	N = No Medical Land Uses

Table 1. Permitted and Conditional Medical Land Uses by Zoning District
Source: Asheville Zoning Ordinance, 1977 (with amendments through 1986)

(City of Asheville, 1986); however, doctors have long since given up this convention (Shumsky, Bohland, and Knox, 1986). In the R-3 medium density residential district, medical offices are a conditional use (i.e., conditional uses require approval from the Board of Adjustments and/or City Council). Medical offices in the R-4 high density residential district are a permitted use. The five commercial and two industrial districts permit medical offices, while the commercial service (CS), office and institutional (OI), and two industrial districts (LI and HI) permit medical offices, laboratories, and hospitals.

Table 2 shows the number and percent of physician offices along with dominant zoning of the five leading streets for each period. In 1948 almost 100 percent of

Year	Location	Physicians*	Percent	Zoning District**
1948†	Battery Park Ave.	22	17.7	Business District
	City Hall	22	17.7	Business District
	North Market St.	20	16.1	Business District
	Haywood St.	12	9.7	Business District
	Patton Ave.	8	6.5	Business District
	Other	40	32.3	Business District
Total		124	100	
1960†	Doctors Dr.	41	33.3	Business District
	Biltmore Ave.	14	11.4	Business District
	Battery Park Ave.	12	9.8	Business District
	Victoria Rd.	10	8.1	Business District
	North Market St.	9	7.3	Business District
	Other	37	30.1	Business District
Total		123	100	
1975††	Doctors Dr.	62	32.4	Office & Institutional
	Biltmore Ave.	42	22.0	Office & Institutional
	McDowell St.	24	12.6	Office & Institutional
	Victoria Rd.	22	11.5	Office & Institutional
	Zillicoa St.	8	4.2	Office & Institutional
	Other	33	17.3	Office & Institutional
Total		191	100	
1991††	Biltmore Ave.	93	25.2	Office & Institutional
	McDowell St.	77	20.9	Office & Institutional
	Doctors Dr.	45	12.2	Office & Institutional
	Victoria Rd.	27	7.3	Office & Institutional
	Asheland Ave.	21	5.7	Commercial Service
	Other	106	28.7	Office & Institutional
Total		369	100	

Table 2. Asheville's Five Leading Streets With Physician Offices

Sources: †Asheville City Directories, 1948 and 1960; ††Southern Bell, Asheville Telephone Directories, 1975 and 1991; Asheville-Buncombe Zoning Ordinance, 1948; Asheville Metropolitan Areas: Commercial Areas Study, 1966; Asheville Zoning Ordinance, 1977 (with amendments through 1986; Asheville Zoning Map, 1991

Notes: *Physicians and Surgeons-MDs; ** For each street the dominant zoning classification influencing the greatest number of physicians is shown in the zoning district column

physicians were within a business district (BD) zoning classification. Observe the shift in classification from business district (BD) to office and institutional (OI) from 1948 to 1991! In 1991 four of the five streets with offices - Biltmore Avenue, McDowell Street, Doctors Drive, and Victoria Road - were within an OI district. Asheland Avenue, with 5.7 percent of physician offices was within a commercial service (CS) district. The contemporary medical district conforms to the office and institutional (OI) zoning district between Biltmore Avenue and McDowell Street. The OI and CS districts, along with the less restrictive light (LI) and heavy industrial (HI) districts, permit the full range of medical facilities, including offices, clinics, and hospitals (City of Asheville, 1986).

Discussion

What has been the role of land use planning on evolving patterns of physician offices and related medical land uses? Obviously, health care delivery systems are dependent on the health status, demographics, and distribution of populations plus a supporting infrastructure including transportation, water and sanitary sewer, and numerous factors other than land use controls. However, land use controls protect existing and emerging patterns of medical uses from incompatible land uses. Thus, the past, present, and potential future roles of land use planning in Asheville form the basis for the following discussion.

In Asheville, there was a concentration of physician offices within and even a general hospital (Memorial Mission Hospital from 1885 to 1954) near the CBD prior to the adoption of the 1948 zoning ordinance. The municipal officials of 1948, recognizing pre-existing conditions and historical inertia, assigned the historic medical district a business district (BD) zoning classification. In the 1960s areas zoned as BD were divided into office and institutional, commercial, and industrial districts; variant forms of these extended from the CBD along much of the Biltmore/McDowell corridor. The division of areas zoned as BD into more specialized non-residential districts had minimal influence since none were particularly restrictive to medical offices and facilities. Here the major restriction excluded hospitals in areas zoned commercial regional (CR), commercial general (CG), and central business district (CD). This discouraged the siting of hospitals in the more congested areas of the city.

Barbour-Cooper & Associates, a planning consulting firm, recommended a complete reevaluation of the zoning classification along the Biltmore/McDowell corridor in 1966 (Metropolitan Planning Board of the City of Asheville and Buncombe County, 1966). The majority of parcels adjacent to Biltmore Avenue and McDowell Street in the early sixties was zoned for business, and with a shift in the concentration of physicians from the CBD after 1960, south to Biltmore Avenue and McDowell Street (contemporary medical district), the business district zoning designation became inadequate. Here the argument went that light industrial uses

(LI), permitted within a business district, were incompatible with existing office and institutional land uses in the emerging contemporary medical district. Thus, at some time between 1966, when Barbour-Cooper & Associates recommended zoning changes, and 1975 (Table 2), the zoning classification of the contemporary medical district became office and institutional. This restricted light manufacturing activities from competing for space with an expanding medical center.

This concern for safeguarding adequate space for health resources was reemphasized more than twenty years later in the 2010 Asheville City Plan (Asheville City Planning Department, 1987). Under the section on health services the following objectives, indicating a strong commitment among citizens, planners, and municipal officials to protect its medical district from incompatible land uses, pertained to land use planning:

- Consider zoning changes to provide adequate land for health related development.
- Ensure that adequate transportation arteries exist to major health-care providers and transportation services are available to high risk population groups (Asheville City Planning Department, 1987, p. 73).

The Asheville City Planning Department, in response to the objectives set forth in the 2010 Asheville City Plan, submitted a draft zoning ordinance to the Asheville City Council for review in November 1993 (Personal Interview, December 24, 1992; Personal Correspondence, October 12, 1993). There are several unique aspects of the draft ordinance that would set Asheville apart from other cities in North Carolina, the Southeast, and perhaps the United States. If approved, the revised ordinance would have a considerable influence on the kind of land uses permitted within the contemporary medical district.

First, the draft ordinance calls for the separation of the current office & institutional (OI) district into two districts, an office district and an educational/campus institutional district (E/C&I). The purpose of the E/C&I district is "to reserve for the development of major educational facilities and health care facilities located in a campus-like setting..." (Personal Correspondence, October 12, 1993). Medium intensity offices uses and service uses that complement the E/C&I district would be permitted. The current (OI) district is too inclusive and does not adequately separate the less intensive uses of the campus-like institutions from the more intensive office uses.

A second aspect of the draft ordinance is the creation of a medical institutional district. To the author's knowledge, no other city in North Carolina has a zoning district specifically addressing medical land uses (City of Charlotte, 1985; City of Greensboro, 1993; City of Raleigh, 1993). The stated pur-

Creating a 'medical institutional district' meets the goal of the 2010 Asheville City Plan of providing adequate land for health related services

pose of the medical institutional district is to provide an area for the development of major medical facilities, health-related development, office development, public services and their necessary support services. The district will help achieve the goal stated in the 2010 Asheville City Plan of providing adequate land for health-related developments.

The draft ordinance is an improvement over the current zoning ordinance in its organization, preciseness, clarity, and forwardness. For each zoning district the purpose, permitted uses, restricted uses, development standards, and other requirements are specifically noted. For example, in the medical institutional district the development standards include: maximum building size (none), minimum size lot (20,000 square feet), minimum lot width (100 feet), minimum side yards (front = 15 feet, sides = 10 feet), maximum impervious surface (80%), maximum height (none), landscaping and buffering (required), parking and loading facilities (required), sidewalks (required), and access (restrictions).

Other North Carolina cities would do well to follow the Asheville example of using land use planning in providing manageable health care

In sum, the draft ordinance separates the previous office and institution district into an office district and an educational/campus institutional district, it creates a medical institutional district, and it refines development standards. Once approved, this version of the zoning ordinance will encourage compatible land uses to group together. The improved development standards should reduce conflict along the edges of different zoning districts while increasing internal homogeneity within districts (i.e., both the educational/campus and the medical institutional districts contain additional access and building height restrictions for parcels within 200 feet of residential districts). The draft ordinance reserves areas for health care uses in recognition of Asheville's status as a regional medical center and to ensure the continued economic health of the city as well. As of December 1994, the draft ordinance continues to be reviewed by the Asheville City Council (Nicholson, 1994).

Conclusions

This paper has examined shifting patterns of physician office locations together with the evolution of land use planning in Asheville. In recent decades, citizens, planners, and elected officials of Asheville have sought to protect existing and emerging patterns of health-related development through land use controls such as zoning ordinances and comprehensive plans. Other cities serving as regional medical centers might follow Asheville's example and consider land use planning to manage areas that specialize in health care services.

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STRANGE WORLDS AND FAMILIAR PLACES: THE NATIONAL GEOGRAPHY STANDARDS AND RE-THINKING GEOGRAPHIC EDUCATION

Tyrel G. Moore and Donald L. Mitchell

Introduction

There hardly could be a more appropriate time for methodological reflection in geographic education. The publication of the National Geography Standards is anticipated as a potential watershed for geographic educational reform in America.

Geography's content as outlined in the Standards' published form, *Geography for Life*, (Geography Education Standards Project, 1994) signals the acceptance of geography in the school curriculum at a national scale. Recognition of geography's status is underscored by specific support in a bill signed by President Clinton and by the fact that geography is written into the 1994 National Assessment of Educational Progress (Salter and Salter, 1994). Furthermore, the Standards place the discipline in a select group of fields for which national standards were prepared and identifies geography as essential knowledge, integrated into American education (Birdsall, 1994). Excitement about these developments which squarely place geography back into a national curriculum should not be confined to the adoption of new initiatives. In a cumulative sense, the Standards are built on at least a decade of hard work by professional geographers and public school teachers. State Geographic Alliances, in particular, have been at the vanguard of the collective activities and successes of those efforts. Achievements of the North Carolina Geographic Alliance provide real reason for optimism. Since its inception in 1987, the Alliance has trained over 350 teachers and its membership has grown to include 6,000 of North Carolina's public school teachers (Wilms, 1994). Simply put, there are tried and tested pedagogical bridges between where we have been and where the Standards may take us. If progress is to continue, those connections need to be considered carefully by public school teachers and by professional geographers.

The overarching purpose of this article is to point out that while the Standards give unprecedented status and visibility to geography in the public school curriculum, a conscious geographic education effort will be required to maintain that status and to implement the Standards. Support of the Standards represents an unusual opportunity to enhance geographic

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The National Geography Standards, aided and abetted by 6000 plus North Carolina Geographic Alliance trained teachers, give unprecedented status and visibility to geography in the state's school systems

education in North Carolina and at a national level. Bednarz and Bednarz (1994) suggest that realization of that opportunity depends heavily on the development of new strategies and teaching innovations which emanate from the Standards' content. This article argues that new directions should be grounded in a renewed commitment to geographic education, one that first involves a rethinking of the successes that the Standards were built upon. We develop that notion with a brief overview of the evolution of geographic education efforts that brought professional geographers and public school teachers to a point of collaboration, and then discuss the links between the new initiatives and the geographic education strategies of the past decade, particularly the Five Fundamental Themes of Geography. Finally, an excerpt of a model lesson is presented to illustrate geographic perspectives embodied in the "elements of geography" model which predates the five themes. The model has pedagogic value for the five themes and for the initiatives of the Standards. We do not recommend the elements model as an alternative to those strategies, but as a useful prerequisite that can enhance their effectiveness. Data for this paper comes from a review of a literature which provides an historical view of directions in geographic education, and geographic education experiences which incorporate the dual perspectives of a professional geographer and a public school teacher. This latter source spans involvement in geographic education seminars and in Alliance Summer Geography Institutes in North Carolina as well as discussions with professional geographers and public school teachers in the state.

An Overview of Geographic Education Efforts

Salter and Salter (1994) have captured the essence of the policy-forming process for educational reform that drove geographic education strategies for roughly the last decade. They outline the process as one triggered by alarm, bolstered by media attention, followed by concerted reform efforts which culminate in a document conveying associated strategies for implementation and assessment.

If a national symbol of the mid-1980s alarm over geographic literacy were identified, *Newsweek's* 1986 publication of the "Strange World" depicting the mapped results of the University of North Carolina survey, might have served as the banner. While the map portrayed a geography that could revolutionize television weather reports with references to invasions by cold, dry African air masses and perhaps legitimize American foreign policy of the "Cold War" era Central America, it was symptomatic of something severely wrong with geographic education. A 1988 Gallup Poll offered further evidence in support of the 1986 survey, revealing geographic illiteracy at a national scale. Americans not only performed more poorly on locational abilities than their previous generation, but also lagged behind performances of 18-24 year olds in almost every industrialized country in the world (Hardwick and Holtgrieve, 1990; Viadero, 1992). By extension, the magnitude of mapping errors offered proof that, popularly defined, geography in America's

schools was "the subject everyone loves to hate—a dreary litany of state capitals, mountain ranges and principal crops" (Salholz, Katz and Wright, 1986, 67). That the errors were made by college students reflected the dismal status of geography's place in public school curricula and made an associated statement about teacher training in geographic education.

Geography's place in the curriculum had been subsumed by the the dominance of social studies since the late 1950s. Teachers simply were not being trained to teach geography's small role in the larger curriculum (Hardwick and Holtgrieve, 1990). The educational backgrounds of teachers enrolled in geographic education seminars in the University of North Carolina at Charlotte service area reflect a related lack of training. In three seminars for example, over two-thirds of the participating teachers had no previous geographic training; the remainder had taken no more than one or two geography courses in their undergraduate curricula. These ratios paralleled data from a 1982 national survey and underscored the minimal formal training held by many social science and history teachers (Gardner, 1986).

Concerted reform efforts and the crafting of a policy document outlining strategies were well underway by the time geographic literacy gained the attention of the media. In 1984, the Joint Committee on Geographic Education, which pooled the resources of the Association of American Geographers and the National Council on Geographic Education, published *Guidelines for Geographic Education-Elementary and Secondary Schools* (National Assessment Governing Board, 1994; Natoli, 1994). This served as a catalyst for attention in the professional media. Between November 1985 and August 1986, no fewer than fourteen geographic education entries appeared in issues of *The Professional Geographer* and the *Annals* of the Association of American Geographers. Much of the discussion centered on strategies for state-wide curricular change, development of curriculum materials for local school systems and, for professional geographers, more active involvement in teacher training. Presidential commentaries in Newsletters of both the Association and its Southeastern Division echoed the call for efforts that would improve the quality of geography in our public schools (Abler, 1986; Aiken, 1986).

Implementation strategies of the 1984 School systems across North Carolina have adopted the familiar Five Themes of Geography into their basic K-12 curriculum Using the five themes as a content oriented framework runs the risk of pigeonholing geographic facts that are divorced from the synthesis of geographic phenomena, the heart of the discipline rested pedagogically on the now familiar Five Themes of Geography: Place, Location, Human-Environment Interactions, Movement, and Region. (Hardwick and Holtgrieve, 1990; National Assessment Governing Board, 1994). With these themes as organizing ideas and a content-defining centerpiece for geography, professional geographers were brought into a collaborative effort by the Geography Education National Implementation Project in 1985 (Viadero, 1992).

School systems across North Carolina have adopted the familiar Five Themes of Geography into their basic K-12 curriculum

The five themes also hold a central place in policy reform and curricular change. Public school systems across North Carolina have adopted the themes into their basic curriculum. Individual themes exist as strands throughout the K-12 state curriculum (Henson, n.d.). Their utility has been demonstrated by State Geographic Alliances which have created a common ground for teacher training and an effective lobbying voice for geography at the state level. Backed by matching resources of the National Geographic Society and its highly successful Geography Education Program, Alliances now exist in all 50 states and in Puerto Rico. This network carries the National Standards into future via a highly visible and active coalition of professional geographers and public school teachers (Salter and Salter, 1994).

The Five Themes and the National Standards

The National Standards are touted not just because they place geography into a nationally-recognized curriculum, but because they offer new possibilities for teaching geographic content (Salter and Salter, 1994; Bednarz and Bednarz, 1994). Although professional geographers would recognize elements of the Standards as long-held geographic relationships, Bednarz and Bednarz define the structure of the Standards as comprised of five innovations (Table 1). These are seen as improvements on the following grounds: the way that place geography has been conceptualized, the holistic approach provided by viewing sets of phenomena as interrelated systems, opening avenues for application of concepts, and by identifying a natural partnership between geography and history in social studies (Bednarz and Bednarz, 1994).

- 1) mental maps
- 2) systems
- 3) physical geography
- 4) environmental education
- 5) the importance of geography for understanding the past, the present, and the future

Table 1. Innovations Contained in the National Geography Standards
Source: Bednarz and Bednarz (1994).

Like previous policy efforts and reforms, the Standard's pedagogic framework rests heavily on the Five Themes of Geographic Education. Harper (1990 and 1992) and Gershmel (1992), however, have critically appraised the five themes on both philosophical and pedagogical grounds. Their criticisms exemplify a broader debate centered on the five themes' definition of the content of geography, and on

their rigidity and overall utility as a teaching strategy. These concerns will persist with the coming of the Standards because they dovetail with the five themes in two important ways. First, the five themes are identified as components of familiarity in the Innovations of the Standards. Second, the skills emphasized in the Standards (asking geographic questions, acquiring geographic information, organizing geographic information, analyzing geographic information, and answering geographic questions) were first identified along with the five themes in 1984 (Bednarz and Bednarz, 1994). In this interpretation, the five themes form important philosophical and operational bridges between older and newer geographic education strategies. Harper's warnings (1990 and 1992) that the five themes did more to identify content that might just as well fall under the purview of history or sociology, than to define the perspective of geography may therefore be a caveat common to the Standards. Gershmel's (1992) caution that the five themes work best when used inductively rather than deductively adds to the argument that a geographic perspective may become lost when the quest for unifying principles are stressed in favor of relationships that exist in different places.

Using the five themes as a content oriented framework runs the risk of pigeonholing geographic facts that are divorced from the synthesis of geographic phenomena, the heart of the discipline

One inherent danger is that the five themes may be understood as a taxonomy, rather than a process-oriented structure for teaching geography and comprehending spatial relationships. Using the five themes as a content-oriented framework runs the risk of isolating geographic phenomena into a pigeonholing of facts that are divorced from the synthesis which lies at the heart of the geographic perspective. Metaphorically, a simplistic grasp of the five themes may be likened to individually recognizing the fingers and the thumb of a hand without seeing that they work together to give function to the hand. Connections lost in this way limit the use of the five themes to that of a checklist for identifying place-specific geographic information. This kind of oversimplification yields little insight beyond the isolated memorization that produced a geography comprising a dreary litany of state capitals, and features.

The Elements of Geography and Familiar Places

Regardless of the relational innovations outlined in the Standards and the ease of content identity carried via the five themes, significant initial barriers to geographic education exist for teachers and their pupils. Common complaints often center around interpretation and use of teaching materials. For example, the previous generation of North Carolina's elementary school textbooks introduced concepts of location by dividing the world into hemispheres. While this global perspective has merit in a broader understanding, it is not easy for students to grasp for example, that they could be located in the town of Troy, in Montgomery County

and in North Carolina at the same moment. Approaching the fundamental issue of scale from a local context, working from the more familiar ground of classrooms or home areas to introduce concepts of absolute and relative locations provides an effective solution. This also meshes with the theme of location, and is especially applicable in school systems that use textbooks organized around the five themes.

A second barrier rests in untrained teachers' limited perspectives of the content of geography. Even for those with some collegiate training in geography, there is an overwhelming tendency to focus on physical features and influences, perhaps because they are more tangible than cultural or social geographic influences. The net result is that many teachers take rather deterministic views of geography into their classrooms. Social studies teachers often omit geography from history lessons after it has been used to establish a physical setting for the history which follows. Omitted, too, are the explanatory power and understanding that geographic relationships can bring to social and historical processes.

An approach that we have employed successfully is to use local geography or the geography of a favorite place as a written exercise that introduces geographic Inspectives. The model of physical and cultural geographic elements, which appears as standard in virtually all introductory college-level textbooks and as an introductory handout in North Carolina Geographic Alliance notebooks is used effectively as a conceptual model (Table 2). It's a simple tool with great capacity. By providing a comprehensive introduction of the content of geography, it also holds exceptional potential as a prerequisite to introduce the five themes.

PHYSICAL ELEMENTS	G	CULTURAL ELEMENTS
Weather and Climate	E	Population
Landforms	O	Settlement Patterns
Soils	G	Language
Mineral Resources	R	Economic Systems
Water Resources	A	Culture Groups
Natural Vegetation	P	Cultural Institution
Animal Life	H	Environmental Perception
Location	Y	Religion
		Transportation Systems,
		Technology, Location

Table 2. Elements of Geography.

The geographic perspective depicted in the model is one of interrelated sets of phenomena and influences that shape the geography of places and regions. Seen together, the elements comprise a system which lays the foundation for each of the five themes. Bednarz and Bednarz (1994) baldly assert that while systems are familiar to scientists, they are new to geographers. The elements of geography, an organizing model within the discipline for decades, is nothing if not a system. As such, it communicates geographic relationships and geography's relationship to other subjects. It is a relatively simple tool and has great capacity.

Seminar assignments oriented to the elements sought to achieve two objectives: 1) introduce the content and relationships of geography via the elements of geography in a written geography of some local example or favorite place; and 2) use perspectives gained in the first activity to produce a similar activity to be used by pupils the teachers' classrooms. The second activity thus focused upon a classroom application, with modifications to suit to specific grade levels. Seminar projects featured an array of teaching units produced by teachers using the elements as a base to incorporate mathematics in map skills exercises, ecological inventories in science, and analyses of land use and census data in geography. Others adapted the synthesizing perspective of geography to writing and language arts classes. Excerpts from one of the more innovative seminar projects, written by Don Mitchell, is provided as an example. It evolved from a draft of the geography of a teacher's favorite place, to a more innovative geographic concept of activity spaces. In the process, it captures a number of relationships that give significance to spatial relationships and a sense of place that are part of the typical school community across the state. A second component of the example comments on a method for using the activity for students at the seventh grade level.

The Newton-Conover Middle School Red Devils Basketball Court as Activity Space

The relative location of the Newton-Conover Middle School Gymnasium intersects with other areas of the school to create a community of learning. Most obvious among the gym's connections to the school is the physical element of a common wall linking it to a main hallway. This connection neither begins nor ends at that point, but extends into the realm of the cognitive domain (academics), aspects of the affective domain (social/emotional development), and the psycho-motor domain (physical skills) of the students that inhabit this building during the school term. Elements of the cognitive domain emphasize the study of strategy, along with rules interpretation and knowledge on the history of the physical activity. Affective domain features include the ability of individuals to interact with others of different backgrounds and to develop skill levels in a particular game. A common goal of

The 'Red Devils' Basketball Court can be used in the classroom as an example of the concept of geographic activity spaces

this interaction is to play together as a team. It is also important that the participants learn to handle successes that result from victories, as well as develop character in the face of adversity.

Although the gym is not the focal point of the school, it is a place of daily contact for almost all students in the school. It has many meanings to many individuals. Among those meanings, it goes beyond being just a basketball court, to become a place for student assemblies, athletic events, intramural activities and faculty walking. The gymnasium is also a significant community place that provides location for fund raising events, including the ever popular student-faculty basketball games. Funds that have been raised from this location often benefit community projects, such as assistance for families of Persian Gulf veterans or a special restoration project at the State Capital building. Finally, the gym provides a haven for the eighth graders' socializing prior to school during the winter months.

During basketball season, the gym is a point of intersection for the school and the community culture. Many basic social institutions are represented in that blend of the two cultures. Wild animal life is sometimes represented in the emotional level of participants and spectators, especially their reaction to the zebras, (referees) who patrol the activity and its participants. At times, cultural behavior takes on dimensions that resemble a religious ceremony when transfixed spectators respond to game action. Languages expressed verbally consist of different jargon provided by each team and the officials controlling the game. Each group also uses specific hand signals that have meanings to their particular group. Spectators and participants know there are certain taboos not to be expressed, if they want to continue to be involved in the event. In many respects, on game night, the gym is a model of significant elements of the larger cultural landscape.

Writing about the geography of a place is an excellent way of combining all aspects of geography into a format that can be understood, not just by teachers, but by their students across a number of grade levels. As a student assignment, carefully defined assignments and feedback through the teacher's comments and peer evaluation in small groups are essential to the effectiveness of such projects. This is an intensive process that best lends itself to a semester-long social studies activity, somewhat akin to the "expanding horizons" strategy employed in teaching social studies. Writing about geography, editing, and producing improved versions keeps geography in the forefront of a broader on-going integration with social studies concepts and material. In the wider context, the student assignment provides meaning, purpose, and structure to the significant perspective of geography. Finally, it is an exercise that sets the stage for effective use of the five themes by building a strong foundation for the content of geography and its conceptual relationships. In that context, the elements approach could have future utility where the five themes are embodied in the Standards.

Conclusions

Universal application of the National Geography Standards represents an achievement and an opportunity earned through the hard work of geography teachers over the past ten years

Progress and reform in geographic education has been recognized as a disciplinary hallmark of the past decade. Acceptance and publication of the National Standards is not merely geography's windfall gained through legislation. Instead, it represents an achievement and an opportunity earned through the hard work of geographers and public school teachers, particularly during the last ten years. Salter and Salter (1994) point out however, that, in the wake of the National Geography Standards, reality will still be shaped by the fact that many teachers will be called upon to teach geography without any significant formal training in the discipline. Our efforts must continue. To do that effectively, rethinking, rather than complacency, are needed to realize continued progress. Both old and new pedagogic strategies have merit and should not be viewed as mutually exclusive. A number of approaches seem viable, and choices should be made thoughtfully.

If geography is back from exile in the social studies, we need to maintain its new status and place in the curriculum. We would be helping our students and our discipline.

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RECORDING DEVELOPMENT AND CHANGE AT THE SHORE

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Introduction

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In addition to the natural forces at work on coastlines there is the change being brought about by increasing populations. With the passage of time the shorelines of this state are becoming more crowded with people and their structures. Where rates of development are rapid we find that map revisions cannot keep pace and we must rely on other information sources for data. Standard vertical aerial photography, of the type produced by governmental agencies and private concerns, can provide very complete information about structures, vegetation, and coastal morphology. But, even these photographs may not be available for the desired time periods or at suitable scales. Also, ordering such coverage on a recurring basis can be very expensive.

In this report we focus on the needs of public and private agencies in acquiring reasonably low cost aerial photography. These basics include considerations of choice of aircraft, weather conditions ideal for flying and photography, camera and film needs, and, most importantly, a sample test flight. In this example we are more concerned about recording changes in coastal land use, but interests in coastal morphology, hydrology, and natural vegetation may be well served as well.

Oblique Photography

Agencies of municipal, county, and state governments, concerned with coastal development and public safety, have a relatively low cost data recording system available to them. It is a system of aerial photography which can be carried out by the agencies themselves. No great technical expertise is necessary. Once the method has been learned, it becomes possible for an agency to obtain a photographic record of its shoreline of responsibility at short notice taken by its own staff. The equipment required is available in any good camera store, and suitable aircraft can be hired by the hour to do the job.

For purposes of this discussion it should be understood that the type of camera referred to is a standard 35mm single lens reflex with a lens of normal focal length (about 50mm). The end product of this method is a 35 mm color transparency taken at a low oblique angle. Such small photographs are capable of display-

With the example of recording changes along our North Carolina coast, in this report we focus on the needs of public and private agencies to obtain low cost aerial photography

ing a great deal of detail when projected. It is also possible to make prints from the color slides. Both the slides and prints can be processed at relatively low cost anywhere in the country.

An oblique photograph is made by pointing the camera somewhere between the horizon and straight down. If the horizon is visible, the view is called a high oblique, otherwise it is a low oblique. Figure 1 shows how such a photograph may be made. The resulting images are perspective views and can not easily be used to make maps. However, they do provide a visual record which is understood by everyone without difficulty. No special training in aerial photographic interpretation is necessary (Reynolds, 1981).

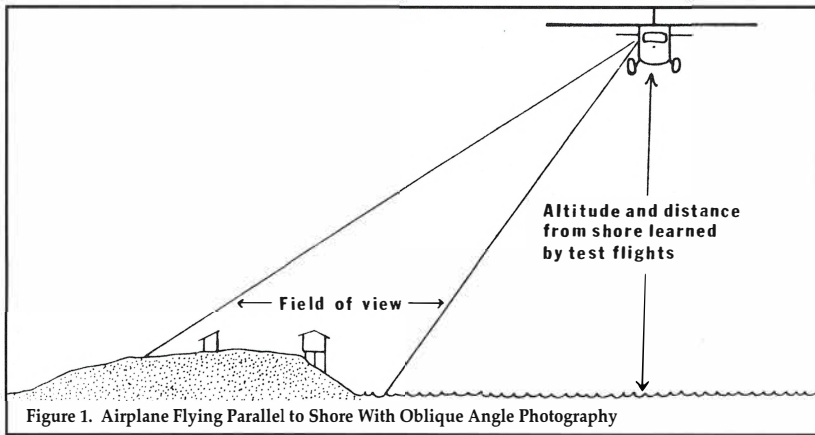


Figure 1. Airplane Flying Parallel to Shore With Oblique Angle Photography

Air Craft Selection and Pre-Flight Preparations

For many types of aerial photography the special flying characteristics of the helicopter makes it the obvious and best choice. Its ability to hover at any altitude allows the photographer to choose his angle carefully and compose a satisfactory image. The type of photography being proposed in this report does not require this special ability, so the higher hourly rental fee of a helicopter is not warranted. Fixed wing airplanes slowly flying along a coast will provide satisfactory platforms to carry out the types of missions described below. Suitable aircraft are available as either high-winged or low-winged types. Low-winged airplanes often do not have windows that can be opened and the wing may come between the camera and the scene to be recorded. High-winged light airplanes are preferable for the making of oblique aerial photographs (Figure 2). The placement of the wings is less likely to interfere and they have windows which can be opened and doors that can be removed, should this become necessary (Eastman Kodak, 1985).

High winged light aircraft flying slowly along the coast provide a satisfactory platform for this kind of mission

At airports in the United States high-winged rental aircraft will usually be products of the Cessna Company. Those models produced after 1964 have, with few exceptions, the swing out type of window. These are latched at the bottom and are mounted on hinges across the top. They are kept from swinging out too far by a metal strap when the window is opened in flight. The size of this opening is too small and constrictive for photography so, before taking off, the metal strap should be detached from the door frame. This is easily accomplished with a screwdriver and should be undertaken by the pilot or rental staff. In flight, the window is carefully unlatched and firmly held until it swings out and rests against the underside of the wing where the flow of air will keep it out of the way during the mission. Obviously, not having the window between the camera and the scene to be recorded will produce better photographs. When flying and photographing with the door removed or through an open window it is necessary to maintain a firm grip on the camera and to wear the camera strap around the shoulder. At several thou-



Figure 2. A High Winged Airplane, the Cessna 17

sand feet altitude with the window open it will be cooler than on the ground so warm clothes are often necessary, even in summer.

Before take-off, the pilot must be fully informed about location, mission objectives, and procedures to be followed. Consulting a map of the area to be photographed will enable the pilot to plan his approach and to estimate flight time. Once in the air the normal cockpit noise will make conversation very difficult so the pilot

should be briefed as fully as possible before take-off. Not only should the pilot understand the objectives of the mission, but a group of hand signals ought to be agreed upon to indicate changes in aircraft position desired by the photographer during the flight. Voice communication with the pilot through a head set is another way of dealing with desired alterations in airplane position, but some photographers find this arrangement too cumbersome while working in a confined space (Eastman Kodak, 1985).

Weather, Time of Day, and Season for Optimum Results

Best photographic results will be obtained in bright, clear, and calm weather. Given the record keeping objective of the oblique coastal photography being described here, there will be little urgency to carry out a mission on a particular day. It should be possible to wait a few days for best weather conditions. Close contact with the airplane rental company will provide the most up-to-date forecasts for the target area. Federal Aviation Administration (FAA) 12 hour forecasts are available for specific terminals and areas. This will provide sufficient lead time for the photographer and pilot to prepare for a mission on the following day (Reynolds, 1981).

In general, weather conditions are considered to be good when visibility is 15 miles or more and winds do not exceed 10 to 15 miles per hour (Eastman Kodak, 1985). Conditions may be good inland but haze is a coastal phenomenon and is always present in varying degrees. On extremely hazy days it may be necessary to cancel the flight. Also, scattered cumulus clouds on an otherwise bright day may cast their shadows over the target area. Since part of a scene will be illuminated and part will be in a black shadow, setting the camera for a proper exposure becomes difficult. Rather than use expensive flying time waiting for the clouds to move on, it may be better to cancel the flight until conditions change. The low angle of the sun above the horizon in the early morning and late afternoon is responsible for the longest shadows of the day. For most aerial photographic purposes long shadows are considered undesirable because they obscure detail. The least shadow is cast at noon when the sun is highest in the sky but some photographers object to that time of day because they feel that the resulting pictures lack depth. For record keeping purposes, however, clarity is more important than artistic appearances and a little experimentation with noon photography will indicate its suitability.

It is generally agreed that the best times for most purposes is to fly and shoot in the mid-morning or mid-afternoon. At those times the shadows are of intermediate length and the scene is well illuminated. The camera may be pointed in almost any direction with the possible exception of shooting a coast that is back lit. In such a case the camera is facing the sun and shadows will be cast toward the camera obscuring desired detail. If back lighting along a particular stretch of coastline

occurs in the morning, better results will be obtained by an afternoon flight and vice versa.

The object of the aerial photography being described here is to record structures on or near the shore. Such structures may be obscured by dense vegetation in summer. In such cases better results may be obtained by doing the photography in early spring before trees are in leaf or late autumn when the leaves have fallen. If the weather is not too cold, winter flights may be undertaken.

Cameras, Films, and Filters

A standard off-the-shelf 35mm single lens reflex camera, with eye level viewing and shutter speeds of 1/1000, will well serve this kind of photography

As already indicated, this type of photography is for the production of color slides and the best camera for the purpose is the 35mm single lens reflex. Any standard off-the-shelf camera with eye level viewing and shutter speeds up to 1/1000 second will serve the purpose. The higher shutter speeds are necessary in order to counter the effects of forward motion and airplane vibration. Since the camera is being handheld, vibration can be further diminished by avoiding contact of any part of the photographer's upper body with the airplane (Eastman Kodak, 1985). The author has found that a normal 50mm lens works best for this kind of photography. Using longer lenses tends to accentuate vibration and shorter lenses

may require lower flight altitudes.

Having a built in power winder is helpful because it does away with one more operation which could distract the photographer. And a camera with automatic focusing capability is not necessary since the lens is set at infinity for this type of aerial photography.

There are a number of films made specifically for aerial photography, but these are available only in sizes of 70mm and larger. They do, however, have their counterparts in 35mm format pictorial films which are suitable for oblique aerial photography when used with proper filters. For example, Kodak Aerochrome MS Film 2448 has a 35mm counterpart in Kodak Ektachrome 200 Film. Emulsions here are very similar, but the Aerochrome is formulated for higher contrast in order to reduce the everyday effects of atmospheric haze (Eastman Kodak, 1985). So the 35mm Ektachrome 200 Film (ASA 200) is ideal for the types of photography discussed here since the end product is a color slide. A similar film made by another manufacturer is Fujichrome.

Avoid the use of films with speeds greater than ASA 200 unless light conditions are such that the only alternative is no picture at all. As the ASA speed increases so does the grain size. So slower films have finer grain but will require slower shutter speeds which may result in motion blur. The color slide film for possible aerial use having the finest grain and producing the sharpest slides is

Kodachrome 64 (ASA 64). It can be used successfully under bright and clear conditions, otherwise a speed of ASA 100 should be considered the minimum for coastal aerial photography.

Another very versatile type of film which may be used is Kodacolor VR, Kodak Ektar, or Fujicolor. All of these are color negative films which are mainly used to produce color prints. They can also be used to make black-and-white prints as well as slides from the same color negatives.

Camera settings should be based on a shutter speed of 1/500 second for best results. A speed of 1/250 second is the absolute slowest for aerial photography. Up to 2000 feet altitude the exposure meter in the camera can be relied on for accurate settings when shooting low obliques during the period from mid-morning through mid-afternoon. When flying higher or shooting high obliques, the increased amount of haze will cause the meter to register the scene as being very bright. Under these conditions it will be necessary to close down the aperture by as much as one full f stop (Eastman Kodak, 1985).

Color films are sensitive to wavelengths extending into the near-ultraviolet to about 0.36 micrometers. This portion of the spectrum is below the blue wavelengths and is not visible to the eye. The effect is to register on the film as blue haze and decrease the overall contrast in the resulting photograph. This is in addition to the visible haze which results from the scattering of blue light in the atmosphere by water vapor and suspended particles. While it is not practical to filter out the blue portion of the visible spectrum when using color film, ultraviolet can be controlled with the use of a Kodak Wratten 1A filter. This is the Skylight filter which appears to be colorless but is actually a very light yellow. Since it does not cut out any portion of the visible spectrum, no exposure adjustment is needed when it is used. For this reason many photographers keep Skylight filters on their cameras as lens protectors. Other filters suitable for use in color aerial photography are the Wratten 2B, 2C, HF-3, HF-4, and HF-5 (Blacker, 1975). Photographic dealers can supply more detailed information about their characteristics or inquiries may be directed to: Eastman Kodak Co., Rochester, NY 14650.

Making an Aerial Video Tape Record

In recent years, as the technology has developed, video camera recorders (camcorders) have come into wide use. In some cases recording on video tape may replace still photographs or represent an improved method to collect information. Readers may wish to experiment with a camcorder doing aerial photography. Much of what has been said applying to aircraft, time of day, season, and weather will also apply to flights where the camcorder is used. The instrument should be one using VHS tapes and have a multiple speed shutter going to 1/1000 second for the same reason that fast speeds are needed on

Camcorders a video cassette recorders with high tech telesound systems are increasingly used

a camera.

Of equal importance with the camcorder is the videocassette recorder used in playing the tapes. This machine should have a four-head system in order to provide clear views when the tape is stopped for examining still images. Machines with two heads always show slightly blurred images in the still mode. Finally, a high quality TV with a large screen is needed to round out the system.

A Test Flight

Each organization will need to conduct at least one test flight to determine the camera angle and aircraft altitude of future operational flights. Experience has indicated that the most useful ranges of altitude lie between 1000 and 4000 feet above the shoreline being recorded. A single roll of 36 exposure film will suffice for this test. Flying parallel to the shore at 4000 feet over the water the test may begin with a series of five exposures as illustrated in Figure 3. The aircraft should then swing out over the water and drop down to an altitude of 3500 feet before returning to make another run along the same stretch of coast. Again, five more exposures should be made before the aircraft swings off shore and drops down to 3000 feet to make another pass by the test area.

With each subsequent 500 foot change in altitude down to 1000 feet five exposures should be made taking care to remain the same distance off shore in every case. Examination of the finished slides will indicate which altitude provides the optimum detail required. A second test flight at the selected altitude may be needed to determine how much distance away from the shore will provide the best angle of view.

Carrying Out the Mission

Since the objective is to produce a continuous record of a long shore line it will be necessary to make a series of photographs which overlap each other. It is important that there be no gaps in the coverage. Figure 3 illustrates how this may be accomplished. The task requires the continuous attention of the photographer who

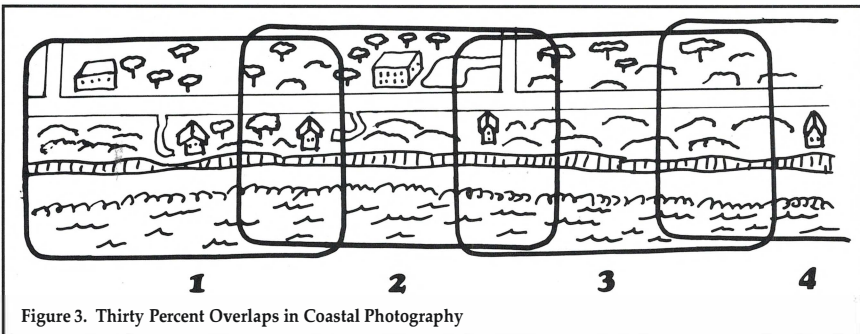


Figure 3. Thirty Percent Overlaps in Coastal Photography

will need to note shoreline features where the leading edge of each frame is located at the instant of exposure. The succeeding exposure should be made before that location disappears from the finder. This means that the position of the camera must not be changed and that the photographer continues to look through the view finder throughout the flight. In addition, the pilot must be carefully briefed before take off as to the altitude and distance from shore to be maintained. In cases where very long shore lines are to be photographed it may be worthwhile purchasing a bulk film back for the camera. Such replaceable backs are capable of holding hundreds of 35mm frames thereby doing away with the necessity of reloading in the midst of the flight. Organizations like municipalities regularly recording shorter lengths of coastline may be able to complete the task using one or more standard 36 exposure film cartridges.

Should it become necessary to reload the camera in order to complete the coverage the following procedure is suggested. On making the last exposure on the roll the photographer should take special note of coastal features included in that view. By previous arrangement, a signal to the pilot activates a maneuver intended to give the photographer time to rewind the film and insert a new cassette. The plane swings out over the water making a large circle bringing it back into position flying parallel to the shore. When this is done correctly, the photographer will have time to reload and return to the window and see some of the coast previously covered before resuming photography. Numbering the cassettes before the flight will avoid confusion in arranging the finished slides sequentially when they are returned after processing. When shooting more than one roll, the author uses the first frame as a quick means of identification. The pilot holds up a hand with one finger extended for the first frame shot on the roll before beginning the actual photography. For the second roll, two fingers are photographed, and so on. Having two similar cameras on board and an assistant to load and unload them is yet another way to insure uninterrupted coverage and a smooth flight.

Indexing the Slides

In order to create an index it is important to key the slides to a map of appropriate scale. Some years ago the author photographed the entire 310 mile Atlantic shoreline of North Carolina and marked the location of each exposure on an official state highway map. For short stretches of coast, a U.S. Geological Survey 7 1/2 minute quadrangle will suffice.

The first step in constructing an index of exposures is to arrange the slides in proper sequence. They should then be renumbered according to this arrangement disregarding their frame numbers, especially if more than one cassette was used. Next, the limits of coastline covered by each slide should be marked on the map and its number recorded in that place. In addition, each slide should be marked with the date of the flight, which must also appear on the index map. A separate

index map is required for each flight. Such oblique aerial photography may be repeated on an annual basis or more frequently in places where there is active construction, or weather related destruction, in progress. Slower developing coast lines may only require coverage every few years. Gradually, an organization will accumulate a visual record of its coastline of responsibility showing details of structures, terrain, and vegetation. The kinds of information depicted in this fashion may simply be unavailable from other sources. In a dynamic environment like the coast, photographs of this type that are only a few years or months old constitute a collection of historic data which may prove invaluable.

Detecting Land Use Changes

Three ways are being proposed as to how oblique aerial photographs of the coast may be used, others will suggest themselves to readers. Repetitive coverage will provide a pictorial inventory of building and other construction activities along the shore and its vicinity. Differences may easily be detected between various dates of coverage of the same segment of coast.

For example, Figure 4 shows the initial situation along a half mile stretch of North Carolina coast. The purpose of the flight was to record the number, location, and types of buildings along the shore. The information is clear even in this somewhat degraded copy of the original color slide. When projected, the slide clearly divulges details of the structures and their surroundings.

Figure 5, taken five years later, shows the same stretch of coast. The old build-

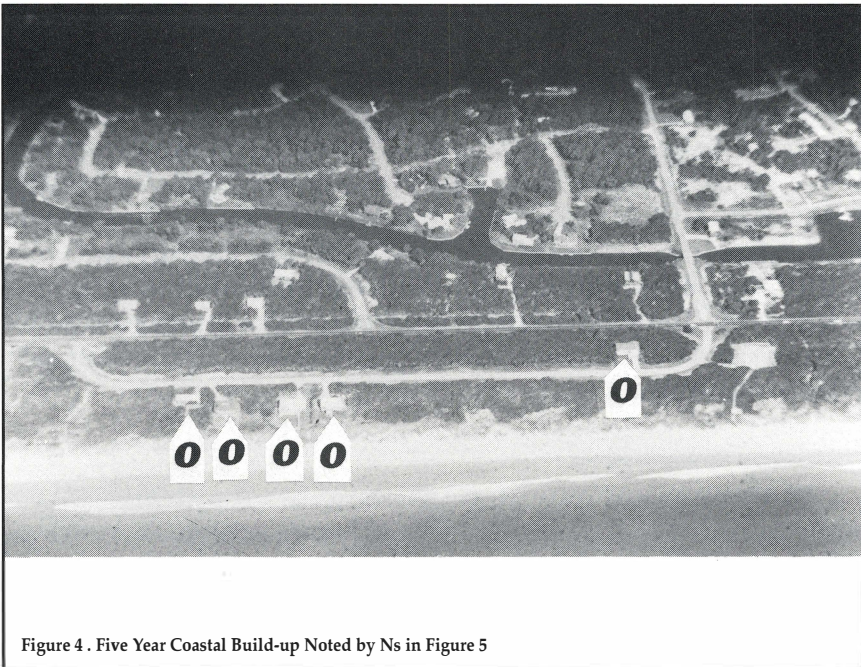


Figure 4 . Five Year Coastal Build-up Noted by Ns in Figure 5

ings are visible and the new ones can be easily identified. Comparisons between the two images when projected on adjoining screens may then be readily made and recorded onto large scale maps.

Storm Damage Assessment

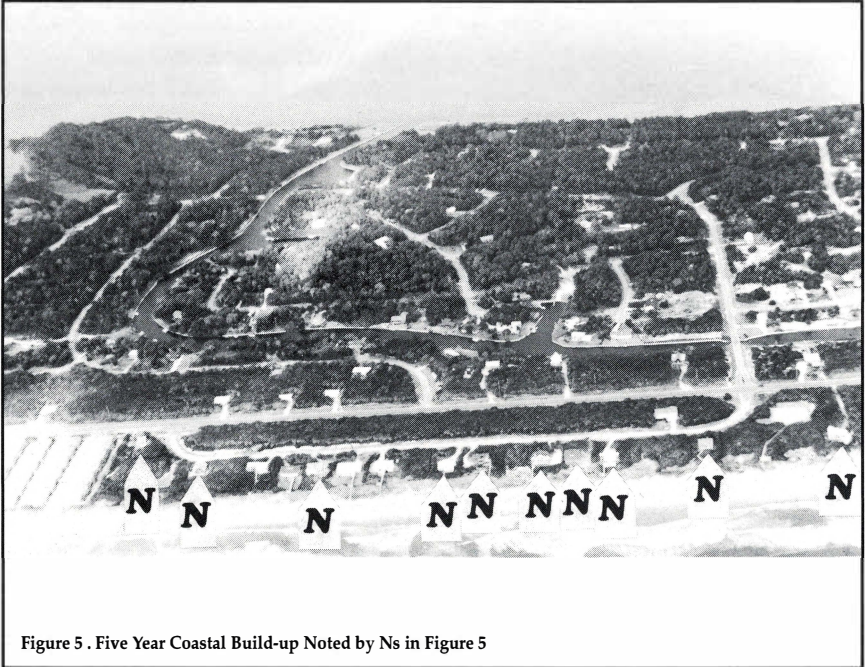


Figure 5 . Five Year Coastal Build-up Noted by Ns in Figure 5

A second way such photography may be used is in storm damage assessment. Let us assume that a serious storm is in progress along the coast covered by Figure 5. As soon as the storm is over and it is possible to safely fly in a light airplane, the photographer is sent aloft to cover that portion of the coast affected by the storm. Flying parallel to the shore over the water at the same height as in Figure 5, a series of overlapping images is made. The next step is to view the post storm photographs along side the most recently made routine normal coverage of the same area (Figure 5). Once again, several people simultaneously observing prestorm and post storm slides will have enough information to make a realistic preliminary assessment of damage.

Public Presentations

The third suggested use of these aerial oblique slides is in making public presentations about the coast to governmental bodies and interest groups. Unlike vertical aerial photographs which present a generally unfamiliar view of the earth, the oblique angle provides a more easily understood perspective view which is like

standing on a high place and looking downward and toward the horizon. Agencies involved with the coast will find that oblique views are extremely useful as parts of their presentations when conveying information about it. Maps are more readily comprehended when accompanied by oblique views showing the actual appearance of areas under discussion. Organizations regularly photographing the coast should be able to put together historical sequences of slides portraying human and natural changes in that dynamic environment, and these will also have considerable impact on non-specialists and specialists alike.

Summary

Oblique aerial photographs, in the form of color slides, are easily made and are relatively low in cost. Even though they do not readily lend themselves to mapping uses, they can provide qualitative and quantitative information about old and new structures to agencies involved with coasts (Branch, 1971). Such photography can be done on a continuing repetitive basis. Each coverage is, at one and the same time, comparable to the previous coverage to show what changes have taken place, and it also constitutes a bench mark against which the next coverage may be compared. Thus, a historic sequence can be created and maintained. The uses of such photographs as suggested here have mainly to do with land use, but those interested in coastal morphology and vegetation will find many ways to use such a photographic data bank.

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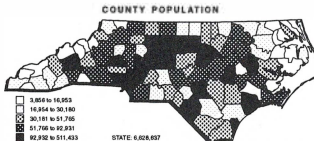
Population	Length of Growing Season
Landuse	Per Capita Income
Annual Precipitation	Hurricanes and Tornadoes
Major Routes	Unemployment

Geographic Perspectives of North Carolina
(Map Sheet #1)

Geographic Perspectives of North Carolina's Economy
(Map Sheet #2)

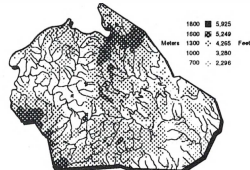
Geographic Perspectives of North Carolina's Climate
(Map Sheet #3)

Geographic Perspectives of Watauga County, North Carolina
(Map Sheet #4)



The 1990 population of North Carolina was more heavily concentrated near the center of the state than on the eastern and western peripheries. A densely populated urban crescent extends from Charlotte through Winston-Salem, Greensboro, Burlington, Durham and Raleigh. The coastal plain, particularly in the northeast, and the mountains are generally less densely populated than the piedmont.

excerpt from Map Sheet #1



ELEVATION AND RIVERS

North Carolina generally rises in elevation from east to west, while Watauga has a more rapid change in elevation. This corresponds to the Blue Ridge Front located in western Watauga County. The contours were overlaid on the elevation map to depict the "trajectories" or dendritic drainage pattern familiar to mountain landscapes. Elevations were interpolated from USGS 1:24,000 scale Digital Elevation Models (DEMs) utilizing Earth Resource Data Analysis System (ERDAS).

excerpt from Map Sheet #4

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ABOUT THE COVER: MAP MAKING GOES DIGITAL

Art Rex

Art Rex in an
Adjunct
Assistant
Professor at
Appalachian
State
University

The earliest forms of communicating mapped information were accomplished by scratching in the sand or on other surfaces. This was often by the use of pictograph or symbolic representations. To a geographer, maps are the primary form of communication, and the art of map making has been around for centuries. Maps, on clay tablets, have been discovered dating back to 2500 B.C. The functions of maps have varied over the centuries but maps were and are still the principal method of depicting location, displaying themes, and showing patterns of distribution, dispersion, or density. The early methods of map making were replaced by new technological advances: the paper and pen, scribe and peel, and typesetting. However, some of the most dramatic changes have come recently, riding the wave of microcomputer technology and the increasing availability of mapping software packages.

Computers are an important part of today's world and they are a part of modern geography and cartography. Computers are in wide use in most publishing circles. Many of the major newspapers in the world utilize some form of computer graphics software. Today, the cartographer can take full advantage of this technology and alleviate many of the more tedious tasks in production cartography.

Computer technology has increased the cartographer's ability to create exciting graphics and maps. Cartographers combine many different data sources with software packages to produce a variety of cartographic products. The cartographer can simply send the finished product to the printer on a disk or even "ftp" (file transfer procedure) it across the telephone line. Color separations are now done via the computer. The selection of colors is accomplished by assigning the percent of CMYK (cyan, magenta, yellow, black). The cartographer still needs to have expertise of how the paper might react to specific ink characteristics. However, now the cartographer can clearly visualize the final product and make adjustments to that product in a matter of minutes.

The covers of this Journal are examples of final products produced at Appalachian State University's Computer Mapping Laboratories as part of a map series presented by the Department of Geography and Planning. Four sheets comprise the series: 1) Geographic Perspectives of North Carolina; 2) Geographic Perspectives of North Carolina's Economy; 3) Geographic

Today the cartographer takes advantage of the new computer mapping technology tied to geographic information systems, which has almost completely replaced the traditional pen and paper, scribe and peel, and typesetting sequences in published maps

Perspectives of North Carolina's Climate; and 4) Geographic Perspectives of Watauga County, North Carolina. The two maps presented on the cover, front and back, show the capabilities of digital cartography. Combining data sets allows the cartographer to display more information, providing a better way of communicating the message to the user.

To be effective and competent in the new world of automated cartography the preparer still must be grounded in basic cartographic theory and principles of design

This map series could not have been accomplished without a cooperative effort between faculty and students. Can computers save time? Or is this a map making myth? It is perhaps true; that is, once the primary work is accomplished. The cartographic preparations are similar. Quality base maps, appropriate scales, selection of classification methods, selection of appropriate symbolization and color schemes, and map design and layout remain important parts of cartography. Time spent in data preparation and capture of desired information in a digital format occupies most of the cartographers time. The end product can be of high quality if the cartographer still pays attention to basic cartographic theory and principles of design. In Summary, the examples provided on the cover clearly illustrate the use of microcomputer mapping and graphics packages in

the creation of high quality cartographic output.

Acknowledgments

Acknowledgments and thanks are extended to the following: 1) Appalachian's Department of Geography and Planning which dedicated the use of the research lab; 2) Jim Young, Pete Soulé, Art Rex, Neal Lineback and Ole Gade, the editors of the map series; 3) the student cartographers Mark Stroud and David Lambert, with technical expertise from Robert McMillan; and 4) the many students and faculty that helped proof this series and provided design input.

BOOK REVIEW

ONE LAND, THREE PEOPLES: A GEOGRAPHY OF ROBESON COUNTY, NORTH CAROLINA

Thomas E. Ross; *Southern Pines, NC: Karo Hollow Press, 1993. vi and 126 pp., maps, tables, diags., index. \$13.95 paper (ISBN 0-9641628-0-6).*

Reviewed by Frank Ainsley

As the title suggests, its unusual demography is perhaps what makes Robeson County distinctive. With its high percentage of Native American population, the county holds a rather unique position among American counties. It is truly a tri-racial society, with an ethnic composition that is 36.1 per cent European-American, 24.9 per cent African-American, and 38.5 per cent Native-American (mostly Lumbee), who are still lobbying for official recognition by the federal government.

One Land, Three Peoples is organized by the author into 21 chapters of facts about the physical and cultural geography of Robeson County in an encyclopedic yet prosaic and well organized style. In Chapter 1, the author introduces this geographic survey by providing a general background and overview. Using an 1880 map and an 1884 descriptive pamphlet of the county, he sets the stage for the century of change which was to follow. Included also are brief historical vignettes describing several of past Robeson County communities, including some with such colorful names as Lumber Bridge, Black Ankle, Shoeheel, and Orrum.

The next six chapters devote considerable detailed attention to geology, groundwater hydrology, vegetation, and climate. One of the most interesting physical geography entries is the discussion of the 'Carolina Bays', a series of hundreds of shallow, elliptical, parallel oriented depressions which cover this region of southeastern North Carolina. The author suggests an explanation for the origin of these somewhat baffling geomorphological features. In addition, the bays and their resulting topography played a significant role in the development of the settlement landscape.

Chapters Eight through Twenty provide a myriad of maps and tables with annotated descriptions, covering such themes as recent trends in agriculture, transportation and trade, education, social services, historical sites, and politics and government. One of the more fascinating is Chapter Ten which relates the interesting demography of the county. Detailed maps of the townships, and tables showing

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Wilmington

population characteristics, give the reader an understanding of the complex population dynamics and distributions involved in the Indian-Black-White mixture.

The author defers to experts from the Pembroke State University faculty and the local communities for descriptive chapters on the county's geology, the Lumbee River, libraries, social services, historical sites, and the arts.

For a county-by-county geography, *One Land, Three Peoples* can serve as a model for providing a rather complete overview of the facts and figures pertinent to a small geographic region. The numerous maps help the reader to focus on a geographic and spatial understanding of various collections of census and other data. *One Land, Three Peoples* is well written, user friendly, and can serve as a planning tool for county officials and other local decision makers.