Economic Valuation of Environmental Services in Fayette County, Georgia

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ABSTRACT

Recent trends indicate the need for a more accurate valuation of the economic services that are provided by the environmental resources in our local areas. Traditionally we have based valuation of land solely on market valuations of services such as food production and recreational benefits and on the development potential of the land. The market has been inadequate in providing an accurate valuation of the services that environmental resources such as forests, wetlands, and open spaces provide. In recognizing this failure, computer models have been developed that measure the value of these services in terms of pollution removal and carbon sequestering among others. In meeting the challenges of global warming and the dwindling capacity of the environment to support our lives, new markets are emerging for carbon credits based on forest biomass and new innovative approaches are employed to protect watersheds. In Fayette County, Georgia, the local government through comprehensive planning and private citizens through the concerted efforts of land trusts have prioritized the preservation of these natural resources. Computer simulations, such as the Urban Forest Effects (UFORE) Model of the US Forest Service have been developed and applied to metropolitan areas in order to value the urban forest and the associated environmental services. This model can also be applied in a rural-to-suburban county such as Fayette County in a cost effective way to aid the local government and citizens in making informed land use and development decisions.

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Chapter I: Introduction

Americans have a deep appreciation and abiding love for the beauty and diversity of the natural landscape that enriches our lives and provides us with the resources we need to live comfortably. In the United States and particularly in Georgia, a large part of the state is preserved in much the same way that our ancestors found it when they opened the land. Local trends and global environmental issues have set in motion redoubled efforts on the part of conservationist and government stewards at the local level to preserve the dwindling natural areas through new approaches and new ways of thinking. Historically, market forces have been inadequate in providing an accurate valuation of the services that environmental resources provides us.

In light of these new developments and new approaches, what is the total economic value of the environmental services that natural resources provide at the county level and what are the tools of measurement? Computer models have been developed and applied to the urban forests where the pressures of development are high and the consentration of development has stretched the capacity of the natural environment to remove airborne and waterborne pollutants. The same pressures that concentrated development has placed on metropolitan areas are beginning to be felt by the surrounding rural and surburban areas. Counties in rural Georgia are seeing their natural environment give way to the pressures of development and the same tools that are being used to enhance and improve the urban forest can be applied at the rural county level to better inform local development decisions and wholesale destruction of the natural landscape.

Market Valuations

Procedures for placing economic value on environmental assets have found practical application since the dawn of the modern environmental era in the early 1970's. Direct negative impacts of human activities to marine environments and sensitive estuaries are felt by a large part of the population. Recreational benefits of coastal areas and the food resources provided to consumers by estuaries are tangible benefits enjoyed by most sectors of society. Often water borne pollutants have immediate negative impact on the livelihood of coastal communities whose lives depend on these coastal resources. There are the obvious pollutants washing up on the beaches, as well as unseen pollutants that affect the quality and value of marine coastal resources (NOAA, 2009).

From these obvious negative impacts and concerns for the economic benefits of environmental resources, valuation techniques are finding increasing application in community planning and urban development. Setting aside natural areas for parks and preserves has always been a part of community planning, however in more recent decades, benefits in terms of dollar values are being considered in development decisions. Just as individual home owners have a good idea that mature trees adds to the value of their property in real dollars, the conservation community and environmental groups are beginning to consider the totality of the environmental assets in their community. Tree lined neighborhoods and proximity to other natural assets translate into cold hard cash when it comes to resale values. Amenities planned into residential developments that come from natural assets are becoming commonplace in efforts to preserve as much undisturbed natural areas as possible to retain the natural environment. This has led to higher density housing, smaller lot sizes, shared open spaces and natural areas. In these cases, the number of individual residences may have to be scaled back, but this is more than made up with higher unit prices (Benotto, 2002).

Contingency Valuations

Economic valuations such as increased property values, degradation of fisheries, or the impact of polluted beaches on tourism can easily be estimated based on market models. These more tangible direct and indirect "use values" are applied in addition to the "non-use" or "passive use" models. These are referred to as Contingency Valuation models and recognize that individuals place values on environmental resources simply because they know that the resources are there. Pristine coastal areas, beaches and other wilderness areas have value to individuals simply due to this "existence value". These models have been advanced that use methods that recognize the value that individuals place on environmental assets that are not market based. For example, visits to beaches or national parks that are untouched by development, individuals benefit directly from their preservation and protection. Children watching a nature program highlighting wildlife in pristine habitat in a mountainous national park on the other hand, may never experience these natural wonders in person; however, they may carry with them the desire to do so and can develop a greater appreciation of natural areas where they live and local wildlife. These non-market based models are not without critics but often the values of contingency based valuations added to market valuations have been upheld in awarding monetary damages in the federal courts (Arrow, 1993).

To obtain these contingency valuations, investigators conduct carefully prepared surveys to measure what an individual is willing to pay to protect or otherwise preserve environmental resources. These economic valuation methods are not new. With the advent of welfare economics in the 1940's and the shift away from purely market valuations, the importance of human behavior and preference is recognized even though demand functions are not observed. While these methods may be based on complex behavioral and economic models, most people tend to agree that society is willing to pay for preservation and expect compensation when degradation occurs. Contingency valuation is one way to estimate this "latent demand" (Hannemann 1994).

New Markets

The Alfred P. Sloan Foundation is funding research to determine the state of existing technological capability to evaluate the key parameters of global forests in order to measure the forests carbon sequestration capability and the impact on global warming. The Sloan Foundation has provided $300,000 for the study that will be conducted during 2009 and 2010 by the nonprofit agency Resources for the Future (RFF). The goal is to "design a convincing and workable framework for developing a comprehensive and real-time 'census' of the world's tropical, boreal, and temperate forests. This is a timely and significant study, since modern forest management has expanded to include climate policy issues, and new global surveillance techniques from space are enabling more accurate and practical observations." (Macauley, 2006). This activity is a direct response to and recognition of the potential of the market for carbon credits and anticipates transfers of wealth on an international scale. Accurate and credible estimates of the carbon sequestering capability of the forest would be a prerequisite for the projected growth in the new emerging market. The current size of the global carbon market is estimated to be worth $80 billion in 2009 with 5.9 billion metric tons of carbon dioxide equivalent (CO_2e) changing hands (Point Carbon, 2009).

Accurate valuations and efficient markets are essential elements in shaping our decisions concerning our natural environment and resources. This study will consider the natural resources of Fayette County, conservation efforts, and development trends that will shape the future way of life that residents will be able to enjoy. The major aspects and impacts of forested areas, wetlands, and open spaces and their specific contributions to the overall value of environmental services will be considered. In light of these essential services, the publicly available and peer reviewed UFORE model will be evaluated along with a success story of the effective application of the model in Houston, Texas. The sampling methodology of the UFORE model will be applied to random sample plots of forested and developed areas of Fayette County and the feasibility of carrying out a full estimation of the forests on a county wide basis will be considered.

Chapter II: Fayette County

As the world begins to understand the impact of global warming and of limits to our water supplies, more emphasis is being placed on the actual services that natural areas provides to the local community. This study will consider the value of the environmental services of Fayette County, Georgia as measured by components that could be best delineated within the county limits. Watersheds are not specifically considered because they are delineated by ridge tops and typically overlap county borders which often have streams and creeks as boundaries. Of course, forest cover, open grassland, and river buffer zones all contribute a healthy watershed and water supply. Similarly, the value of habitat being destroyed is a concern for a community. Habitat is preserved by saving wooded areas, and the associated wetlands and riparian areas which contribute to increased habitat. Most of these services will be based on models developed to measure the services associated with all natural resources based on forested areas.

Demographics

According to the latest estimates from the US Census website, Fayette County has a population in July 2007 of 106,144 persons with 78% living in urban areas and, 22% of the population living in rural areas of the county. It has a land area of 197 square miles (510 km^2) with water area amounting to 2.2 square miles (5.7 km^2). This puts the population density at 539 people per square mile (208/ km^2). Fayette ranks 19 of 159 counties in terms of population growth in Georgia. It is in the Atlanta-Sandy Springs-Marietta Metropolitan Statistical Area.

The downward spiral of development and the associated loss and fragmentation of forested areas is only partially due to population growth. In recent decades we have seen a more rapid rate of fragmentation than could be explained by population growth alone. This is often a direct result of public policies to promote economic prosperity through increases in infrastructure and reduced demand for more consentrated development due to advances in communication technology. Development may be miles away, but the policy promoting development at any cost drives up land prices overall. Increases in tax revenues are needed to subsidize the additional services to support the development. The rural economy based on forests and farms are replaced. Lands once managed for timber are cut and left unplanted, waiting for more development. Animal species that need large expanses of habitat begin to dwindle. Native plants are crowded out by invasive landscape species.

Peachtree City is the largest built up area and has the distinction of being one of the few totally planned cities in the US and is based on a "village" concept. It also contains the most concentrated industrial park. Peachtree city is followed by Fayetteville, the county seat, and Tyrone. These two towns have at traditional town center, street layout, outlying subdivisions and large commercial centers along main transportation routes. The smaller incorporated areas are Brooks and Woosley. They can be best characterized as large whistle-stop and cross-road communities with small farms interspersed with modern residential development.

The Comprehensive Plan

The Natural and Historic Resources section of the Fayette County Comprehensive Plan, amended April 22, 2004, recognizes the rapid loss of prime agricultural and forest lands occurring in rural areas of the county. It is noted in the plan that the number of farms decreased 26 percent from 1987 to 1997 as measured by data collected by the US Bureau of the Census of Agriculture. Also during this period the amount of acreage in farms decreased by 32 percent. The value of land and buildings on farms increased 214 percent. Overall the plan paints a bleak picture of the future of farming in Fayette County. Large country estates and recreational horse breading are replacing crop and livestock production. Much of the loss in farmland is due to subdivision development. Forest land cover in Fayette County consists of a mix of loblolly and shortleaf pines mixed with hardwoods, mainly oak, maple and hickory. Referencing state information, the comprehensive plan indicates that 11 percent of the timberland was lost from 1989 to 1997.

Zoning regulations to protect agricultural lands are provided for in the "Planned Entertainment Farming" district part of the Planned Unit Development zoning category. This allows for uses such as pick-it-yourself farms, petting zoos, educational tours, restaurants, etc. Conservation Easements are given summary treatment in the plan as a way to preserve the benefits of forest and agricultural lands. According to the provision, property taxes are reduced as long as the property owner maintains an active agricultural or forestry use of the land. The term is for ten years and is renewable indefinitely.

Fayette County recognizes that its natural resources are being lost to development however, they have no regulations, ordinances designed to specifically protect sensitive plant and animal habitat. The plan summarizes participation in state initiatives and federal protection programs to preserve water quality and wildlife habitat through watershed buffers, flood plains and wetlands regulations. The county participates in the Georgia Greenspace Program that encourages counties in rapidly developing areas to preserve a minimum of 20 percent of their entire area as green space. This program is a way that the county can work to protect scenic views and rural landscapes. The county Board of Commissioners, through the Fayette County Scenic Roads Procedure, assists property owners in coordinating efforts to have their county roads designated as a scenic road.

While the plan recognizes the challenges that wide-spread residential development brings to preservation of the natural resources of the county, zoning and conservation provisions are weak and non-specific. In areas where loss of wild areas due to development has reached the critical stage a large array of zoning ordinaces, transfers and other innovative means of conservation are available. Public protections through the comprehensive planning process could be more aggressive and to produce legal means to control development and preserve natural resources, farmland, open space, and vital wildlife habitats. The goals and policies expressed in the plan to pursue commitments to low-impact site design such as minimizing the amount of impervious surfaces, encouraging cluster subdivision development, promoting tree canopy preservation rather than tree replanting and applying best management practice in preservation of water resources are found throughout the plan. Protection through direct purchase of land is also considered in objective N-6 which specifies as a goal to "Identify, protect, and enhance an integrated network of ecologically valuable land and surface waters for present and future residents of Fayette County." Conservationists and environmentalists in Fayette County can be encouraged by the proactive posture of the comprehensive plan and its recognition of the challenges of implementing environmentally sustaining growth (Fayette County, 2004).

Conservation Easements

Conservation easements are the best tool used in the preservation of natural areas. They are legal agreements between a qualified conservation agency, usually a land trust, and a landowner that transfers development rights from the owner to the agency to preserve natural and cultural features into perpetuity. Federal laws provide for special tax treatment of lands where the development rights are transferred to a third party such as a local government or other qualified third party. The conservation land trust is established specifically to serve as the holder of the easement. It is a nonprofit organization that actively works to conserve land by undertaking or assisting in land or easement acquisition and management. Tax deductions are allowed for the landowners based on the value of the property rights. These special tax considerations are often used to ease the tax burden of inherited land and take the form of donations to the trust. The benefactors in these property transfers gain much more than adding immediate value to their estates. The primary consideration for the donor is the peace of mind that their descendents and other members of the community will continue to enjoy the natural amenities of the land as they left them and worked so hard to preserve and develop during their lifetimes. Georgia ranks first in the nation in timberland under private ownership and is experiencing one of the highest rates of population growth and economic development. When land passes down to descendents, fragmentation of the forestlands often occurs because it is divided up between heirs and the timber stands are harvested to pay for the taxes (Fragmentation, 2000).

Conservation easements are transfers of property and as such, require all the complexity of other real property transfers. The transaction imposes certain obligations on the part of the property owner to maintain the integrity of the stated purpose of the easement. These easements work in the same way as any other easement such as those that maintain rights of access except that they do not necessarily require public access. Conservation easements have many benefits over outright ownership or zoning restrictions. Conservation easements are appraised at only a fraction of value of the land, and are held into perpetuity. Restrictive zoning ordinances on the other hand often succumb to development pressures placed on local governments through the granting of variances.

Georgia and its neighboring states in the Southeast have enacted legislation that enables local governments to effectively use conservation easements. For Georgia these laws are established in Georgia Code § 44-10-1 as the Georgia Uniform Conservation Easement Act. The stated purpose of the statute includes "retaining or protecting natural, scenic, or open-space values of real property; assuring its availability for agricultural, forest, recreational, or open-space use; protecting natural resources; maintaining or enhancing air or water quality; or preserving the historical, architectural, archeological, or cultural aspects of real property."

The Southern Conservation Trust

The Southern Conservation Trust headquartered in Peachtree City is the organization that promotes and manages the conservation easements for Fayette County. The Trust currently owns, manages and protects 1,300 acres of open land, forests and environmentally unique properties in and around Fayette County. There are three preserves in Fayette County open to the public and has one planned to open in 2009. The trust holds six conservation easements protecting approximately 500 acres of private property from development and owns two private preserves outright that do not allow public access. The properties open to the public are Flat Creek Nature Area, a wetland; Line Creek Nature Area, a riparian zone; and Sams Lake Bird Sanctuary. The Flat Creek and Line Creek properties are owned by the City of Peachtree City and managed by the trust. The Trust owns Sams Lake Bird Sanctuary as well as the planned preserve Morgan Grove in south Fulton County. This public access area will be an example of natural re-forestation of a logged property (Southern Conservation Trust, 2009).

According to the latest five year census of state and local land trusts by the Land Trust Alliance, Georgia ranks fourth among the nine southeastern states with 103,056 acres conserved as of 2005. North Carolina leads the southeast with 228,524 acres conserved. Overall, the southeast accounts for only eight percent of the overall area under conservation by state and local organizations. Nationally 11.8 million acres are conserved by state and local land trusts with the Pacific West accounting for 44% of the total and the Northeast accounting for 30%. This amount of land conserved represents an area twice the size of New Hampshire. From 2000 to 2005, an average of 1 million acres was added each year to the national total. When national land trusts are included, total acreage conserved through land trusts in the United States accounted for 37 million acres in 2005 (Land Trust Alliance, 2005).

Chapter III. Economic Value of Environmental Services

Forests

Valuation of Forestlands has evolved considerably in recent years and has become a complex issue for society. Forests managed for their timber resources alone and valued according to production of successive stands of timber are giving way to environmental concepts such as sustainability and stewardship for successive generations. Historically mankind has depended on the close association with forests for survival and this intimate association with the natural environment may be one reason that we value forest land so highly (Beuter, 2004).

Effective and accurate valuation of forests has to consider non-market use such as recreation, wildlife habitat and watershed services. Through the political processes such as zoning and taxation and private group action through ownership, society expresses the value they place on forest land in the face of market failure to take into account the total value of our forests. The market tells us that a forest value is equal to the present value of expected future net benefits. The problem lies in our not knowing these future benefits and costs of managing the land. It is a commonly held misconception that land is owned into perpetuity. Actually, landholders own a bundle of rights in the land that may not be converted to value or may be subject to restriction by the exercise of police power by government to further the health, safety and welfare of the public. Because of laws and regulations enacted at all levels of government, the rights of forest land owners are restricted and controlled. In states that have vast tracts of forest land under effective timber management, strict forest management laws effectively drive up the costs of management and have the effect of decreasing private forestland values (Beuter , 2004).

Forest valuation may be further reduced by federal laws protecting wildlife. Where forest land is valued for its timber resources only, an appraiser using market values as determined in similar arm's length transactions, may conclude that a property has only residual market value. If a forested property becomes the home to a spotted owl then the federal law will protect the site with a 100 acre buffer zone for as long as the owl chooses the site as a home. The appraiser will have to look for recent transactions for similar wildlife encumbered forest land. In the absence of such transactions, the appraiser would have to conclude that the land has no value due to timber production. Values of the land may be in the form of conservation easements and alternative uses (Beuter , 2004).

Most of the forests across the United States are held in private hands with 90 percent of these less than 50 acres in total area. Most of these small family forests are found in the eastern part of the United States. Studies have shown that these small forests are valued for more that the value of timber alone and are affected by location. Small forests near to urban areas are valued higher than those in remote locations. The future trend is for smaller forest parcels with higher valuations based on factors that include market forces other than timber production (Beuter, 2004).

With the focus on global warming and the use of carbon credits to offset emissions of green house gasses, the value of forests and land set aside for preservation may one day be valued based on new markets. Organizations with large forested reserves are beginning to view these natural resources not for the value that could be extracted by logging, but the value in the sequestering of carbon dioxide. Once the decision is made to preserve the land, other uses such as recreation activities, hunting, fishing, and camping can be developed.

Eglin Air force base in Florida has one of the last large stands of old growth longleaf pines in the United States. This long lived pine species has been extensively logged in the southeast and Eglin's forests represents about 72% of the remaining old growth stands. The forests mainly serve Eglin as a buffer for training exercises, but they have recently begun to view their forest reserves as an asset that could potentially yield much more than the current $1.2 million that it now gets annually from logging operations. If recreational activities currently allowed on the 400,000-acre reserve were developed fully, it is estimated that the base could realize a return of between $8 to $12 million dollars a year (Finn, 2006).

The economic, environmental and social importance of forest necessitates that policy makers and community groups at all levels be better informed about the value society places on forest lands. A close study of the impacts, both financial and conservation, related to the decisions that our local community makes is imperative in preserving forests for uses involving as recreational and aesthetic benefits. Accurate valuation based on sound science can help communities in making decisions as land use changes due to technological and social valuation aspects.

Wetlands

Wetlands are subject to strict government protections through federal regulations. Since the passage of the Clean Water Act in 1972, the federal government has expanded control of over most of the wetlands regardless of size on all public and private lands. Regulations at first were limited to the control and protection of navigable waters, however the EPA defines wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas." (US EPA, 2009). Collectively and historically referred to as "swamp" areas, they were subject to elimination for much of the early history of the United States.

It is estimated that by the 1980's, over half of the wetlands in the US had been converted to other uses. The current policy of the federal government is to promote a goal of "no net loss" of wetlands, and consequently, there has been much research into the identification and delineation of wetlands. The characterization of lands containing wetlands has the potential to impair the value of private property by limiting its potential uses. The restrictive and comprehensive nature of wetland legislation has made it one of the most contentious environmental issues (National Research Council, 1995).

The valuation of the services that wetlands provide for the purpose of mitigation has been the subject of much research. Ecologically, wetlands provide a rich ecosystem that supports a great variety of organisms. Temporary storage of rainfall in wetlands reduces the severity of flooding and facilitates the cycling of organic matter. It also retains suspended and dissolved material. Wetlands provide habitat for wildlife, and serve as nurseries for terrestrial wildlife and fish. These services of wetlands not only benefit the local areas, but may affect the level of streams and animal and fish populations thousands of miles away. Indeed, the first indication of the detrimental effect of the reduction of wetlands was in the reduced populations of migratory game birds.

Misconceptions on the part of the public along with the problems of definition and delineation of wetlands in mitigation are major obstacles to overcome in the valuation of wetlands. When individual preferences concerning wetlands were measured using study groups and questionnaires, incomplete information on the part of respondents was found to be problematic in wetland valuation models. For example, respondents were uncomfortable with the fact that a major service for wetlands is pollution removal. They did not think this use was appropriate and that stopping pollution at its source should be a priority (Hoehn, 2003).

The value provided by wetlands is illustrated with this often cited example in South Carolina. Recently protected by the federal government by being designated a national park, Congaree Swamp provides water purification through excess nutrient and toxins removal and sedimentation of solids. Studies show that an equivalent water treatment plant that would provide the same services for an equivalent volume of water would be a water treatment plant costing $5 million (National Park Service, 1995).

In another well publicized example, investments in natural assets in a distant locality directly affected the vital resources of another. New York City residents thought that the pure water supplied from aquifers up-state was virtually unlimited. Actually this free service was provided by the natural resources in the Catskill Mountains. In 1992 New Yorkers were informed by the EPA that, due to rapid residential development up-state based on septic systems, the water quality was declining so rapidly that the city would soon have to build a water filtration system that would cost upwards of $8 billion for construction and over $300 million a year in operational costs. Instead of building their own water treatment plant, they decided to correct the root cause of the problem and invest in smaller wastewater treatment plants within the watershed to replace failing septic systems. The investment in these plants along with strategic land purchases will be only a small fraction of the cost of the downstream filtration plant. (Morrison, 2005).

In recent environmental protection trends, the recognition of the efficiencies of the natural processes at work in wetlands is evident in the construction of artificial wetlands as secondary treatment of municipal wastewaters. In a local example that is receiving international recognition, Clayton County has constructed a series of wetlands that recycles about 10 million gallons of water back into their water supply each day. This county, which borders Fayette County to the east, has used land application of treated wastewater in spray fields in forested areas for about 30 years. This involved the maintenance of piping and pumping systems and was energy intensive. According to estimates published by the University of Georgia, it takes about 100 acres of spray fields to treat one million gallons a day of wastewater. In Clayton County where surface flow wetlands are used, this same amount of wastewater can be treated in 15 to 25 acres of land. Additional benefits were also realized. The water utility's energy cost went from $30,000 to $10,000 a month and the quality of the Flint River was substantially improved (Thomas, 2005).

The economic value of wetlands is significant and we can understand the reasoning behind wetlands being accorded comprehensive federal protections. Environmental services specific to wetlands and separate from other "open space" environmental services are not as easy to define in the environmental valuation methods and models that are used in this study project. The forest evaluation models used here consider the overall contribution of natural areas in the removal of pollutants from storm water and the purification of our water supplies and not the contributions specific to wetlands.

Open Space

Open Space in land use literature is typically characterized as any undeveloped land such as agricultural lands, parks, and forests that that still exhibit much of its natural character and amenities. For the purpose of this Fayette County study, open space will refer to primarily agricultural lands such as pasture land, land used for growing crops, and fruits. For the local community, preserving open space is particularly challenging. Most people view open space development as a simple trade-off between the value of agricultural production and the potential fiscal value "or highest and best use" in residential or commercial development (Fausold, 1996).

Often in valuing open-space for preservation and conservation purposes, we face the conventional wisdom of competing land uses in development versus the purely intrinsic value of open space. Further complicating the problem, open space in suburban counties are often so fragmented as to preclude any profitable agricultural activity and thus increase the pressure of development. Indeed, it is the proximity to residential development that provides the greatest potential value for open spaces. Here we find the most innovative tools for conservation and development at the local level to preserve open space. Local planners, conservation groups, and developers have long understood that market value added to residential development contributed by open space, makes open space more valuable the scarcer it gets. This "enhancement value" of open-space has long been recognized as value added to residential values (Fausold, 1996).

While the enhancement value based on the proximity to open spaces is proven in the assessment of real estate market values, this direct relationship is greatly influenced by other factors such as the characteristics of open space. Public parks which may be a combination of forested areas, wetlands and open areas set aside for sports are often the subject of these studies. The overall value of open space as narrowly defined in this paper will not be as straight forward as valuing the environmental services provided by forested areas. The value must reflect the values that the citizens of Fayette County place on maintaining the rural characteristics of the land in the face of rapid residential development into every corner of the county.

To illustrate the location specific nature of valuing open space we need to consider that some uses have negative value. Agricultural uses involving livestock operations, pesticide applications can detract from the value of nearby residential developments. Poorly managed parks can deteriorate to such an extent to discourage family use. If open space is in remote or inaccessible areas, its preservation may cause residential development to be more intensive in other areas. (Fausold, 1996). In a suburban area such as Fayette County, development into these interior open spaces should be carefully planned to preserve as much as possible using the most appropriate valuation techniques. With development along main corridors and feeder roads, preservation of individual remaining open space parcels may be more appropriate. In valuing open space as defined in this study, the model should value open space in proximity to neighborhoods and main road vistas at a premium to that of inaccessible, remote or "surplus" open space that retains its value based purely from an environmental services standpoint. As is the case with wetlands, such models have been developed, however specific consideration is outside the scope of this study.

The UFORE Model: Introduction

The Urban Forest Effects Model, or UFORE, was developed in the 1990's by the US Forest Service in collaboration with various universities and private resource groups. It is a computer model designed to use GIS tools and field data to calculate the services and values of the forest ecosystem. As the name implies, it is designed to analyze urban areas that are most vulnerable to degradation due to development, however it can be adapted to areas of any size and ecosystem structure (US Forest Service, 2009).

UFORE consists of three main program groups. The first is a *field plot selector* that helps field workers to locate sampling plots using GIS. The second is a Personal Data Assistant (PDA) based *data collection program* that integrates the selector program and collection program and provides the analysis. The urban forest strata such as tree type, size, health, and biomass as well as tree diversity are examples of the type of data collected. From this tree data, the model uses pollution data from the EPA to calculate the amount of pollution removed and the corresponding improvement in the quality of the air. The amount of carbon stored and annual carbon sequestration of the forest is also calculated. Water quality data is used to measure the effects of impervious surfaces and the absence of trees. Oil, grease, dissolved oxygen, suspended solids along with other standard parameters are determined. Potential infestations by disease and insects are mapped (US Forest Service, 2009).

The UFORE model has found many useful applications from diverse groups such as planners, environmentalist, and conservation groups. Improved forest management benefits the planning process by identifying areas where plantings will benefit most. The inventory and valuation of the forest can be used to integrate these ecological concepts into existing zoning and development projects to improve environmental quality and a healthier community. In metropolitan areas such as Atlanta where regulators struggle to meet clean air regulations, an effective forest management program is an essential part of the State

Implementation Plan. The benefits of such a program can also enhance storm water management plans (US Forest Service, 2009).

Houston, Texas

In the city of Houston, Texas, the Forest Service in conjunction with local policy makers, planners, and state researchers used the UFORE model to map the structure, function and service values of their regional forest. Their study completed in 2001, used 332 field plots in the metropolitan area that included the forested areas in residential, commercial, and outlying agricultural lands. The Houston metropolitan area includes eight counties. The focus of the study was mainly the service functions such as pollution removal, carbon sequestering, and energy savings including the costs to replace the trees. Health benefits, property value enhancement, storm water management and habitat, which are important services of forests, were not included in the study (US Forest Service, 2005).

A map was developed that used satellite imagery to classify land cover into bodies of water, forests and urban greenspaces, agricultural and range lands, residential areas, and urban areas. Using the Forest Inventory Analysis (FIA) program, 800 plot locations were selected as possible sampling sites. Two-thirds of the urban plots, one third of the forest plots, and one fourth of the agricultural and rangeland areas were selected. The plots consisted of one-sixth of an acre plots to sample trees and smaller sub-plots to measure undergrowth and trees smaller than five inches in diameter (US Forest Service, 2009).

The study found that the regions trees, numbering over 663 million, had a replacement value of $205 billion and the value of the environmental services in the form of energy savings and the associated carbon emissions avoided from power plants was estimated at $456 million. Total carbon storage, carbon that has been accumulated in the tree structure, and sequestering values, carbon added each year, were estimated to be $721 million. As expected the carbon storage values were higher in rural areas and the energy benefits were largest in the residential areas (US Forest Service, 2009).

Chapter IV: Methodology

In measuring the economic value of forested areas in Fayette County, an investigation into the feasibility of the UFORE model and the applicability of its computer interface and the interoperation with GIS methods will be tested. Specifically, the model will be applied by assembling the required data and setting up a sampling site plan that would serve as simulate actual field methods. An estimation of the resources in terms of equipment and field work hours required to carry out the study will be determined. Actual measurements of representative trees will be conducted and used to test the functionality of the model.

The UFORE Software

The UFORE model, originally a stand-alone program is now distributed by i-Tree, a cooperative of US Forest Service scientist, Non-profits such as the Arbor Day Foundation, the Society of Municipal Arborists and the International Society of Arboriculture, and a private firm, The Davey Tree Expert Company, which is a full service, employee-owned organization with a long history of tree management services. The i-Tree Software Suite version 2.1 is distributed free from their website, which offers comprehensive support through instruction guides, key linkages to support organizations, and user forums. The software consists of two major parts, the UFORE model, for the analysis of urban ecosystems, and the STRATUM model for assessing tree inventories at the street and neighborhood level. One of the key differences is the scope of the area being studied and the need to sample large areas instead of conducting an all inclusive inventory of trees. The software is not downloadable from the website, but is mailed out upon requests that are placed online from their website. The UFORE model will run on a MS Windows based computer that is also running ArcGIS 8.0 or higher.

There are six key steps in the UFORE process. The three initial steps, configuring the study area, distributing the data points, and collecting the field data are conducted by the study team in the field. The plot data is then forwarded in electronic form to the Forestry Service for analysis and chart generation. The results of the analysis are transmitted back to the study site for report generation.

Configuring the Study Area

The data source for the aerial photos used this study was the Georgia GIS Clearing House. Aerial photos produced under the National Agriculture Imagery Program (NAIP) of the United States Department of Agriculture were downloaded for 2005, 2006, and 2007 were considered. The images were 1:20000 scale (2 meter resolution) a for the 2005 and 2006 data and 1:40000 (1 meter resolution) scale for the 2007 data. Because of the higher resolution the most current shown in 2007 image was used. This image is shown in Figure 4. These images consist of photos of digital ortho quarter quadrangles (DOQQ's) that were mosaicked in the MrSID format with a compression ratio of 15:1. The aerial photography took place during the growing season from June to October. The coordinate system used is the Universal Transverse Mercator (UTM), Zone number 16 (USDA 2007)

For land use stratification, raster data from the Multi-resolution Land Characteristics (MRLC) were also retrieved from the USGS online database. The software specifically requires three images from the 2001 NLCD (National Land Cover Database). Land cover by type, impervious surfaces and the tree cover were the three images specified. These three images are found in Figures 1, 2, and 3 in the Appendex. In configuring the Fayette County 2009 project, species databases, and location databases were contained in the software. These two databases contain the information that will be used along with the field sampling data to calculate the pollution removal capacities, susceptibility to specific tree destroying pests, energy savings and other important parameters contained in the model.

Distributing Sample Points for Sample Location

With the configuration complete, the model required the user to load a tool "LC_Point_Patterns" as a custom tool designed to generate sample plots, however the functionality of this routine was impaired. After trying to work around error messages, a telephone conversation with i-Tree customer service directed this user to the necessary updates and patches to generate the sample plots. The fix consisted of an ArcGIS map with the extensions preloaded. The workaround requires the user to manually add to the ground cover raster data maps the UFORE-required fields in the attribute tables with routines to calculate the appropriate values. This is performed using the "add field" tool in the Data Management section of the ArcMap toolbox. The plots generated are shown in Figure-1 transposed over the impervious surfaces data map.

Collecting Field Data.

For the purpose of this study field data were collected from a sample plots in the wooded green belt areas of Peachtree City and a residential area. The location of these sites are shown in Figure 4. The site selected was adjacent to the cart path and within the Flat Creek flood plain in the southern third of the county. The land was within a wetland area and contained a mix of old growth hardwoods. Two other sample plots that approximate sampling in residential areas were selected for this feasibility study. The area selected is a residential lot the 0.13 hectare with a 230 square meter ranch style home. The site contained two large pines and one red maple that were present before the house was constructed in 1987. The other tree specimens on the residential sample plots are two to five year old saplings that were added by the current owner to the landscape after the house was built. This site was selected due to the familiarity of the trees to the user with the absence of foliage and ease of continued access during the study. The field data collected at the three sites is shown in Table 1 in the Appendix.

At the two residential sites the area specification of 0.04 hectares was not measured and was exceeded. The purpose of collecting tree data in these two plots with a preponderance of freestanding trees was to get an idea of the difficulty in measuring over all tree height, and distance to the crown.

At the forest plot, care was taken to measure all trees within a circle with an 11.7 meter radius using a signature tree as a center point and a tape measure. The data collection team consisted of a team leader, and two assistants. One assistant recorded data in paper form and took pictures as directed by the team leader. The other assistant worked the end of the tape measure and marked trees with chalk as the measurement and identification process progressed. Circumference measurements were taken and condition of the crown and wood were evaluated. The process took a little over two hours for the forest plot to be evaluated, but with experience, better tools, and familiarization with the area characteristics, the time the team would spend on each plot should be reduced to about an hour. Additional team members would not speed up the evaluation process appreciably. Other tools could be made or procured to speed up the evaluation process. For example, cord with meter markings for the distance from the center of the plot would be a great improvement. Binoculars for high-canopy observation and GPS location finder would be a necessity. The manual stated that plots could be located using the plots superimposed over the aerial photo, but for re-measurements and quality control checks precise coordinates are necessary. A PDA with the downloaded plot data, is not required, but for all practical purposes it would be far superior to any paper based system in terms of efficiency, quality of data, and data accumulation and transmittal. For this team, a pocket PC was available for use. The model was a Toshiba 2032SP phone and pocket PC combination with technology at least seven years old. For this team leader, it seemed his handheld device had reached the end of its useful life. As a result, the pocket PC performed flawlessly in synchronizing with the Windows based laptop computer and the UFORE software. With characteristic “drop-down” windows with preset choices, this tool would prove indispensible. At the time the study was completed, working models of this and later models using the same software could be purchased in online auctions for around $50. The software does not work with Palm OS based systems. The other electronic technology resource item that would need to be procured would be a GPS device. Entry level models can be purchased for around $100.

When the field work was completed, a conversation with Mr. Eric A. Kuehler, Technology Transfer Specialist with the US Forest Service, clarified some of the the major challenges of the project. Mr. Kuehler offered the following advice and suggestions.

- It is of primary importance that the scope of the study, the level of detail that is measured, along with the statistical quality considerations be established. For an area the size of an average Georgia county, Mr. Kuehler indicated that most groups measure between 200 to 300 plots. Measuring more plots and additional details down to the stems as small as an inch may not necessarily provide better results.

- Many volunteer groups have been successful; however, the commitment and maturity levels of the some of the volunteers in the initial phases of sampling would quickly become evident. The work involves venturing into forests without established paths and negotiating dense thickets and forest understory. The potential for encounters with dangerous wildlife lurking unseen is more risk than many volunteers are willing to take. The dropout rate the first day is dramatic.
- Extensive training and orientations conducted in classrooms may end up being wasted effort. On-the-job training in the field will build teams that are more effective more quickly.
- Species identification, tree canopy evaluation, and other parameters are major challenges, but they could be overcome with a thorough and rigorous application of the UFORE manual in the field. In the UFORE model, a Red Oak has a different environmental footprint than a White Oak and a high quality study would need to differentiate between the two. However if the project designers decided that the end product did not need this level of detail, then oak species could be combined into one group for data collection purposes.
- The quality control rules that the project members decide upon initially and apply consistently with all teams in their field work will avoid most of the wasted and misdirected effort. Mr. Kuehler illustrated this point by explaining how a project became bogged down by the project design requiring stems smaller than an inch to be measured. When they explained the problem to the their Forest Service resource

person, they were surprised to find out that the model was flexible enough to allow them to set the minimum stem size to whatever they felt appropriate.

V. Conclusion

In a recent interview shown on the i-Tree website, the principal designer of the UFORE model, Mr. David Nowak of the US Forest Service, said that managing forest resources without accurate inventories is like trying to manage a grocery store without knowing what is on the shelves. A convergence of factors makes application of the UFORE Model at the county level not only possible, but a necessary element in any long-range community development and environmental conservation plan. Global effects of the loss of carbon sequestering capacity will have consequences that we can hardly imagine. The struggle at the local level to preserve our natural heritage and legacy is not a recent trend; however, the increasing rate that open, undeveloped land is being converted to suburban sprawl is alarming. In localities where the remaining open space has diminished to critical levels, we find that the more costly and politically prohibitive it becomes to convert farms and forests to subdivisions and strip malls, developers are more likely to direct their activities toward the redevelopment of marginal and abandoned developed property.

The evidence presented in this study demonstrates the advantages afforded to citizens of communities who understand the immense value contained in the natural resources of their community. Essential environmental services that these resources provide are difficult if not impossible to replace when lost. As shown here, the tools of such valuations have been demonstrated in applications across the United States. The software and support are free. The developers of these tools are in the employed in the public sector and are eager to assist as much as possible to make volunteer projects successful.

The application of the UFORE model to Fayette County would not be easy, and would require the sustained commitment of four or five team leaders over the course of a summer with another dozen or so committed team members. These numbers are based on the UFORE manual's estimation that two people could sample two-hundred plots over the course of one summer. This is somewhat surprising in light of the limited field experience presented here, but the information indicates that four teams could easily complete the study in a shorter period with decreased likelihood of losing interest or becoming burned out. An intensive initial effort could do most of the plots, with follow-up and quality control checking work being completed the last month.

The results of the study would provide valuable information, but the greatest benefit may be achieved indirectly. The experiences and efforts of the teams, if well publicized, may give the community as a whole a greater sense of ownership and an increased feeling of interconnectedness with the totality of the ecosystem of Fayette County. Once complete, the system could undergo less comprehensive updates, and using the other tools in the i-Tree suite, gains and losses could be tracked and publicized along with the latest development and planning commission news. Accurate and credible information would be powerful tools in promoting sustainability in development and well informed policy decisions.

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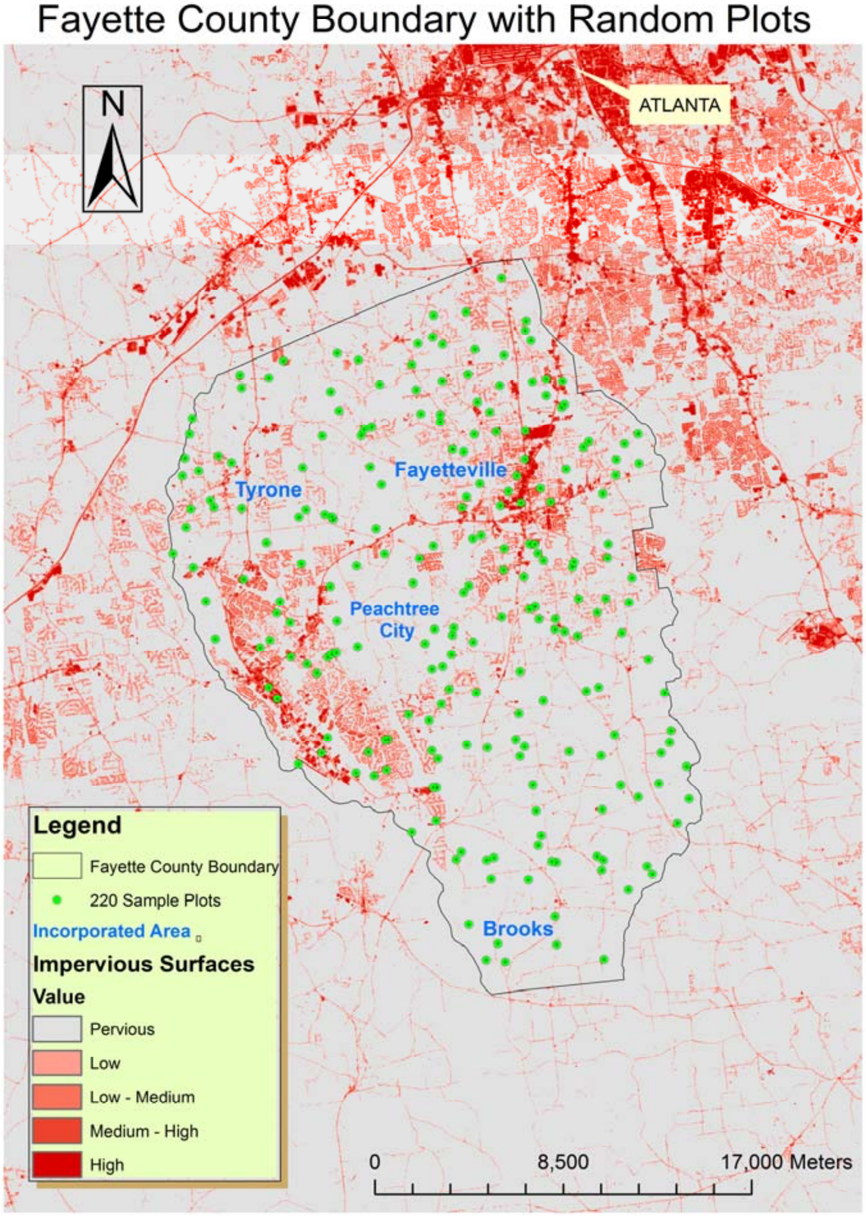

Figure 1.

Data Source for Impervious Layer:
USGS. National Land Cover Database Zone 54 2001.
MRLC Consortium Sioux Falls, SD. Retrieved from:
http://www.mrlc.gov/nlcd_multizone_map.php. March 1, 2009

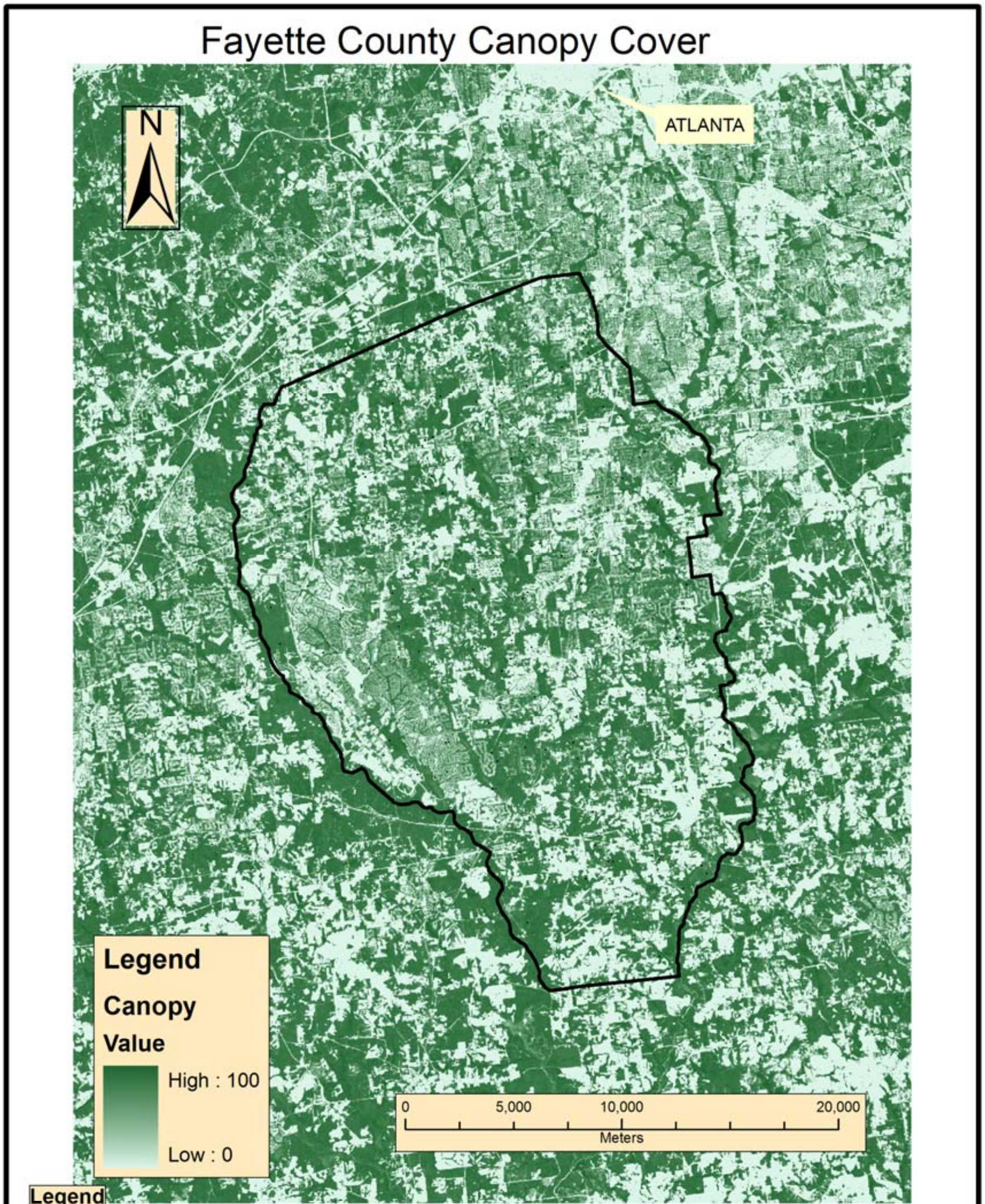

Figure 2

Data Source for Canopy CoverLayer:
USGS. National Land Cover Database Zone 54 2001.
MRLC Consortium Sioux Falls, SD. Retrieved from:
http://www.mrlc.gov/nlcd_multizone_map.php. March 1, 2009

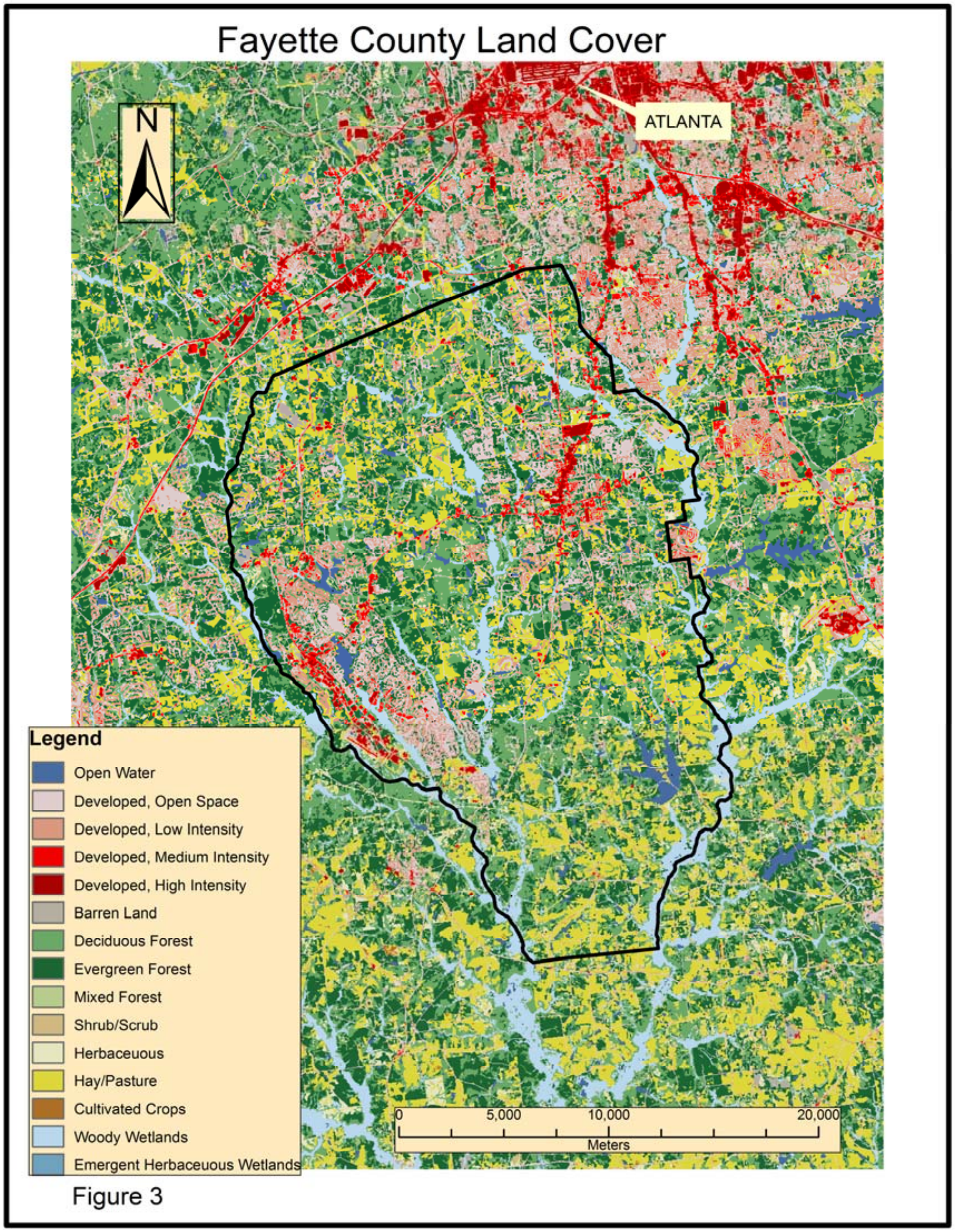

Figure 3

Data Source for Land CoverLayer:
USGS. National Land Cover Database Zone 54 2001.
MRLC Consortium Sioux Falls, SD. Retrieved from:
http://www.mrlc.gov/nlcd_multizone_map.php. March 1, 2009

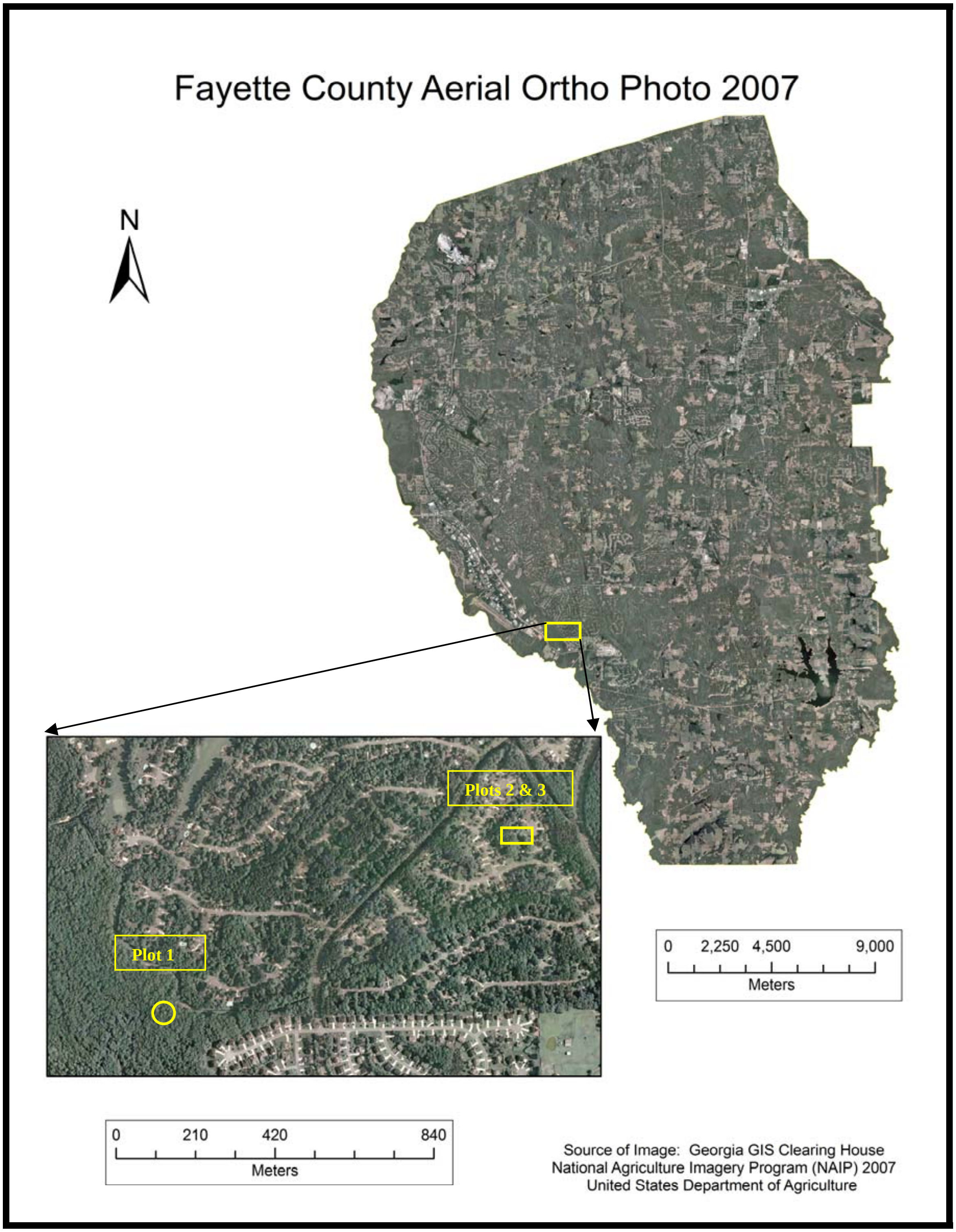
Fayette County Aerial Ortho Photo 2007
N
Plots 2 & 3
Plot 1
0 2,250 4,500 9,000
Meters
0 210 420 840
Meters
Source of Image: Georgia GIS Clearing House
National Agriculture Imagery Program (NAIP) 2007
United States Department of Agriculture

Figure 4

Table 1: Selected Sample Plot Data

TreeID	*LocationType*	*BotanicName*	*CommonName*	*Circumfrence (cm)*	*DBH (cm)*	*Tree Height (m)*	*ConditionWood*
1	Wetland Forest Trees	Acer rubrum	Red Maple	150	48	35	Good
2	Wetland Forest Trees	Acer rubrum	Red Maple	55	18	35	Good
3	Wetland Forest Trees	Acer rubrum	Red Maple	110	35	35	Good
4	Wetland Forest Trees	Fraxinus species	Tulip Poplar	162	52	35	Good
5	Wetland Forest Trees	Quercus alba	White Oak	90	29	35	Good
6	Wetland Forest Trees	Quercus alba	White Oak	134	43	35	Good
7	Wetland Forest Trees	Quercus alba	White Oak	120	38	35	Good
8	Wetland Forest Trees	Quercus alba	White Oak	143	46	35	Good
9	Wetland Forest Trees	Quercus alba	White Oak	95	30	35	Good
10	Wetland Forest Trees	Quercus alba	White Oak	101	32	35	Good
11	Wetland Forest Trees	Quercus alba	White Oak	148	47	35	Good
12	Wetland Forest Trees	Quercus alba	White Oak	88	28	35	Good
13	Wetland Forest Trees	Quercus alba	White Oak	120	38	35	Good
14	Wetland Forest Trees	Arborus morbidum	Dead Tree	40	13	4	Dead
15	Wetland Forest Trees	Arbous morbidum	Dead Tree	46	15	5	Dead
16	Wetland Forest Trees	Arbous morbidum	Dead Tree	42	13	7	Dead
17	Res Landscape Tree	Pinus taeda	Loblolly Pine	180	57	45	Good
18	Res Landscape Tree	Pinus taeda	Loblolly Pine	162	52	45	Good
19	Res Landscape Tree	Platanus occidentalis	Sycamore	185	59	35	Good
20	Res Landscape Tree	Acer saccharinum	Silver Maple	126	40	15	Good
21	Res Landscape Tree	Acer rubrum	Red Maple	10	3	12	Good
22	Res Landscape Tree	Quercus palustris	Pin Oak	110	35	12	Good
23	Res Landscape Tree	Quercus palustris	Pin Oak	107	34	12	Good
24	Res Landscape Tree	Ilex x 'Nellie Stevens'	Holly	44	14	4	Trimed clean 2m
25	Res Landscape Tree	Ilex x 'Nellie Stevens'	Holly	40	13	4	Trimed clean 2m
26	Res Landscape Tree	Ilex x 'Nellie Stevens'	Holly	40	13	4	Trimed clean 2m
27	Res Landscape Tree	Ilex x 'Nellie Stevens'	Holly	35	11	4	Trimed clean 2m

Table 1: Selected Sample Plot Data (continued)

TreeID	*LocationType*	*BotanicName*	*CommonName*	*Circumfrence (cm)*	*DBH (cm)*	*Height (m)*	*ConditionWood*
28	Res Landscape Tree	Ilex x 'Nellie Stevens'	Holly	43	14	4	Trimed clean 2m
29	Res Landscape Tree	Ilex x 'Nellie Stevens'	Holly	38	12	4	Trimed clean 2m
30	Res Landscape Tree	Ilex x 'Nellie Stevens'	Holly	36	11	4	Trimed clean 2m
31	Res Landscape Tree	Ilex x 'Nellie Stevens'	Holly	35	11	4	Trimed clean 2m
32	Res Landscape Tree	Ilex x 'Nellie Stevens'	Holly	33	11	4	Trimed clean 2m
33	Res Landscape Tree	Ilex x 'Nellie Stevens'	Holly	33	11	4	Trimed clean 2m
34	Res Landscape Tree	Ilex x 'Nellie Stevens'	Holly	39	12	4	Trimed clean 2m
35	Res Landscape Tree	Pyrus calleryana	Bradford Pear	143	46	10	Cut Back
36	Res Landscape Tree	Pyrus calleryana	Bradford Pear	131	42	12	Cut Back
37	Res Landscape Tree	Pyrus calleryana	Bradford Pear	132	42	12	Cut Back
38	Res Landscape Tree	Prunus x yedoensis	Yoshino Cherry	145	46	9	Good
39	Res Landscape Tree	Prunus x yedoensis	Yoshino Cherry	133	42	9	Good
40	Res Landscape Tree	Prunus x yedoensis	Yoshino Cherry	110	35	9	Good
41	Res Landscape Tree	Acer rubrum	Red Maple	204	65	12	Good
42	Res Landscape Tree	Acer rubrum	Red Maple	57	18	9	Fair
43	Res Landscape Tree	Acer rubrum	Red Maple	32	10	9	Fair
44	Res Landscape Tree	Acer rubrum	Red Maple	27	9	9	Good
45	Res Landscape Tree	Acer rubrum	Red Maple	18	6	9	Good
46	Res Landscape Tree	Acer rubrum	Red Maple	73	23	9	Good
47	Res Landscape Tree	Acer rubrum	Red Maple	36	11	9	Good
48	Res Landscape Tree	Acer rubrum	Red Maple	31	10	9	Good
49	Res Landscape Tree	Acer rubrum	Red Maple	37	12	9	Poor
50	Res Landscape Tree	Acer rubrum	Red Maple	70	22	9	Poor
51	Res Landscape Tree	Acer rubrum	Red Maple	15	5	9	Fair
52	Res Landscape Tree	Acer rubrum	Red Maple	17	5	9	Fair
53	Res Landscape Tree	Acer rubrum	Red Maple	72	23	9	Poor
54	Res Landscape Tree	Acer rubrum	Red Maple	48	15	9	Poor
55	Res Landscape Tree	Acer saccharinum	Silver Maple	116	37	9	Fair (Weak Fork)

Table 1: Selected Sample Plot Data (continued)

TreeID	***LocationType***	***BotanicName***	***CommonName***	***Circumfrence (cm)***	***DBH (cm)***	***Height (m)***	***ConditionWood***
56	Res Landscape Tree	Acer saccharinum	Silver Maple	36	11	9	Poor
57	Res Landscape Tree	Acer saccharum	Sugar Maple	51	16	9	Poor
58	Res Landscape Tree	Acer saccharum	Sugar Maple	33	11	9	Poor
59	Res Landscape Tree	Acer saccharum	Sugar Maple	45	14	9	Poor
60	Res Landscape Tree	Acer saccharum	Sugar Maple	43	14	9	Poor
61	Res Landscape Tree	Acer saccharum	Sugar Maple	36	11	9	Poor
62	Res Landscape Tree	Betula Nigra	River Birch	84	27	9	Poor
63	Res Landscape Tree	Fraxinus pennsylvanica	Ash Marshal S.	34	11	9	Poor
64	Res Landscape Tree	Fraxinus pennsylvanica	Ash Marshal S.	43	14	9	Poor
65	Res Landscape Tree	Fraxinus pennsylvanica	Ash Marshal S.	36	11	9	Poor
66	Res Landscape Tree	Cercis canadensis	Eastern Red Bud	59	19	9	Fair