

# *Aggressive Urban Annexation and Conservation Site Protection in North Carolina*

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## **ABSTRACT**

Aggressive urban annexation is a land use control tactic used by incorporated municipalities to exert political authority (especially taxation and zoning) upon proximate, unincorporated areas. In North Carolina annexation has been actively encouraged since 1959, and cities have unilateral power to annex without being subject to popular referendum or other authority. North Carolina leads the nation in the percentage of state population annexed. In terms of biodiversity North Carolina's eco-regions are among the richest in North America. Subsequently, the conservation protection status of many ecologically-sensitive sites is subject to the consequences of dramatically changed land use regulations resulting from municipal annexation. Aggressive annexation trends were compared to ecologically-sensitive sites in eco-regions using ESRI geo-processing tools. Datasets were statewide in extent, spatially-detailed, for the time period 1994 to 2002. This research demonstrates the potential of geo-database technology for allowing multiple stakeholder assessment and monitoring of urban development threats to environmentally-sensitive areas.

## **I. Urbanization and Environment in North Carolina**

### **I.A. Aggressive Urban Annexation – An Overview**

Aggressive urban annexation is a land use control tactic used by incorporated municipalities to exert political authority (especially taxation and zoning) upon proximate, unincorporated areas. The process originated in the later part of the 19<sup>th</sup> century as northeastern cities became more industrialized and grew geographically with the authority to annex territory granted by their state governments. This authority was granted as the states envisioned the expansion of city boundaries as a means to facilitate economic growth on par with population growth. At this time industry was located in city centers and promoted city growth beyond its boundaries in order to acquire future facility locations along with the additional revenue generated from extended service areas. This new power for cities to annex territory was embraced with enthusiasm and when combined with the mass influx of immigration, resulted in rapid industrialization and uncontrolled urbanization.

In the early decades of the 20<sup>th</sup> century the heavily industrialized cities of the northeast were experiencing the consequences of rapid industrialization and uncontrolled urbanization. These cities experienced a decline in affluent residents as they left in large numbers as a result of the negative impacts from uncontrolled growth and industrialization. In response to this phenomenon northeastern states began to limit the boundary expansion and the aggressive annexation policies of cities by regaining authority in their respective state legislatures.

Only in three states, Idaho, Nebraska, and North Carolina, is annexation solely a function of municipal determination. Unlike the situation of northeastern cities, annexation continued to be a politically influential policy for the enhancement of economic development for southern cities. Business interests and higher income residents remained in southern city centers late into the 20<sup>th</sup> century. Urban growth policies reflected this annexation view as a means to acquire an expanded tax base of populations on the urban fringe. (Austin, 1999)

### **I.A.1. Urban Annexation Policy in North Carolina**

In North Carolina annexation has been actively encouraged since 1959, and cities have unilateral power to annex without being subject to popular referendum or other authority. The desire to create an economic environment conducive to growth and to avoid the problems associated with rapid urbanization in northern metropolitan areas led the state to adopt annexation reforms in 1959. (Lawrence, 2003)

The services and standards method was passed in 1959, accompanied by the assertion that what is urban should be municipal. The services and standards method permits cities to annex territory virtually at will as long as the area is adjacent to or contiguous with city boundaries, developed in urban uses, and the annexing municipality can provide the area with services on the same basis that services are provided within the existing city. Provisions are also available for satellite annexation of non-contiguous territory. (Lawrence 2003)

Under law a city is a municipal corporation – meaning an entity separate from its owners, existing without regards to changes in ownership and permits a limited commitment of assets for its obligations from its resources. Municipal corporations are organized to provide public services and regulate activities of the community. In the context of a government entity, a municipal corporation in North Carolina owes its existence to the state constitutional authority of the General Assembly. In North Carolina, the General Assembly retains the authority to incorporate cities and to delegate to cities the right to expand their boundaries via annexation. The authority for cities to annex comes from the General Assembly passing of two types of legislature. The first type of legislature is one of General law that applies to cities of a population of 5,000 or more and provides them with the authority to pass local legislation. The second type is by local act; the General Assembly retains the constitutional authority itself to annex property to cities and to undo annexations by removing territory from one city. (N.C. CONST., art. VII, § 1.) (Lawrence, 2003)

## I.A.2. Rate and Extent of Urban Annexation in North Carolina

North Carolina cities annexed the greatest percentage of population and most of the southern states were leaders both in terms of absolute numbers annexed and percentage of the population annexed from 1990 to 2002. (US Bureau of the Census 2002) In 1992 North Carolina officially became an “urban state” when the percentage of the population living in urban areas passed 51%. As of 2000, 60.2% of the population lives in urban areas and 67.5% of the population lives in or within area of influence of the state’s incorporated municipalities. North Carolina ranked 11<sup>th</sup> in the nation in population in 2000, it ranks 16<sup>th</sup> in the percent of population living inside urbanized areas (46.7%), and 13<sup>th</sup> in the percent living in urban areas (67.5%). (US Bureau of the Census 2002)

## I.B. North Carolina’s Environment and Biodiversity

In terms of biodiversity, North Carolina’s eco-regions are among the richest in North America. From the Great Smoky Mountains National Park in the western part of the state, through the Carolina Piedmont region, to the Atlantic Coastal plain, North Carolina contains a wide range of vulnerable ecological communities containing numerous threatened and endangered plants and animals. Several ecological classification schemes have been applied to the region, with this research utilizing the following system.

The following is an integrated classification schema and matrix for conservation status and biological distinctiveness, with recommended conservation action categories.

Table #	Critical	Endangered	Vulnerable	Relatively Stable	Relatively Intact
Globally Outstanding	I	I	I	III	III
Regionally Outstanding	II	II	II	III	III
Bioregionally Outstanding	IV	IV	V	V	V
Nationally Important	IV	IV	V	V	V

Source: Ricketts et al., 1999

*Class I.* Globally outstanding ecoregions requiring immediate protection of remaining habitat and extensive restoration.

*Class II.* Regionally outstanding ecoregions requiring immediate protection of remaining habitat and extensive restoration.

*Class III.* Globally or regionally outstanding ecoregions that present rare opportunities to conserve large blocks of intact habitat.

*Class IV.* Bioregionally and nationally important ecoregions requiring protection of remaining habitat and extensive restoration.

*Class V.* Bioregionally and nationally important ecoregions requiring protection of representative habitat blocks and proper management elsewhere for biodiversity conservation.

In 1996, the World Wildlife Fund Organization used this schema to rank the threat analysis for ecoregional conservation status for all of North America. The WWF's terrestrial ecoregions of the world are based on a biogeographic regionalization of the Earth's terrestrial biodiversity. They use the term biogeographic units within ecoregions, which they define as, a relatively large unit of land or water that contains a distinct assemblage of natural communities sharing a large majority of species, dynamics, and environmental conditions. Ecoregions represent the original distribution of distinct assemblages of species and communities. (WWF, 2003) The primary use of the WWF ecoregion schema is to aid the efforts to conserve biodiversity around the world, by means of a map of terrestrial biodiversity that gives enough detail to be useful in global and regional conservation priority-setting and planning efforts. The three ecoregions used in this study in North Carolina were ranked as follows:

- Appalachian/Blue Ridge Forests ecoregion - **I Vulnerable**, Globally Outstanding
- Southeastern Mixed Forests ecoregion - **II Critical**, Nationally Important
- Middle Atlantic Coastal Forests ecoregion – **I Endangered**, Globally Outstanding

The WWF threat analysis criteria rank habitat conversion as a major threat to the above ecoregions, due primarily to population pressures and proximal threats to their ecological integrity.

### **I.C. Potential Implications of Aggressive Urban Annexation for the Protection of Biodiversity**

The intersection of land use policies and choices with vulnerable biological systems results in a range of potential negative and positive changes in the human-environment inter-relationship and "sustainability." Aggressive urban annexation patterns in North Carolina appear to be increasingly encompassing places identified by environmental conservation organizations as being ecologically sensitive. Subsequently, the conservation protection status of many ecologically sensitive sites is subject to the consequences of dramatically changed land use regulations resulting from municipal annexation, such as the imposition of zoning and building codes.

It is important to realize that there could be both negative and positive implications for an ecologically sensitive site that is incorporated into an urban area. Sites located in unincorporated areas may have few if any land use controls that limit what types of land uses are allowed in the vicinity of the site. The imposition of land use limitations by the annexing municipal entity could serve to enhance environmental protection. However, we assume for this phase of the research, that aggressive urban annexation is generally associated with urban-suburban sprawl patterns, with affected areas tending to be characterized by conversion to more intensive land uses (e.g., forest to subdivision), increases in human population densities, and the extension of services and

utilities. Hence, at the spatial and temporal scales examined here, municipal annexation and incorporation is taken to have negative implications for ecologically sensitive sites, with sites that are identified as incorporated through annexation being considered at increased risk of damage, degradation, or destruction. Future case studies at more detailed scales could look at more detailed, site-specific factors (such as terrain, hydrology, infrastructure, population and land use patterns, as well as legal factors).

In order to further investigate and illuminate the relationship between aggressive annexation and environmental protection in North Carolina, a geographic database containing spatio-temporal representations of the relevant variables was compiled and analyzed using ArcGIS. The following sections describe the processing, analyses, and results obtained through the research, and how these results can help to provide an updated threat assessment for the successful protection and management of ecologically sensitive sites.

## **II. Geodatabase and Geoprocessing of Urbanization and Environmental Data**

### **II.A. Geodatabase – Data and Data background**

The datasets used for this paper were statewide in extent; spatially-detailed, for the time period 1994 to 2002 and projected in NAD 87 North Carolina state plane feet coordinate system. The datasets are composed into a personal geodatabase and organized into a feature dataset of feature classes as follows:

#### *NHOS Program Data– point feature class*

The North Carolina Natural Heritage Program (NCNHP) is a part of the Office of Conservation and Community Affairs within the NC Department of Environment and Natural Resources (NCDENR). The program inventories, catalogues, and facilitates protection of the rarest and the most outstanding elements of the natural diversity of North Carolina. These elements of natural diversity include those plants and animals, which are so rare, or the natural communities that are so significant that they merit special consideration as land-use decisions are made (NCNHP, 2001).

#### *Municipal Powell boundary data sets – polygon feature class*

The North Carolina Department of Transportation (NCDOT) GIS Unit developed the digital Municipal Boundaries Powell Bill data sets from the Powell Bill boundaries, which incorporated municipalities in North Carolina were required to submit to NCDOT their official municipal boundaries on a regular basis. The data is created to assist governmental agencies and others in making resource management decisions through use of Geographic Information Systems.

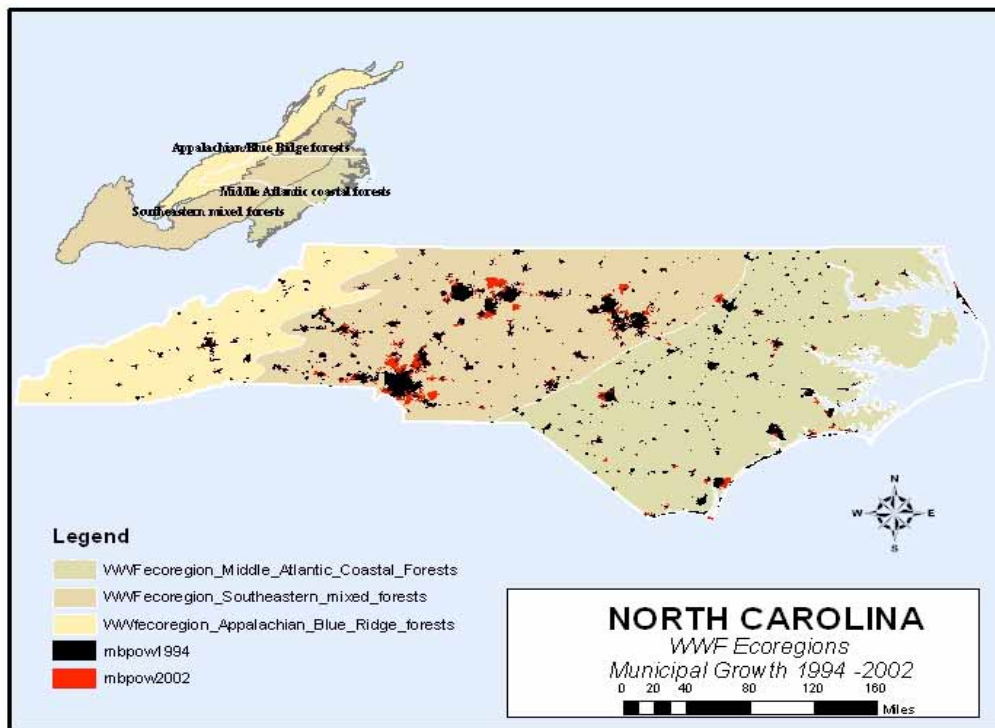
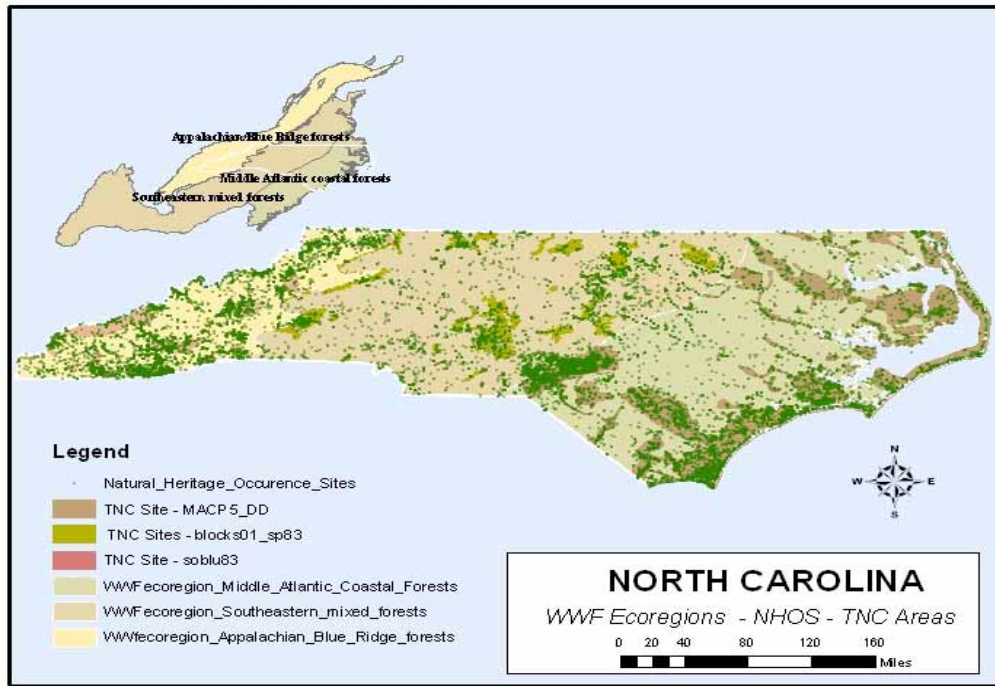
*The Nature Conservancy's conservation study area's within The World Wildlife Fund Ecoregions data sets – polygon feature classes*

The Mid-Atlantic Coastal Plain (MACP) occupies 26 million acres east of the fall line between the Piedmont and Atlantic Coastal Plain, south of the James River in Virginia and north of Charleston Harbor in South Carolina. About two thirds of this very rich ecoregion is in North Carolina. (TNC, 2001) This ecoregion consists of many species of flora and fauna including longleaf pines, bald cypress trees, pocosins and palmettos, Red-cockaded Woodpeckers, Venus Fly-traps, Red Wolves and Black Bears. This region's landscape is made up of Sandhills, bottomland hardwood forests, swamps and some of the world's best and most active coastal dunes, sounds, and estuaries of the Outer Banks. The ecoregion's dynamics occur at the interfaces between continent and ocean and between tropical and temperate climates.

The Southern Blue Ridge Ecoregion (SBR) is one of the most biologically significant ecoregions in the United States. A World Wildlife Fund study identified this ecoregion as globally outstanding, requiring immediate protection or restoration based on the extraordinary endemism and species richness of the forests (Ricketts et al. 1999). The SBR and surrounding Southern Appalachian Mountains have been found to have some of the highest concentrations of endangered species in the United States (Ricketts et al. 1999). In addition, the ecoregion's ecosystems and species are considered at extreme risk for biotic impoverishment due to the risk of development (Noss and Peters 1995). 217 sites were included in the ecoregional portfolio. The sites represent over 2,200,000 acres of the SBR ecoregion or roughly 23% of the total area. Of these, 109 sites protect terrestrial species and communities, 29 protect aquatic or riparian species and communities, 54 protect bogs and non-alluvial wetlands and their associated species, and 12 are a combination of terrestrial with aquatic or non-alluvial wetlands. Sites were characterized and assessed in terms of ecological function, ownership, and recommended conservation approach.

Piedmont mixed forests ecoregion is a moderately rolling landscape, dissected by rivers and streams with gentle ridge tops in between. The terrain becomes rugged where it meets the mountains at the westernmost boundary. Sizable portions of this region once supported open prairies. Most of the region's rare species habitats occur in remnants of these prairies and a few areas with hardpan soils. Major natural community types are upland oak-hickory forests, moist hardwood forests and floodplain forests. Dams or reservoirs have altered Major rivers of this region heavily, but a few smaller streams have significant aquatic communities and extremely rare mussels. The nature Conservancy is still in the process of completing the ecoregional portfolio for the piedmont area of North Carolina, however, 50 sites were included in the initial ecoregional portfolio. The sites represent over 2,1100,000 approximate acres of the PMF ecoregion. These 50 preliminary sites consist of terrestrial species and communities, aquatic or riparian species and communities, bogs and non-alluvial wetlands and their associated species, and a combination of terrestrial with aquatic or non-alluvial wetlands. Sites were characterized and assessed in terms of ecological function, ownership, and recommended conservation approach.

Figure 1 & 2 *Datasets*



## II.B. Geoprocessing

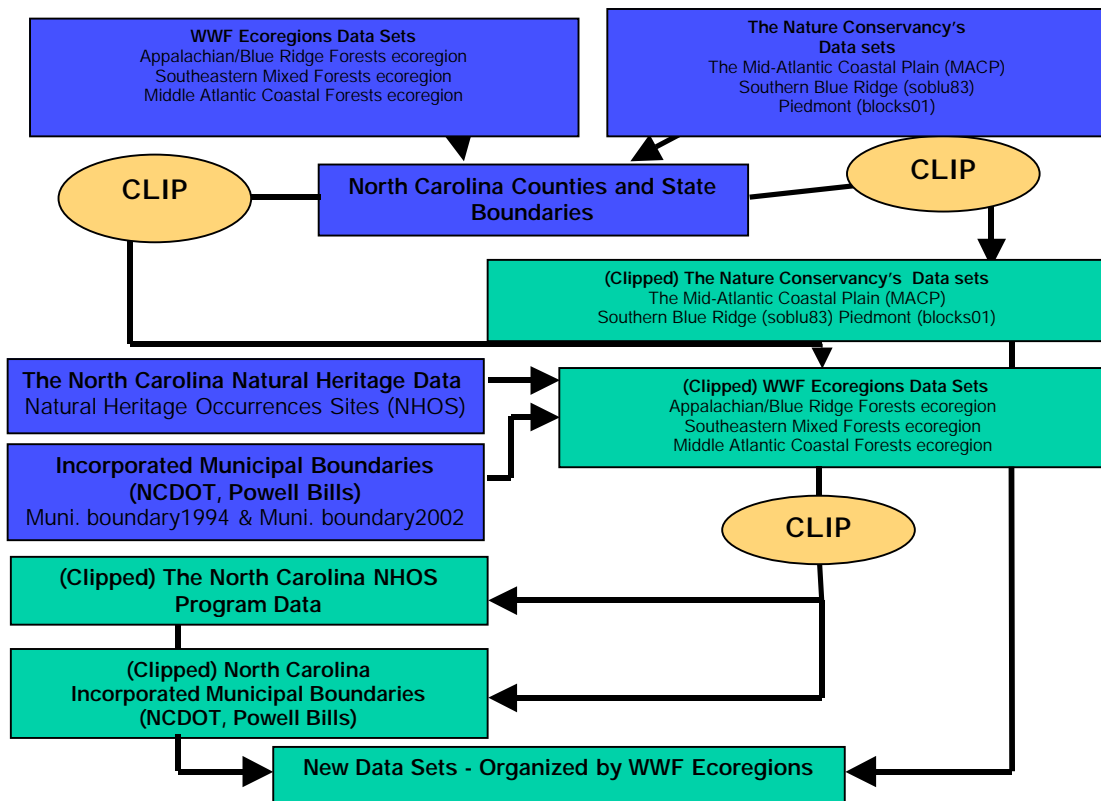
### II.B.1. Procedures

The previous section introduced the polygon and point data layers to analyze in this project. The analysis takes a two-prong approach. The first analysis approach is a spatial measurement of point distribution description as discussed in "Statistical Analysis with Arcview GIS", (Lee and Wong, 2001). Point distribution of the data sets will be analyzed using the descriptive geostatistics and centrophagic measures derived from the point data's location information. Central tendency of the point distributions will be represented using the spatial mean, standard distance deviation, and standard deviational ellipse techniques. The objective of this technique will expectantly reveal the extent and directionality of induction of The Nature Conservancy's Conservation sites into the boundaries and areas of influence of municipal (urban) incorporated areas.

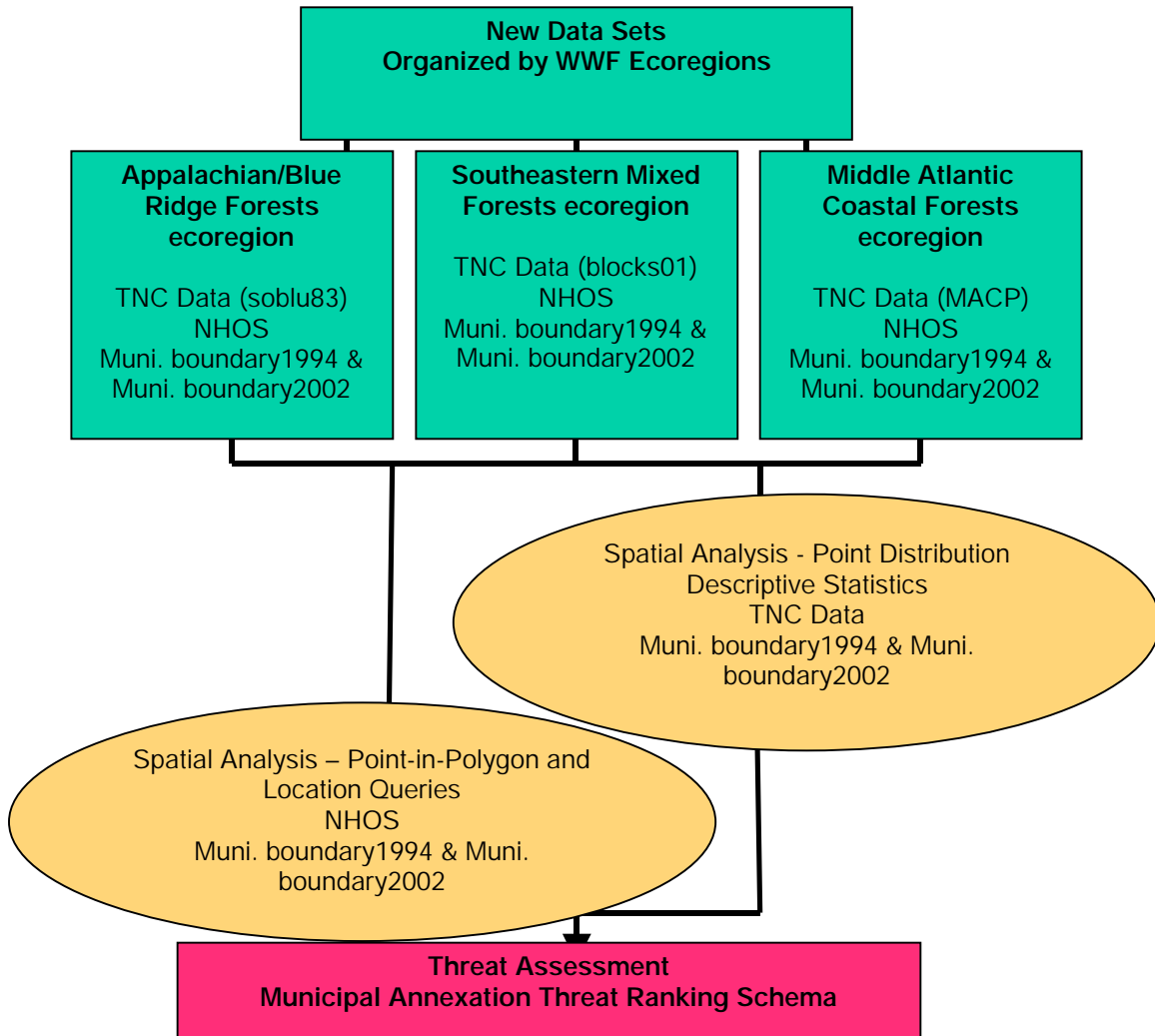
The second analysis approach will use the spatial measurement techniques of polygon overlay and location queries for polygon point inclusion. The objective of this technique will expectantly reveal the total area (sq. miles) of change for municipal boundaries from 1994 to 2002 within the ecoregions of North Carolina and the total amount of natural heritage occurrence points that become influenced by these municipal boundaries growth.

The final objective from these two analysis approaches will be the identification of the level of threat from municipal (urban) incorporated areas to The Nature Conservancy's Conservation Sites and study areas.

Figure 3 & 4 Geoprocessing Model







### II.B.2. Results

From 1994 to 2002 there was an approximant 770 sq. mile increase of municipal incorporated land conversion for the entire state of North Carolina. Within the WWF ecoregion Middle Atlantic Coastal Forests, there was an approximately 155 square mile increase of municipal incorporated land conversion. Within the WWF ecoregion Southeastern Mixed Forests, there was an approximate 600 square mile increase of municipal incorporated land conversion. Within the WWF ecoregion Appalachian Blue Ridge Forests, there was an approximant 16 square mile increase of municipal incorporated land conversion. The WWF integrated classification schema and matrix for conservation status and biological distinctiveness classified the Appalachian/Blue Ridge Forests ecoregion as vulnerable, and the Southeastern Mixed Forests ecoregion as Critical and lastly the Middle Atlantic Coastal Forests ecoregion as Endangered. Through this simple GIS data analysis technique an agreement between the percentages of municipal incorporated land conversion rate and the WWF's threat analysis criteria rankings would support the assumption that habitat conversion is a major threat to ecoregions due primarily to the proximal urban threats to their ecological integrity.

The results of the point-in-polygon analysis reveals that the highest percentage of change in NHOS being encompassed by the boundaries and areas of influence of municipal incorporated areas is in the Southeastern Mixed Forests Ecoregion of North Carolina's piedmont area. Although, this ecoregion did not experience the highest number of NHOS being encompassed by the boundaries and areas of influence of municipal incorporated areas, it experienced the greatest amount of municipal incorporated land conversion. This trend of the amount of municipal (urban) incorporated land conversion compared with the percentage of change in NHOS being encompassed by the boundaries and areas of influence of municipal (urban) incorporated areas is paralleled in each of the WWF Ecoregions in North Carolina. The WWF ecoregion Southeastern Mixed Forest had the greatest total amount of urban land conversion for the years 1994-2002. When measuring the difference in spatial central mean location of mbpow1994 and mbpow2002 in comparison to the spatial central mean location of TNC blocks conservation sites, a movement of 18.25 miles occurred. This change was substantial with regard to the fact that in 1994 the spatial mean center of incorporated municipalities was located 24.5 miles southwest of the TNC blocks conservation sites spatial central mean and in 2002 the spatial mean center of incorporated municipalities was located only 6.25 miles southwest of the spatial central mean of TNC blocks conservation sites. This is also represented in the movement of the areas of standard distance circles. When comparing the angle of rotation (i.e., the angle from north clockwise to the axis) of the standard deviational ellipse of mbpow1994 and mbpow2002 at 52 degrees and 50 degrees respectively, a southwest –northeast directional movement of incorporation is established. This movement of incorporation land conversion trend demonstrates 2.28-mile average yearly movement over the 8-year study period of the spatial mean center of incorporated municipalities towards the spatial mean center of TNC blocks conservation sites, which has a standard deviational ellipse of 61 degrees. This trend clearly identifies that the location of The Nature Conservancy's conservation sites and study areas and a rate of induction of these sites into the boundaries and areas of influence of municipal incorporated areas are happening at a substantial rate.

The final goal of this paper is to classify the level of threat of municipal incorporated areas to the Natural Heritage Occurrence Sites contained within each WWF ecoregion in North Carolina. The reasoning behind this goal being the crucial step of this paper is that the conservation study areas of the Nature Conservancy contained the majority of Natural Heritage Occurrence Sites (NHOS) of each of the ecoregions. Within North Carolina there are 21,263 NHOS and 15,740 of those are contained by conservation study areas of the Nature Conservancy, thus the attributes of the NHOS are attributed to the conservation study areas. By totaling the number and percentage change of NHOS to become encompassed by the boundaries and areas of influence of municipal incorporated areas and then comparing that with the location of the Nature Conservancy's Conservation Sites and study areas and the rate of induction of these sites into the boundaries and areas of influence of municipal incorporated areas, a schema is developed on the basis of the level of threat from municipal Annexation.

Figure 5 Municipal Annexation Threat Ranking Schema

WWF Ecoregion	Rate of NHOS Change Municipal Annexation threat 1994 -2002	WWF Threat analysis	Conservation rate of Municipal Urban induction	Municipal Annexation Threat Ranking
Appalachian Blue Ridge Forests	13.4%	I Vulnerable, Globally Outstanding	-0.53-mile	Lowest
Southeastern Mixed Forests	25%	II Critical, Nationally Important	+2.28-mile	Highest
Middle Atlantic Coastal Forests	18.4%	I Endangered, Globally Outstanding	-0.22-mile	Middle

Figure 6

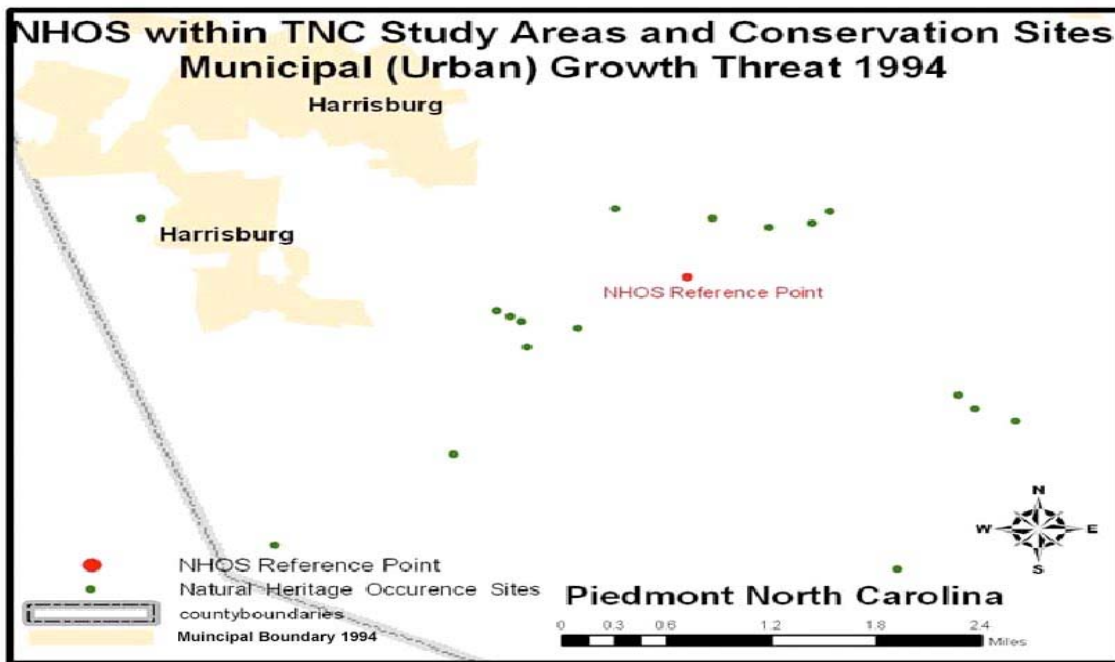
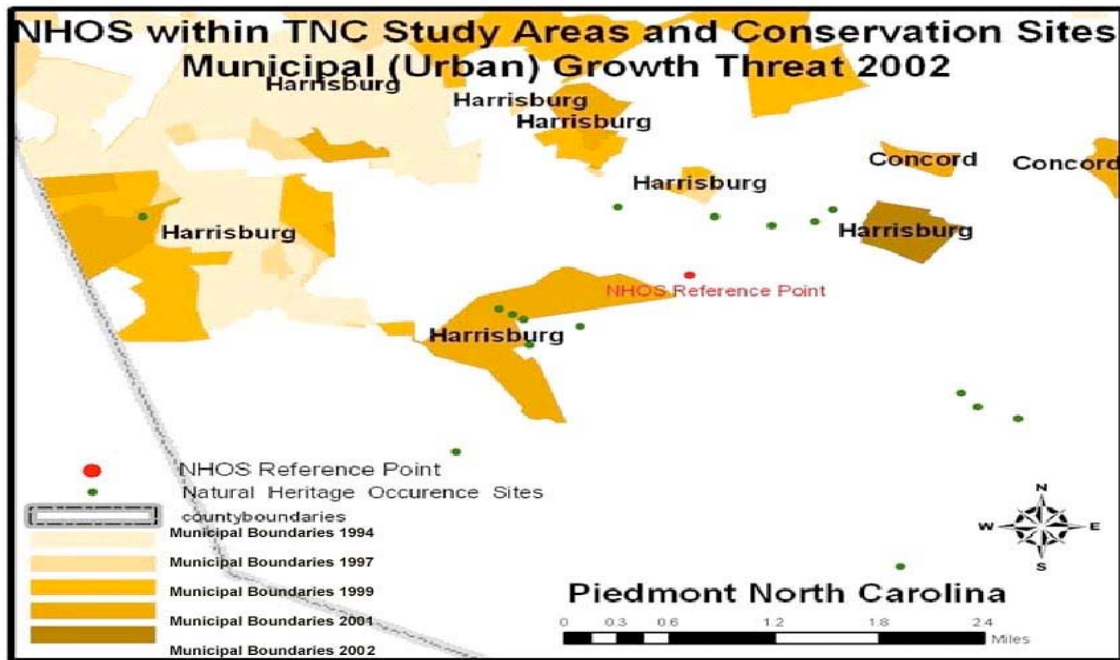


Figure 7



#### IV. Conclusions

This research demonstrates the potential of geo-database technology for allowing multiple stakeholder assessment and monitoring of urban development threats to environmentally-sensitive areas. This research can pave the way for future GIS projects and policy development, such as a TNC & North Carolina Natural Heritage Program development of a GIS SDE database for statewide and site specific monitoring or municipal budgeting and resource allocation targeting for the protection of environmentally sensitive areas. Scale specific testing and finer filtering of data for threat analysis can take place on real datasets or on hypothetical datasets for predictive modeling. In the area of policy development, the question of whether or not annexation will have adverse effects to a particular area could be addressed. Policy for environmental protection could be developed as part of the annexation process, where as municipal annexation is declared as an action for environmental assessments or impact statements, resulting in enhanced regulations for environmentally sensitive areas within municipal boundaries that take advantage of environmental planning for best fit land use tactics to reduce negative impacts of urbanization.

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