To the Graduate Council:

I am submitting herewith a thesis written by Nathan Asher West entitled "Analyzing Ecotourism Potential Using Geographic Information Systems." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Planning.

George E. Bowen, Major Professor

We have read this thesis and
recommend its acceptance:

Accepted for the Council:

Associate Vice Chancellor and
Dean of the Graduate School

ANALYZING ECOTOURISM POTENTIAL USING GEOGRAPHIC INFORMATION SYSTEMS

A Thesis

Presented for the Master of Science in Planning Degree

The University of Tennessee, Knoxville

Nathan A. West

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DEDICATION

This thesis is dedicated to my family

Charissa West

Jason West

John West

Gwendolyn Caldwell

And

Bill Caldwell

who have given me support throughout all stages of my graduate and undergraduate learning experiences.

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I want to specifically thank George Bowen as my thesis chair who supplied me with a working model of capability, suitability, and carrying capacity analysis. I also want to thank Mur Muchane who inspired me to learn more about geographic information systems and the PC world in general. Additionally, I want to thank John Peine who supplied me with invaluable resources on ecotourism and a job opportunity which enabled me to conduct my study on ecotourism in Europe. I would like to acknowledge further thanks to Cecilia Zanetta who encouraged me and helped me through many decision making processes. Finally, I would like to thank Greg Toth, Larry Watson, and Bill Caldwell for their frequent consultations in the research and writing of this thesis.

ABSTRACT

This study is a guide and manual for the development and management of ecotourism communities utilizing geographic information systems. It capitalizes on the fact that there are limited resources available for providing direction for ecotourism development with geographic information systems. The study outlines the concepts and ideas of geographic information systems specialists and ecotourism experts. In addition, it explores case studies of ecotourism development and the steps involved in inventorying environmental assets and attractions using GIS. Strategies and models for community development with ecotourism are also identified. Finally it establishes a case study where the authors guidelines are applied in a simulation of an ecotourism development in a rural county in the Appalachian region of the US. Overall, this study stresses and promotes the creation of sustainable ecotourism development.

PREFACE

The author of this thesis has been a strong supporter of sustainable forms of development for several years now. He has been a contributing team member to two long-term development plans one in rural east Tennessee and the other in central Portugal. In addition, the author has explored a wide variety of GIS uses including environmental impact assessments in east Tennessee, transportation pattern analysis in Great Smoky Mountains National Park, and community GIS support for the use of the Southern Appalachian Man And Biosphere database. Through such achievements and a long time interest in the sustainable forms of development that revolve around nature based tourism, the author has chosen to venture into the unexplored area of ecotourism development using GIS.

Chapter One includes an introduction to GIS and Ecotourism. In addition, it includes a statement of the problem, overview, of the subject matter and a literature review of leading authors in ecotourism development, GIS applications in environmentally sensitive areas, and GIS applications in community development.

Chapter Two explores in great detail ecotourism as a whole. It also covers the rising interest and success of the industry as well as the most applicable and accepted definitions of the term. Successful case studies of ecotourism are both analyzed and reviewed. Finally, this chapter explores ecotourism as a form of economic development.

Chapter Three begins by looking at how GIS databases for ecotourism development should be created. It demonstrates how assets of the community should

be defined. Portrayal of GIS analysis of potential attractions based on the asset inventory is discussed. Next GIS' use in the overall ecotourism assessment is clarified.

Chapter Four explicitly defines a strategy for ecotourism development including goals and objectives that should be a priority when creating sustainable ecotourism. In addition, this chapter illustrates models of various relationships that must be considered for sustainable development.

Chapter Five consists of a case study utilizing previously defined strategies, models, and GIS analysis to look at the potential of ecotourism in Cocke County, Tennessee. It includes examples of GIS, attractions, assets, and development standards applied in a real life community.

Chapter Six provides a summary and conclusion of the thesis including the clarification of what can be gathered from this study.

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Chapter I

INTRODUCTION

Statement of the Problem and Background

At this time many developing communities have large expanses of undeveloped land. As the world rapidly loses its green spaces this land will become more valuable. However, the traditional development of this land is often unsustainable, wasteful and inefficient. Similarly, many communities have not broken away from traditional development paradigms. In addition, many do not know how or why to use ecotourism as an alternative approach to economic development. When they are aware of such alternatives they often proceed with them in an unsustainable fashion. Valuable environmental assets within a community are often exploited rather than used to the communities advantage. Conservation of resources needs to be an end rather than simply a means for economic development. While a community may see green space as a means to produce income, through high and low density development, they may be ignoring greater income potential through tourism.

Ecotourism itself is in many cases developed with a lack of sensitivity to the environmental assets on which it is based. The term "eco" has connotations that may tempt a community to use it out of context. Communities may associate with the environmentally friendly term ecotourism to take advantage of its attractive power. However, sustainability is lacking in these situations and the local environment may be jeopardized through lack of connected information. In many cases communities

have the intentions of being sustainable and environmentally sensitive, but they lack the insight to obtain such a status.

Many communities cannot develop sustainable ecotourism economies because they have not done the necessary homework. A critical information base is an inventory of the communities assets. The best way to develop an inventory of community assets is to use GIS (Geographic Information Systems). GIS is a tool which many ecotourism communities do not use or do not use effectively in the development of their economy. When combined with concepts such as capability, suitability, carrying capacity, and sustainability, GIS can be a powerful tool in ecotourism development in environmentally sensitive areas.

In this analysis, the specific case study of Cocke County, Tennessee is used to demonstrate the applicability of GIS and ecotourism. Cocke County has the advantage of being in a perfect location to promote widespread visitation. It's position next to Smoky Mountains National Park and the fact that it is less than one days drive for two thirds of the population of the U.S. give it very positive potential.

Overview

As a prerequisite to determining the methods and strategies of ecotourism, development definitions must be agreed upon. These definitions of ecotourism and nature based tourism vary greatly. However, truly sustainable versions of these ecotourism definitions show the greatest potential for successful long-term development. In such instances ecotourism is defined as travel to undisturbed natural areas while seeking knowledge, and immersion into the natural environment (Boo

1990). In addition, to the intentions of the traveler, ecotourism should include factors that both conserve the local environment, culture, and economy. One definition suggests ecotourism travel sustains the well-being of local people through responsible tourism to natural areas that conserves the environment (Blangly 1993). In a more elaborate definition the term is described as:

> Nature-based tourism that involves interpretation and education, and is managed to be ecologically sustainable (recognizing that the natural environment includes cultural components and that ecologically sustainable involves an appropriate return to the community and long term conservation of the resource) (McArthur 1997).

This definition characterizes the many components of ecotourism, combining the benefits of tourism to the local economy, the preservation of the local environment and the added dimension of cultural considerations. Ecotourism specializes in building upon specific environmental attributes while maintaining their integrity into the future. Through impact assessments and monitoring, ecotourism activities strive to be environmentally benign (Wall 1997).

Controversy arises in ecotourism definitions as nature-based tourism lacking long term considerations use the term under false pretenses. For example many tourism industries have been repackaging themselves by selling themselves under the environmentally friendly term. In many cases: "ecotourism may be little more than old wine in new bottles" (Wall 1997). In addition, a large number of tourism developments are operated with negative effects on the local environment, poor return to the local community and culturally degrading practices. By excluding such developments from the definition of ecotourism the positive attributes of its manifestation can be recognized.

Ecotourism Development

Development of sustainable ecotourism should be approached in a holistic manner using the broadest of the above definitions. In developing ecotourism there are two main issues to consider: 1.) the management of the tourism development 2.) the management of environmentally sensitive areas. The challenge is to come up with sustainable forms of mass tourism that are economically viable while finding a means of inserting small numbers of environmentally aware visitors into pristine environments (Wall 1997). By providing a balance between these factors ecotourism environments will have longer lasting effects without requiring subsidies from future generations. Setting goals for development such as enhanced visitor satisfaction, improved economy, business success, protected resource assets, and community integration, should be the starting point for development. With these goals, a framework for development can be established (Gunn 1994). After developing goals and establishing the framework, the developer must assess the nature of the tourism project. Questions should be asked to arrive at a determination of the attractiveness, special features, carrying capacity and potential market (Boo 1990). Ecotourism development can be further perpetuated with the help of tools such as geographic information systems.

GIS Applications in Analyzing Environmentally Sensitive Areas

Prior to the development of ecotourism, it is necessary to assess and analyze the existing environmentally sensitive areas within the community. GIS allows for

more efficient and meaningful analyses of these areas. The combination of area information and map coordinates provide a basis for rational decision making that traditional forms of analysis may lack (Muchane 1997). GIS is capable of representing resources and environmental elements spatially which can add to the effectiveness of developing ecotourism in forms relevant to the surrounding conditions. GIS allows planners to conceptualize solutions through visual interpretation using maps and tables. Data storage, multidimensional measurement, transformable surface characteristics, hypothesis testing, and spatial organization are additional advantages (Kliskey 1995). Generation of GIS models speed up the process of analysis by turning large data sets into maps, allowing resource information layers to provide overlay capabilities (De Gouvenain 1995). Planning techniques such as overlay can be performed with more accurate and meaningful results when using GIS.

Building the GIS is the first step in analyzing environmentally sensitive areas. Attention to detail is critical to managing the accuracy of the analysis. Once data is mapped, site checks should be conducted to verify map characteristics and overall quality. Five phases are identified in the building of a dependable GIS database.

Phase 1: Data Collection
Flyovers and aerial photograph evaluation; field mapping, creation of ecologically relevant data; literature evaluation.
Phase 2: GIS-creation and Data Processing
Development of maps, tables, diagrams, and statistics as a basis for the subsequent assessments.
Phase 3: Model Application and Resource Assessment
Professional modeling and statements from various disciplines; development of assessed spatial units.
Phase 4: Prognosis and Balancing Methods of Impacts

Combination of ecologically assessed spatial units with the affected areas for the different variants; variant oriented impacts balance.
Phase 5: Total Evaluation and Presentation of Results
Summarized expert statement (Schaller 1992).

GIS use in the form of overlays can guide development in and around environmentally sensitive areas. Suitability of these areas for protection, promotion, active or passive recreation, and even structure development can be determined with this method (McHarg 1971). Each of these areas has an intrinsic suitability to fit into one of the above categories. Many areas may be determined to be unsuitable for any human use while others may prove suitable to multiple uses while maintaining the ecosystems integrity (McHarg 1971). Single and multiple environmental characteristics can determine suitability. For example, soil type alone may make clear that human use would result in the jeopardy of the ecosystem due to a high likelihood of erosion. On the other hand, a number of characteristics such as the combination of slope, soil type and surrounding streams may result in the determination of a location being unsuitable for a trail. As a result, the use of a GIS overlay is critical in determining suitability. Anywhere from one to thirty environmental factors might be explored prior to the determination of suitability. The results will illustrate areas which will not create problems associated with land compatibility (Bowen 1997).

In further analysis, capability assessment will be used to determine uses that environmentally sensitive areas are able to withstand. By creating layers of environmental factors in the form of maps they too can be overlaid to illustrate how

environmental areas can best be protected when locating tourism developments (Bowen 1997).

Both suitability and capability maps need to include not just visual maps but a comprehensive table of data associated with each attribute displayed. If, for example, capability analysis determines that a location is not appropriate because of endangered species habitat, it would be important for the table associated with this location to have every possible characteristic of the species' niche and habitat that might be inhibited by development. A closer look at the location and related species data may show that the endangered bird (which may potentially be preventing development) migrates to another area during the tourist season (De Gouvenain 1995). The more comprehensive the database the greater accuracy and reliability the GIS overlay will have. This overall functionality of GIS gives it the potential of being an indisposable tool in environmentally sensitive area analysis (Kliskey 1995).

GIS Applications to Community Development

GIS is an excellent tool for environmental assessment, however, its potential is even greater. In community development, GIS can be used for input, manipulation, management, organization, query, analysis, and visualization (Muchane 1997). Through such means GIS can evaluate social, economic, cultural and environmental factors. These factors may include heritage, local culture, demography, landscape, infrastructure and economic base (Coombes 1993). All of these factors should be included in the GIS database to the extent that they can be mapped. In addition, notations as to the quality and presence of these factors should be included (Geertman

1995). Several layers of each factor can be analyzed at once. Awareness of existing community features and their capabilities will help to establish future goals and needs for development (Deller 1993). The various interactions of people and pieces of land used should be mapped in order to gain a better understanding of the community as a system. However, determining the relevance of the data to the development should be a prerequisite (Coombes 1993). GIS might also be used to illustrate potential impacts of natural disasters, trends of population growth across communities, and/or determine parcel ownership.

Access and locational information are necessary attributes to develop a working GIS model for ecotourism communities. "Accessibility is the ability to command the transportation facilities that are necessary to reach desired locations at suitable times" (Geertman 1995). This realization points out further importance of using GIS to document transportation systems, travel patterns, distances and destinations.

Another attribute that GIS deals with to support community development is the "what if" question. By placing ideas on map models and overlaying community factors it is possible to answer if a location has the capacity to handle a specific land use (Edralin 1991). For example, if a hotel was placed in this location are the road systems, infrastructure, and environmental attributes sufficient to handle the new influx of people? Most importantly, GIS can be customized in a way that efficiently fits the needs of a developing community. The need for GIS in ecotourism development is apparent when one considers the variety of contributions it can make to community development.

Chapter II

ECOTOURISM: THE RISING INTEREST AND SUCCESS

The Growth of Environmentally Based Tourism

As the developed world continues to exceed their own carrying capacity we are seeing more and more exploitation of third world countries. Pressures to develop economically viable communities where living conditions and per capita incomes are substandard have grown immense. Still many of these areas have comparatively untouched natural resources that inevitably must be made profitable. However, these growing nations and communities need to rise above temptations and the norm; and learn from the mistakes of the developed world. The developed world on the other hand is at a point where development has reduced environmentally sensitive areas to a small percentage of the existing landscape. As a result, many of the remaining areas have greater environmental significance. They are not only valued as a natural commodity but an escape from the surrounding congestion. Both developed and developing nations must look down the road to their long-term future and consider consequences of sporadic short-term gain. By practicing sustainability they can and will thrive.

With diverse ecosystems still intact, developing countries have assets which can be found few other places in the world. Similarly, developed countries, historic or rejuvenated ecosystems are an appealing rarity. This gives both a chance to practice the most beneficial and profitable economic opportunity there is: tourism. Tourism draws money inside the community from around the world rather than the typical recycling of less stable economies. But, tourism alone is often as

exploitative as the harvesting of natural resources. In order to make tourism last for generations sustainable tourism is a necessity. Today, this type of tourism is known as ecotourism. However, one must consider that ecotourism is not always a sustainable practice and sustainable tourism does not have to include an ecological base. Before going into definitions of ecotourism we must first consider why it is here and how it grew to the popularity of today.

Tourism as a whole has grown significantly over the past several years. The rise in disposable income from the increase in two income families and the influx of allocation of funds towards travel has made a significant impact on tourism and its role in economies around the world (Inskeep 1991). In 1991, the World Tourism Organization found that tourism created approximately 121 million jobs in that year alone. It is also expected that by the year 2000, tourism will be the number one global industry (Francis 1997). The following chart (Figure II-1) and table Table II-1) illustrate the dramatic

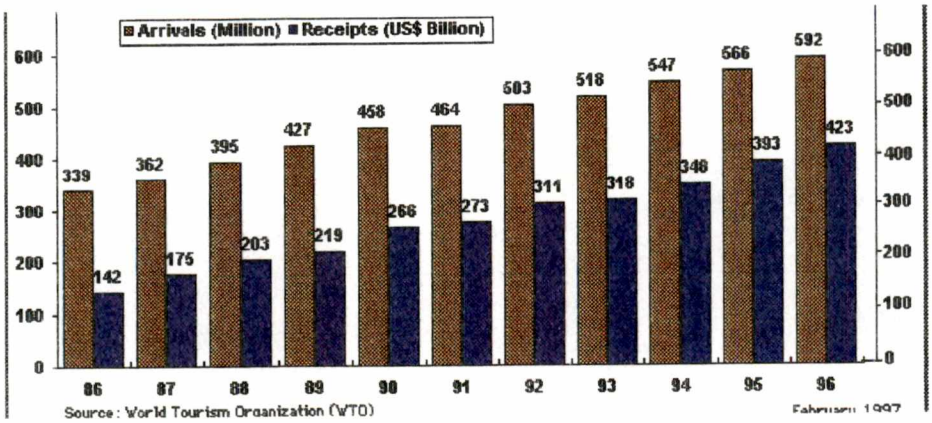


Figure II-1. Global Tourists Arrivals and Receipts 1986-1996

Source: World Tourism Organization 1997, http://www.wto.org

Table II-1. Worlds Top 20 Tourism Destinations

Source: World Tourism Organization 1997, http://www.wto.org

Rank				Country	Tourist Arrivals (thousands)			% Change	Market Share Percent of World Total	
1990	1994	1995	1996		1990	1995	1996	96/95	1990	1996
1	1	1	1	FRANCE	52497	60110	61500	2.31	11.46	10.39
2	2	2	2	UNITED STATES	39363	43385	44791	3.24	8.59	7.57
3	3	3	3	SPAIN	34085	39324	41295	5.01	7.44	6.98
4	4	4	4	ITALY	26679	31052	35500	14.32	5.82	6.00
12	6	6	5	CHINA	10484	23368	26055	11.50	2.29	4.40
7	7	5	6	UNITED KINGDOM	18013	24008	25800	7.46	3.93	4.36
8	10	8	7	MEXICO	17176	20162	21732	7.79	3.75	3.67
5	5	7	8	HUNGARY	20510	20690	20670	-0.10	4.48	3.49
28	8	9	9	POLAND	3400	19200	19420	1.15	0.74	3.28
10	12	11	10	CANADA	15209	16896	17345	2.66	3.32	2.93
16	11	12	11	CZECH REPUBLIC	7278	15500	17205	11.00	1.59	2.91
6	9	10	12	AUSTRIA	19011	17173	16641	-3.10	4.15	2.81
9	13	13	13	GERMANY	17045	14847	15070	1.50	3.72	2.55
19	16	15	14	HONG KONG	6581	10200	11700	14.71	1.44	1.98
11	14	14	15	SWITZERLAND	13200	11500	11097	-3.50	2.88	1.87
13	17	17	16	PORTUGAL	8020	9706	9900	2.00	1.75	1.67
14	15	16	17	GREECE	8873	10130	9725	-4.00	1.94	1.64
-	23	18	18	RUSSIAN FED.	-	9262	9678	4.49	0.00	1.64
24	22	20	19	TURKEY	4799	7083	7935	12.03	1.05	1.34
15	18	19	20	MALAYSIA	7446	7469	7742	3.66	1.62	1.31
				TOTAL 1-20	329669	411065	430801	4.80	71.94	72.79
				TOTAL WORLD	458278	566384	591864	4.50	100.00	100.00

growth in tourism over the last decade. In the past six years there has been a 4.5% overall growth rate in world tourism. Travelers have prioritized the quality and value of the visit. Still, money is the key factor in making travel decisions and choice of destinations. New records were reached in the tourism market in 1996, the growth rate of international tourism rose significantly and receipts reached an all time high at approximately 592 million arrivals an equivalent of 423 billion dollars in US currency. This was a 7.6 per cent increase over 1995. Between now and the year

2010 it is almost certain that these growth rates will continue (World Tourism Organization 1997).

According to the World Tourism Organization:

> Two factors will combine to create a steady pace of growth of 4 per cent a year, or slightly higher:
>
> **i.** the acceleration of multiple, relatively short duration trips on the part of the travelers of industrialized countries (i.e. serving to boost arrivals totals and receipts because average daily expenditure on shorter trips tends to be higher than on longer visits).
> **ii.** the strong uptake of foreign travel (particularly holiday taking) by the populations of the developing countries. (World Tourism Organization 1997)

Long haul and intraregional travel will both grow in the form of international tourism. The highest growth rates will be in East Asia and the Pacific, Middle East, South Asia and Africa. While these countries continue to grow at rapid rates the US is by no means lacking. In addition the U.S. has had the second strongest tourism base for the past six years. Approximately 2% of this tourism consists of ecotourism (World Tourism Organization 1997). However, increasingly the typical tourist has added to their more typical visit: excursions in National Parks, Wildlife Refuges, and visitation of other national areas found within the region of their place of visit (Goodwin 1996).

Prior to the environmental movement tourism as a whole was helpful to developing economies but was far from being ecologically friendly. Tourism lacked respect for local communities and cultures and urged a change in the destination of travel from its native characteristics to those more familiar to the visitor. Environmental, social, and cultural values were jeopardized in order to provide

services and expectations for the consumer. As a result, Communities and ecosystems lost integrity.

In the early seventies the environmental movement partly influenced by Rachel Carson's Silent Spring of the 60's and the rise of environmental legislation throughout the world; an environmental conscious began to transform tourism. Small island tourism and ecologically pristine areas began to be appreciated for what they were rather than what they could be made into. Only in the last two decades has ecotourism began to emerge as a profitable form of economic viability. In 1986, the Brundtland Commission published a report known as "Our Common Future" illustrated the relationship between environmental issues and development issues. It promoted the concept of sustainable development and specifically addressed problems of intergenerational subsidies (D'Amore 1994). In 1987, the World Commission on Environment and Development recognized ecotourism as a form of tourism that meets present economic needs without jeopardizing the needs of the future (Burr 1995). By 1988, one fourth of tourist dollars from developing countries came from ecotourism (Laarman and Gregersen 1994). However, the largest question that arises is; how much of this "ecotourism" should truly be considered ecotourism? It is likely that much of this tourism is simply a non-environmentally friendly form of tourism that simply markets itself with the name of ecotourism. The term ecotourism has been "used opportunistically in marketing, where the tag 'eco' has come to be synonymous with responsible consumerism" (Goodwin 1996). Many of those that now use the tag do not act environmentally responsible. This seems to be a large percentage of the growing industry that calls itself ecotourism. Tourism

labels itself as such because today environmentally based tourism sells whether it is sustainable or not. Before considering the recent benefits of ecotourism it is important to manifest a working definition of ecotourism.

Definitions and Principles of Ecotourism

Ecotourism has been given a very wide variety of definitions. While many simply define the term as nature based tourism, others believe that ecotourism includes strict criteria. This might include travel to a remote location of an indigenous culture, local food and amenities, environmentally sound practices, and a virtually untouched natural environment. Another way of looking at ecotourism may be to consider it like a living natural history museum. It reminds the traveler of the limitations of the natural environment which they are visiting (Garfield 1994). Others see ecotourism as a means of generating financial support for the protection and management of natural areas. Similarly, it may be viewed as a way of economically benefiting residents of sensitive natural areas (Enriquez 1996). A well noted ecotourism author named Ralf Buckley observes ecotourism as a series of links between tourism and the environment. The links occur as follows:

> components of the natural environment as the basis for marketable tourism attraction or product; management of tourism operations so as to minimize or reduce their environmental impacts; economic or material contribution of tourism to conservation, either directly or indirectly; and attitude of tourists towards the environment and environmental education of clients by tourist operators (Buckley 1994).

The links encompass most definitions of ecotourism, however others definitions exist that are both broader and restrictive as well as more simplified.

Two distinct philosophies often occur in the definition of ecotourism. On one side are the environmental organizations and on the other are industries and governments. Environmental organizations often imply that ecotourism must be nature based, sustainably managed, conservation supporting, and environmentally educated. Industry and government on the other hand are concerned only with the product being sold in this case, a form of nature based tourism (Buckley 1994). In reality, ecotourism can meet the requirements of both philosophies. It can also encompass as many, and as few definitions as needed to meet the desired goals and objectives. Ideally, ecotourism would be developed with a definition that promotes conservation and educates, however, a nature based product can often be helpful as well. For example, simply selling a sensitive natural area as a product can enhance respect for the beauty of the area and help establish respect and admiration for that product. In addition, the sale of the product can provide economic means which may prevent local people from destroying the natural environment in more exploitative ways such as clear cutting, poaching, and mining. By selling the product as a tourism destination the local community can see it as having greater value.

In some cases tourist activities that exploit the environment are referred to as ecotourism. Often the very activities that sustainable ecotourism strives to avoid are now themselves labeled as ecotourism.

The definition of ecotourism should predominately include a nature based tourism that contributes to sustainable development through economic, environmental, and socially sound practices. Due to the falsification of the ecotourism term, true ecotourism might better be referred to as Sustainable Tourism.

Sustainable tourism like any form of sustainable development should "integrate economic, environmental, and social values during planning; distribute benefits equitably across socioeconomic strata and gender upon implementation, and ensure that opportunities for continuing development remain undiminished to future generations" (McCormick 1996). Sustainable tourism should also adhere to the following principles:

1. Provide for a 'hands on' adventurous tourist experience with the indigenous culture and natural environment.
2. Turn over tourist expenditures in the local economy.
3. Provide for an equitable distribution of benefits.
4. Diversify the local economy.
5. Alter consumer patterns to support conservation practices.
6. Actively market to attract clients desirous of premium values.
7. Always focus on long term consequences. (Peine 1996).

The first of these principles should include or resemble the lifestyle of those native to the area. Otherwise, the practices could not be sustainable, as conditions would begin to lean towards the lifestyle of the typical visitor. Maintaining existing lifestyles provides consistency, which is necessary to help plan for the future. The experience is simplified and more beneficial when the tourists are hosted, guided, and taught by the local population. This also further contributes to the success and employment of the community and relieves stress placed upon the environment. Without such interaction natives may be alienated from tourist activity. Most importantly, having natives included will help to change their way of living into an environmentally conscious way of living. Where as excluded natives may not see a direct relationship between the ecotourism industry and their well being; opening the door for them to continue exploitation and poaching for their economic viability.

The second, third, and fourth principles suggested by Peine urge the turnover of tourist expenditures into the local economy and equitable distribution of benefits. This turnover helps to promote quality of life within the community again linking the well being of the environment to human well being. By distributing benefits equitably, conflict and animosity between the community is reduced. Similarly the economy itself is diversified.

By simply introducing native lifestyle to the tourist rather than importing the tourists' lifestyle, conservation and protection of the environment can and will be maintained. Tourism that is compatible with conservation is crucial (Common and Driml 1996). The limitation of external contamination from the outside world is a necessary step in assuring economic security into the future. In this way consumer patterns must be altered.

In keeping the integrity of the natural environment the marketing and attracting clients will be easy, however, the seventh and final principle is by far the most important. The plan for ecotourism within a third world community must first consider long-term consequences. In doing so a holistic approach would be ideal. It should include environment, economy, social, cultural, and ethical properties as one system. Local control of these factors is the most efficient way of preventing long-term consequences and avoiding intergenerational subsidies.

Successful Case Studies of Ecotourism

Developing countries are typically the most common backdrop for today's practice of ecotourism and the practice is rapidly growing in more developed

countries such as the US and Australia. However, it is rare that they practice sustainable means of hosting the visitors. The following case studies will illustrate both problems and solutions of ecotourism in both developed and developing countries.

Tortuguero, Costa Rica

The basis of ecotourism in Tortuguero, Costa Rica is typical of some of the more successful forms of ecotourism. Tortuguero is located on the northeast coast of the country and has developed an ecotourism base with the promotion of Tortuguero National Park. Prior to the development of the local ecotourism the entire population of 300 lived of the exploitation of local resources. Trees were shipped out daily and as well as tons of native turtles. Prior to the implementation of the national park the economy was on the verge of collapsing. Now, visitors are lured to the location with anticipation of excellent sport fishing, sea turtle nesting, and the locations vast landscape of rivers, forests and beaches (Jacobson 1992). The goals of the park and the ecotourism development were as follows:

1. Natural Resource Conservation
2. Sustainable Development
3. Community Environmental Education
4. Tourism Environmental Education

(Jacobson 1992)

While these goals where ideal in developing a strong ecotourism economy the community found that many more significant steps needed to be taken to ensure

livelihood into the future. The community soon found that its infrastructure was unfit for the influx of visitors. In addition, a majority of the opportunities to bring in tourist dollars were being missed. The primary problem was the fact that the community had not fully realized the potential of its assets and the economy itself needed to be diversified in order to keep up necessary maintenance of the natural areas.

Currently, the ecotourism community has achieved a successful status due to the additional training of guides, the diversification of tourism jobs, and the active upkeep of the local infrastructure. To further insure the quality of the experience and preservation of the local environment the number of guides per tourist were increased. Quality was also improved by the active surveying of local residents and tourists (Jacobson 1992). Jacobson sums up the how the successful ecotourism in Tortuguero with the following quote. "Input from resource managers, current and potential tour guides, hotel owners, and/or managers, and the tourists themselves was necessary to ensure that the program could be achieved " (Jacobson 1992).

Saint Johns US Virgin Islands National Park

With the exponential growth of ecotourism in recent years there have been a wide variety of failures. Ecosystems, ideal for ecotourism activities, have been used to the point of breakdown. The most sensitive of such cases occur in island situations.

Saint John a US Virgin Island is one case where ecotourism has not maintained a sustainable rate of development. The Virgin Islands National Park can

be found on this island and is considered a well known ecotourism attraction. Due to its status as a national park the control of tourist use is not locally based and is handled from outside the community. As a result conflict exists between the national and local constituencies. In addition, those visiting the park are typically not looking for the type of ecotourism defined previously as sustainable tourism. However, the problems of the park are primarily the result of overuse. With more than 760,000 annual visitors the park has been operating above full capacity (UNEP 1994). Possibly due to the lack of control and lack of benefit received by the locals; they are pushing for increased capacity and increased development within the park. Currently Saint John is at a critical stage of economic development, however, if they continue to develop at the rate of previous years the population on the island will exceed carrying capacity. As a result, the system may fail as infrastructure and housing may intrude on the environment which attracted visitors in the first place. Looking more closely at the situation, it is apparent that because visitation was beyond capacity the need for development grew causing the natural capital to be placed in jeopardy. Such uncontrolled practices are likely to destroy the natural environment that attracted the tourism and economic growth to begin with (Hanneberg 1994).

Costa Rica: Monteverde Cloud Forest Reserve

The Monteverde Cloud Forest Reserve was created in 1973, is one of the most famous ecotourist attractions in the world. The rise in ecotourism, and the slowly cultured ethic of a conservation oriented community, made Monteverde a leader in the practical application of theories of sustainable development before the term

ecotourism had truly evolved (Bowman 1997). Monte Verde is a privately owned preserve in Costa Rica and has been a positive example of ecotourism for several years now. The park staff is made up mostly of local community members. The employees' income is paid entirely by the daily park entrance fee required by visitors. Still the preserve works within carrying capacity by limiting the number of visitors. Only 76 people are admitted into the park each day. Fees and limits on the number of visitors allowed in the park help to raise revenues and stimulate private investment (Laarman and Gregersen 1994). The preserve has an additional income from research grants, donations, and the Tropical Studies Organization. Part of the success of this organization is the result of Costa Rica's familiarity with, and policies on, ecotourism. The country has formed its own definition of ecotourism "as an activity aimed at the enjoyment, research, and protection of the natural wealth of the country." In addition, the government maintains that:

> the most rational use of the countries natural resources under present circumstances is in the area of ecological tourism, which is considered to be an activity which achieves the following objectives:
> - Strictly-controlled use of the environment, thereby ensuring its integrity and stability;
> - A substantial contribution to the inflow of foreign currency
> - Improved socio-economic conditions in the regions where this tourism activity takes place
> - Preservation of cultural assets of the population
> - Promoting the development of an environmental culture
> - Incentive to local tourism (UNEP 1994).

As a country Costa Rica is doing a good job of setting standards and policies for tourism to assure that it will last into the future. However the National Parks of Costa Rica have not shared the success of the Monte Verde Cloud Forest Preserve. This

may be attributed to several factors. First, Monte Verde is private, allowing for those who are directly dependent on the preserve to set standards and guidelines. In addition, they are able to charge higher prices. The importance of funding through research establishes a greater incentive to maintain the integrity of the natural environment.

Amazonas, Brazil: Ecotourism and Fishing in the Americas

Ecotourism and Fishing in the Americas is a small-scale private ecotourism business in the state of Amazonas. Because of its size it is able to easily maintain sustainable practices. It is also a positive example of ecotourism as it fits most of the seven principles illustrated by the definition of sustainable tourism. It "provides for a 'hands on' adventurous tourist experience with the indigenous culture and natural environment" (Peine 1996). By travelling along the Rio Negro River in a boat the tourist is placed directly into the natural environment with few luxuries. Figures II-2 and II-3 illustrate the atmosphere found in this ecotourism experience.

Canoeing and hiking experiences led by native guides further enhance the experience of the surrounding culture and environment. The food served is predominately native to Brazil and sleeping



Figure II-2. Amazon Accommodations

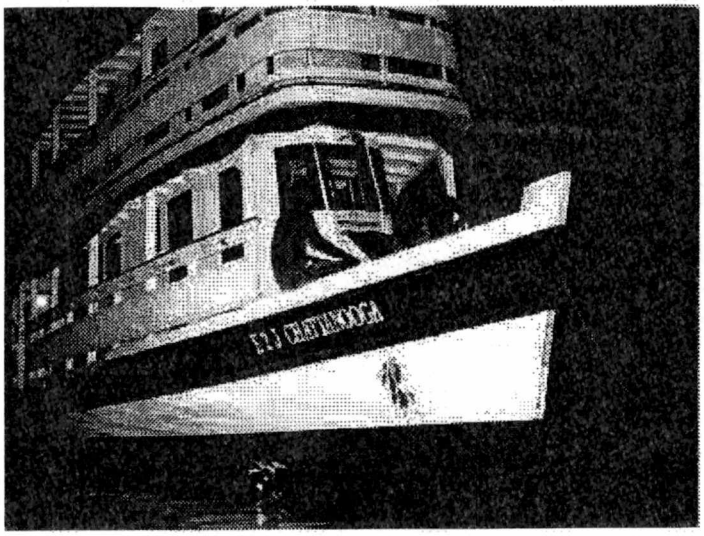


Figure II-3. Amazon Boat

arrangements are also closer to those of the native population than to those of the visitor. The turnover of tourist dollars into the local economy occurs through the hiring of cooks, guides, and the boats captain. Not only does this ecotourism diversify the local economy but it helps locals to realize the importance of caring for and respecting the environment. This is predominately the result of training employees on sustainable practices such as eliminating the dumping of trash over the side of the boat. Ecotours by EFA are also educational for the visitor they work in cooperation with the University of Tennessee and the University of Amazonas. Students and those seeking educational fulfillment benefit from the experience. This low impact form of ecotourism is more stable than those conducted by large-scale organizations such as national parks. In addition, no intergenerational subsidies are taken.

European Ecotourism

Ecotourism in Europe is very different from that of third world countries. However, many of the same principles can still be followed. In Europe, historically

significant locations and environmentally important locations can both be part of developing an ecotourism economy. In the following cases, ecotourism can be found in an environmentally rejuvenated area, a historically significant environmental area, and an urban based aesthetic landscape. One distinct difference of European ecotourism is that regardless of location, most destinations cater to the tourist. In the developing world this can become a hazard to the local culture and environment. However, the centuries of exposure, experienced by European communities to tourists seems to demonstrate that catering will have minimal effects on these comparatively ancient ecosystems. Another difference of European ecotourism is that most areas do not seem to attract the great numbers of people that developing countries often experience. As a result, management can maintain sustainability without worrying about excessive populations of tourists.

Dunas De S. Jacinto: Reserva Natural

The San Jacinto Natural reserve is located on a man-made peninsula south of Porto, Portugal. Figure II-4 is an image of the reserve. The reserve consists of six hundred and sixty six hectares of pine forest and dunes. While the ecosystem within is not historically natural; the Portuguese government treats and protects it as if it were. Diversity of flora is primarily made up of exotic species but vast influxes of birds native to the area frequent the large wetlands. As a result, tourists to the area experience a seemingly natural environment. School students from around the country come to the reserve to gain an environmental education. The reserve includes an interpretive center where tourists and students can see up close, the natural

background of the area. The reserve includes both wetlands and dunes that are excellent examples of preservation and tourist management. It includes a dune walk (see Figure II-5) that that hovers the dunes to reduce impact of visitors. The wetlands (see Figure II-6) have two blinds, which allow for viewing but not disturbing wildlife. In most cases there is no cost to visitors, as a result, up keep of the facility is left to the government. Turnover to the local economy does result from many of the visitors that camp or stay over night in the reserves cabins. Still the diversity that the reserve brings to the local economy is minimal and the jobs that it provides are few. Consequently, this is not yet the ideal form of European ecotourism. However, tourism in the park is far from exploitive and has the

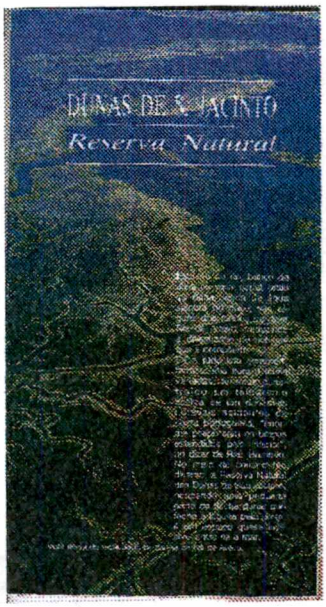


Figure II-4. Dunas De S. Jacinto

Source: Instituto da Conservacao da Natureza. 1994. Reserva Natural, Dunas De S. Jacinto



Figure II-5. Dune Walk



Figure II-6. Wetland

potential to expand its sustainable practices to the point of being profitable to the community.

Forest of Bussaco

The Forest of Bussaco was formerly a hunting palace of Portuguese Kings (see Figure II-7). It is a two hundred and fifty-acre forest made of exotic species from around the world. The species were introduced by monks centuries ago. Like the previous example, this example is not a naturally occurring area. However, due to its historical significance and exotic beauty it is a prime location for ecotourism. With an abundance of well-maintained trails and a palace turned hotel in the center of the forest; the infrastructure is prepared to handle the incoming tourists. In addition, the forest and palace are a strong economic base for the town of Luso, Portugal. The hotel and surrounding forest both supply a variety of jobs for citizens of the local community. The only disadvantage for this example of ecotourism is the lack of educational and conservation based promotion. However, the historical significance and success of the compiled ecosystem make up for the



Figure II-7. Palace of Bussaco

disadvantage. The area is an exceptional instance of sustainability as it has remained intact for several centuries.

Vier Waldstattersee

Vier Waldstattersee is an ecotourism company in Lucern, Switzerland. It provides boat tours on Lake Lucern (see the brochure in Figure II-8). The boats depart in the center of the city across the street from the train station. Within minutes the tourists finds themselves outside the urban area. The boat becomes surrounded by beautiful mountain scenery with snow capped peaks and layers of mountains that close the view to all densely inhabited areas. Few of the areas surrounding the lake have been disturbed due to their steep topography and limited access. As a result, the majority of the area still supports its original ecosystem. In essence, the visitor is enjoying the natural environment with minimal impact. In addition, the boats used to take tourists out on the lake supply jobs within the community and help

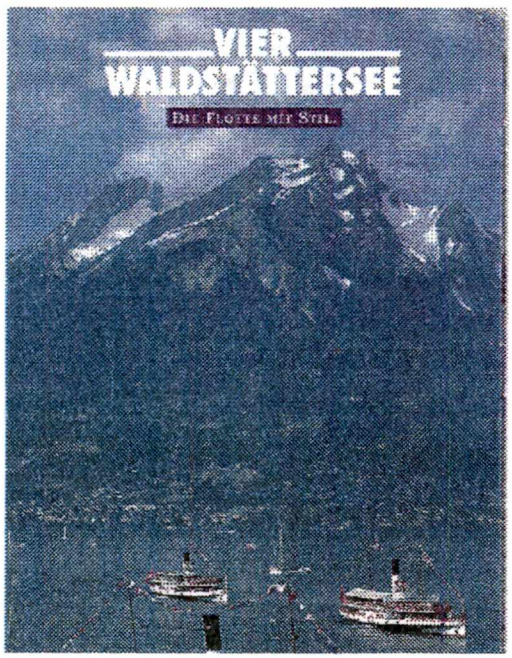


Figure II-8. Vier Waldstattersee Brochure

Source: Buochs, W.P. Burkhardt. Lake Lucern Navigation Company

to diversify the local economy. It also promotes respect for the natural environment as tourists experience sustainability within the vicinity of an urban area. The small amounts of pollution created by the boat's motors are the only form of intergenerational subsidy that can be accounted for in this ecotourism scenario.

National Ecotourism Strategies

Several countries in recent years have come up with strategies for ecotourism development. These strategies are typically a set of goals and standards that a country promotes. While the US has no such standards, following those of other countries can still help shape successful ecotourism. In most cases they are highly effective in assuring the sustainability and quality of an ecotourism development. The most reputable countries in developing such standards are Australia and Costa Rica. The following example of Australia's ecotourism standard illustrate their helpfulness.

Australia's Commonwealth Department of Tourism developed a National Strategy for Ecologically Sustainable Development in December of 1992. There were three main goals in the development of this strategy. The first was to identify major issues that affect the planning, development, or management of ecotourism. Second was to develop a national framework to guide operators, natural resource managers, planners, developers, and government offices to achieving a sustainable ecotourism industry. Finally they set out to establish policies and programs to assist interested parties to achieve a sustainable and viable ecotourism industry (Jones 1995). Development practices should be expected to recognize ecosystems as the

basis of development involve local community input in the decision making processes. Furthermore the strategy emphasizes and gives support for infrastructure projects, baseline studies and monitoring projects, a national ecotourism accreditation system, ecotourism education, market research, business skills, and energy and waste minimization initiatives (Jones 1995). Following the above strategies and support framework, the Commonwealth Department of Tourism introduced the National Ecotourism Accreditation Program in 1994. The program was established to help reduce the confusion in the interpretation and definition of ecotourism. As a result the program substantiated the following definition of ecotourism.

> Nature-Based Tourism that involves interpretation, and education, and is managed to be ecologically sustainable (recognizing that the 'natural environment' includes cultural components and that 'ecologically sustainable' involves an appropriate return to the community and long term conservation of the resource) (Commonwealth Department of Tourism 1994).

Once the definition was clarified a range of benefits was also announced. They included: a baseline criteria that all operators must achieve, an opportunity to promote and market the business as an accredited ecotourism operation, an opportunity to improve performance to a standard recognized as best practice, provide information to businesses on operating more sustainably, and finally what is referred to as the Ecotourism Accreditation Starter Kit which includes a certificate and other material to express to the customer the standard of accreditation (McArthur 1997). To illustrate the benefits further, advantages for natural areas and natural area managers were stated. Accreditation was also strengthened by the requirement of eight assessment criteria. The following principles comprise the criteria.

1. Ecotourism focuses on personally experiencing natural areas in ways that lead to greater understanding and appreciation.
2. Ecotourism integrates opportunities to understand natural areas into each experience.
3. Ecotourism represents best practice for ecologically sustainable tourism.
4. Ecotourism productively contributes to the conservation of natural areas.
5. Ecotourism provides constructive ongoing contributions to local communities.
6. Ecotourism is sensitive to, interprets and involves different cultures, particularly indigenous culture.
7. Ecotourism consistently meets client expectations.
8. Ecotourism marketing is accurate and leads to realistic expectations.

In addition to the above criteria for assessment the accreditation program accounts for three types of ecotourism focuses: Accommodation, Tours and Attractions. Accommodation includes considerations for infrastructure, and overnight services; including lodges, resorts, or camps. Tours include considerations for guides, excursions, and general activities. Attractions involve natural areas and infrastructure designed to help people explore and learn (McArthur 1997). By setting these standards and the accreditation program Australia has become one of the top leaders in the ecotourism industry.

The Ecotourism Society is another organization which can add to the effectiveness and success of ecotourism. It is an international organization to which has an objective of promoting and educating ecotourism tour operators and stressing the necessity to preserve the natural environment in a sustainable manner. In addition it holds regular international seminars and workshops that help with the development of ecotourism around the world (Murphy 1996).

Ecotourism as Economic Development

In developed countries economic growth from ecotourism will likely be an addition to the existing economy. However, economic growth in typical third world countries is often stuck in limbo where high-level government organizations or foreign companies hire those from local communities to extract natural resources for low wages. This style of growth limits the local economy and short changes future generations. Those exploiting the resources have been given subsidies from generations not yet born. Using ecotourism as a tool for development communities can "seek the needs and aspirations of the present without compromising the ability to meet those of the future" (Common and Driml 1996). Such development requires that stocks of natural capital within a community remain intact.

Conclusions on the Success of Ecotourism

By looking at existing ecotourism economies, downfalls and benefits are easily identified. From the above case studies it is evident that for ecotourism to be truly sustainable small scale private or community based organizations work best. Ecotourism can be an effective tool in providing long-term alternative growth for both developed and developing countries. To achieve such a status ecotourism must be more than just tourism tagged 'eco'. It must be a sustainable form, of developing local economies while preserving environmental and social integrity. In addition, historically significant and man-made ecosystems can also provide economically useful ecotourism. The future of natural, unique, and historic environments can be secured with the proper implementation of sustainable tourism.

Chapter III

GIS AS A TOOL IN ANALYSIS OF ECOTOURISM POTENTIAL

GIS Applications in Determining Environmental Assets

GIS is still a rarity in many communities throughout the world and the United States. However, the potential power of GIS as a development tool is quite vast and can help with significant developments when proper management is applied. Though the cost of GIS is high and the programming very time consuming, the end result is worth the effort and the expense.

The primary asset that should be considered is undeveloped land that continues to support a viable ecosystem. This is the base asset and others will depend upon this asset. To determine where such assets exist, satellite imagery and aerial photographs are most helpful. Such products can easily be put to scale and imported into raster GIS systems. Figure III-1 is the direct result of such a method. By looking

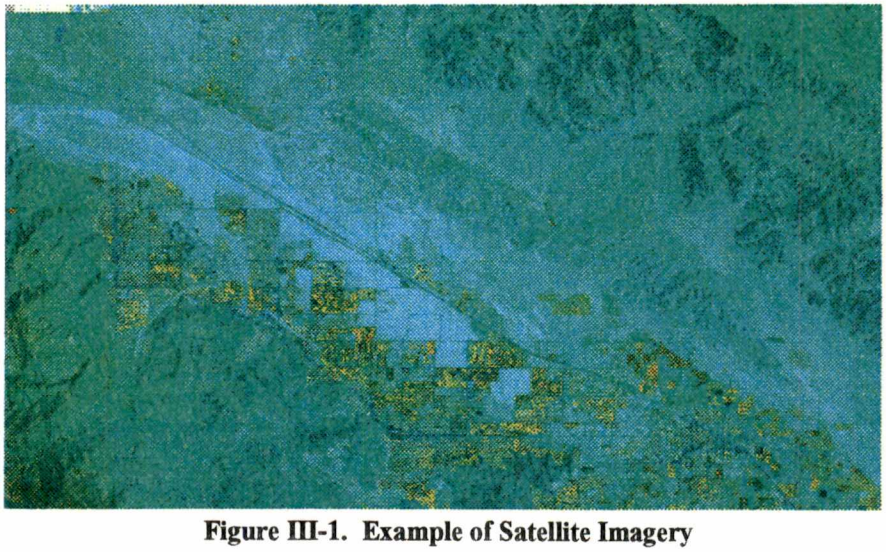


Figure III-1. Example of Satellite Imagery

Source: Created from ESRI Arcview Dataset

at colors and related land cover characteristics one can recognize potential assets. The raster image should then be digitized in a vector format and put to scale. From this map the areas of potential assets can be outlined and a base map of this area should be digitized. Figure III-2 illustrates what the transformed product may look like. Once digitized in a vector format specific features were identified and colors were added to help establish patterns.

There are many additional ways to locate assets. For example windshield surveys might bring greater perspective to the mapping process. In addition, on foot investigations are typically the best way to get a feel for particular assets, however, it can be a very time consuming method. Next, a process similar to an Environmental impact study should be conducted. It should include a complete inventory of the local natural environment.

The first thing to map is the topography and slope of an area. This will help in determining limitations of the area under consideration. These maps may already be available from US Geological



Figure III-2. Digitized Imagery

Source: Created from SAA GIS Data Base

Survey in a digitized format. Topography can illustrate many critical environmental characteristics that will effect ecotourism development. For example, topography can help with determining surface drainage patterns, slope, and solar aspect (Chapin 1995). Watersheds and drainage basins can also be identified and outlined using topography. The following guidelines for steep slope and topography should be a part of any development considerations.

Percent slope is calculated by dividing the *change in elevation* by *distance*, then multiplying this number by 100. The following definitions of slope are based on a range of percent slope:

Gentle = under 5 percent

Moderate = 6-15 percent

Steep = 16-25 percent

Very Steep = more than 25 percent

(Chapin 1995)

Suitability of development on slopes based on percent range:

- *Very steep* slope - Failure is highly probable if disturbed by construction or deforestation.
- *Steep* slopes are prone to erosion and gully formation if plant cover is removed. Good surface vegetation stabilizes slopes.
- *Moderate* slopes will support residential and agricultural land uses but these slopes are susceptible to serious erosion if construction is not properly mitigated. Included in the moderate slope percentage is the

maximum grade for major collectors (8 percent), minor collectors (10 percent), and local streets (12 percent).

- *Gentle* slopes will support the most intensive land use. Gentle slopes of maximum 5 percent support development of commercial centers (neighborhood, community, and regional centers).

(Marsh 1978)

Categories of Slope Problems

- Grade: When slopes are too steep, or too gentle, they may need to be changed by cut or fill.
- Erosion: Slopes with steep inclinations and little vegetative cover are prone to erosion. Vegetative cover holds the soil intact and minimizes erosion.
- Failure: Occurs on slopes which are composed of weak materials that are not weight supporting, therefore mass movements such as mudflows, slides, and creep are likely.

(Marsh 1978)

Factors to be considered when developing on hillsides:

- *View* - In residential development, both view from the site, as well as the obstruction of the overall view for the community, should be considered. The development site is less desirable when 1) the site does not have visual aesthetic value, and 2) the visual aesthetics a community has of the hillside is lessened by development occurring on the site.

- *Slope Steepness* - Land uses are limited by the steepness of slopes. The maximum slope for roads, for example, is about 10 percent. Generally, slopes of over 25 percent are considered too steep for any kind of development and should be avoided. However this does not mean very steep slopes cannot be developed. Recommended development on slopes of 25 percent or greater is very low density.
- *Street Accessibility* - The condition and the width of the existing roads should be considered. If the road is too narrow, it may need to be widened for development; the primary concern for road width is fire protection. The condition of the road, whether the road is gravel or paved, is important. If paved, the condition of the pavement should be examined; wide cracks in the pavement can indicate earth movement downhill.
- *Availability of Utilities* - The availability of electricity, gas, water and sewer should be examined, as well the ease and expense of installing the utilities if they do not exist.

(Chapin 1995)

A Hillside Planning Information Checklist

Topography

- Prepare a detailed topographic map of hillside areas
- Create a slope map
- Define "hillside"

- Make inventory of structures on or adjacent to hillsides

Slope Stability

- Prepare maps of landsliding and erosion features
- Use both geotechnical engineers and engineering geologists to analyze slope stability
- Determine types of instability phenomena, their causes, and frequency of occurrence
- Identify the potential consequences of slope instability
- Identify possible effects of slope instability on downhill and downstream areas beyond the hills
- Determine maximum stable steepness of cut slopes
- Review model grading ordinances for possible adoption

(Chapin 1995)

The above slope guidelines should be considered in determining if an asset has potential to be developed.

Land cover is another significant item that should be taken into account when determining assets. In many cases land cover can be determined principally by looking at aerial photographs and keeping in mind geographic location and climate. Maps of land cover should include both terrestrial and aquatic land cover. They should be as detailed as possible and include everything from species name to a calculation of the Area which is covered by each ecosystem type. Density of land cover is very significant in determining environmental assets. Attribute files of each

ecosystem and land cover type should be associated with a point or shape on the vector map. For quality and accuracy a GPS (Global Positioning System) can be used and taken into the field for verification of the aerial photograph interpretation.

Water Bodies and Wetlands should be identified and rated according to federal water quality standards. In the US the National Wetland Inventory issued by the US Fish and Wildlife Service may be very helpful in locating such environmental features (Chapin 1995). In fact, they now have a web page from which wetland maps and data files can be downloaded or "ftp-ed" for cities and areas all over the US. Wetlands are potentially the most significant asset found in natural environments. This is due to the fact that they are the most diverse form of ecosystem and often supply a large variety of attractions based on recreation and education.

Wildlife habitats are often an overlooked asset, however, they are slowly becoming a significant part of ecotourism. Habitats are often difficult to inventory using GIS due to their constant changing of species location through succession and/or migration. The mapping of endangered species can be difficult, as well as negative due to the dangers of poaching and malicious intent towards specific species. In most cases, local fish and wildlife services will be reluctant to give out information. However, many environmental organizations will sell the information if proper security precautions are assured and motives are defined. In this day and age species do not have to be endangered to become an asset. A lively ecosystem with a variety of species that can hold their own are often just as desired. Another way of seeing wildlife as an asset is in the form of diversity. An area with a wide spectrum of bird species will be much more of an asset than an area with just a few.

Geologic considerations such as bedrock and surface material are also important prior to the determination of assets. Sink holes and karst topography may significantly deter or promote environmental areas as an asset. Many other geologic formations can be identified as assets. Rare rock outcroppings, or prehistoric sediment layers are just a few examples of such assets.

Soil must also be considered when conducting an inventory of assets. While soil itself is rarely an asset, it must be thoroughly reviewed before any ecotourism development begins. Many soils are highly susceptible to erosion. Any soil found on slopes that exceed 10% and have gravel based or sand based loam should be avoided. GIS is a great way to associate soil types with soil characteristics in a geographic representation. Soil information can be gathered from site sampling but more realistically should be retrieved from the local department of soil conservation. Slowly these organizations are selling or making available their maps and information to the public in a GIS format.

GIS Applications in Developing an Inventory of Potential Attractions

First let us establish a working definition of an attraction. The following is one posible definition. "Attractions....Involves a combination of a natural area and fixed infrastructure designed to help people explore and learn" (McArthur 1997, p. 32).

Attractions are typically already in existence but not yet realized as such. Often they are a combination of an environmental asset and the potential for a working infrastructure that can support visitation (McArthur 1997, p. 32). As a result

GIS maps of assets and environmentally sensitive areas must be used to determine the areas which should be avoided.

The most necessary aspect of the GIS database for locating potential attractions is the identification of existing infrastructure. Once assets have been mapped, an overlay of existing roads, paths, greenways, hiking trails, bike paths and utilities will help to determine which assets are accessible. If possible, those assets which lack access and infrastructure should be avoided and not declared attractions.

Infrastructure itself can often be an ecotourism attraction. Roads in combination with land cover, topography, water bodies, and wildlife habitats can serve as valuable ecotourism attractions. Bike trails and greenways may serve as similar attractions as long as they are combined with an area of environmental interest.

Many potential attractions for tourism can be identified with the help of GIS when a database of land cover is produced. Attractions such as parks, campgrounds, wildflower sites, autumn foliage areas, scenic overlooks, scenic drives, scenic photography sites, and habitat for wildlife can be located with these maps (Gunn 1994). For example dense areas of undeveloped deciduous forest might be a prime attraction and should be designated as such if views to such areas are accessible.

Topography maps can also suggest significant attractions. The following attractions might be developed after looking at a GIS topography database. Mountain resorts, winter sport areas, mountain climbing, hang gliding, scenic sites, vista photography, plains, ranch resorts, and scenic drives are just a few of the potential attractions (Gunn 1994). Advantages of attractions on steep topography must be

carefully weighed as these are some of the most sensitive and fragile ecosystems in existence (Mieczkowski 1995). The following quote illustrates further why mountainous areas are so sensitive.

> Climatic extremes, brevity of the growing season, lack of nutrients, low biological activity, low productivity, youthfulness, island-like character, steepness of slopes, and the basic conservatism of the dominant life forms, all make the rate of restoration original conditions after disturbance slow: in some cases, the original conditions may never return... Restoration is hampered by the marginal conditions of exposed steep slopes with their thin and poorly developed soil (Price 1981).

Water Bodies and wetlands can support attractions such as resorts, campgrounds, parks, fishing sites, marinas, boating, rafting, kayaking, shell collecting, waterfront areas, and even scuba diving sites (Gunn 1994). Wildlife viewing and hunting locations such as duck blinds would be ideal attractions along existing water bodies. Since many of today's water bodies are in high demand for both economic and recreation uses it may be more difficult to promote sustainability in their development (Mieczkowski 1995). However with ecotourism rather than dams or hydro development a water body is more likely to last into the future.

Wildlife habitats can become an attraction if the dangers to the species can be negated. Otherwise, the attraction will disappear. There are many attractions that can form out of species diversity. For example, nature centers, interpretive centers, hunting, fishing, wildlife observation, wildlife photographic sites, and attractions based on specific species can be very successful attractions (Gunn, 1994). Recently activities such as bird watching, and wildflower identification have grown dramatically in popularity.

While geology is an important asset it can also have significant potential as an attraction. One example of this is karst topography. Karst topography typically occurs where limestone is the dominant rock type. In such conditions sink holes often form and caves are likely. By looking at the GIS map of the local geologic structure it may be realized that there are caves which are an increasingly popular ecotourism attraction. Additionally, rock types may suggest significant formations such as fault lines, excessive folding, or even sedimentary outcroppings with a tendencies for fossils.

The following is a list of potential ecotourism attractions that could be considered for manifestation.

1. Old growth forests
2. Birding areas or sanctuaries
3. Nature centers
4. Fly fishing lure fishing, and bait fishing sites
5. Hunting areas and resorts
6. Biking trails or paths
7. Hiking trails
8. Ecological resource facilities
9. Cross country ski trails
10. Scenic or informational drives
11. Rafting streams or rivers
12. Canoeing lakes or rivers
13. Kayaking streams
14. Kite flying
15. Butterfly migration paths
16. Hang gliding areas
17. Diving sites
18. Volcanic sites
19. Fault lines
20. Beaches
21. Historic cultural sites
22. Sailing
23. Mountain climbing
24. Fire towers
25. Tide pools

26. Family camps
27. Paddle boats
28. Bunge Jumping
29. Caves

GIS: An Ecotourism Assessment

By utilizing an existing GIS database created for the identification of assets and attractions, an ecotourism assessment can be simulated. Overlays of assets and attractions will show a community if it has the proper ingredients for a successful ecotourism development. With the two previous inventories GIS becomes a functioning instrument that can determine where tourism will work. In addition, it will help to suggest an ecotourism system of interrelated activities with a similar theme. It is at this point in the process that infrastructure comes into play. While it previously helped to determine where potential attractions are; it now points out how various attractions work together and how they fit in with the surrounding community. Existing land use inventories can also help to establish how assets and attractions fit into the system.

Analysis of the maps and the databases will help to make the final assessments. At this point several important questions must be answered. The first and most important question is can this attraction maintain an influx of tourists without destroying the surrounding environment or the attraction itself? This is best answered by looking at the limits affecting potential attractions.

The most important part of the final assessment is the careful attention to the limits recognized in the GIS overlays. When determining assets soil was a significant

factor, however, in the final assessment an overview of the soil type maps is critical in developing sustainable ecotourism. If ideal attractions are located on unstable soil erosion could have wide spread negative effects. Not only will trails and activities be difficult to maintain on these soils, but, erosion can result in loss of ground cover and species diversity. It can also result in the pollution of water bodies, which will have negative effects on water activities such as fishing, diving, and most importantly drinking. Exploitation of other natural resources such as trees and land cover can result in the degradation of water quality as well. Few ecotourism communities would be able to survive without high water quality standards.

Time limitations should be recognized as well. For example, when wildlife is involved tourists should be excluded during times of breeding, feeding, or nesting of many species. Similarly, other attractions might be limited by weather. For example certain trails with highly erodable soil should be avoided during heavy rains. All of these conditions can be carefully managed and monitored using a GIS database.

GIS can also help in the establishment of tour patterns and ideas. Another way of looking at it, is the blending of attractions. For example, an activity such as hiking might be blended with bird watching and wild flower identification. Package themes where activities are planned for the visitor that vary from day to day are another strong argument for the blending of activities. Blending will help to keep more popular areas of ecotourism from being overly visited.

Once a system of attractions is created, a carrying capacity should be set for each attraction and for each piece of infrastructure within the ecotourism development area. Carrying capacity should be a conservative estimate of how many

people can enjoy an attraction at one time without damaging the local ecosystem or making the experience less enjoyable for those around them. These numbers can be simulated and tested using the existing GIS maps and data. Two figures should be calculated one being number of people per square mile and the second being number of people per day. The first figure can be constructed by a measurement of an attractions area utilizing a GIS workstation. If an attraction is a series point in a vector coverage, rather than a polygon, capacity should be measured an determined based on the infrastructure connecting these points. In situations where attractions are linear, such as fly fishing streams or mountain biking trails capacity can be done with a linear mile measurement. While an acceptable number of people per square mile can be derived from scientific computations they may not always be accurate and some experimentation should be done based on the results of a more conservative figure. If necessary, working up to a larger figure over time is the safest approach.

Groups and guides for each attraction can also be managed using GIS. Each guide can be issued a point on a map which can be placed in a different position based on a time schedule. A combination of this and a sustainably sized group can control and reduce environmental damage. In addition, this will assure quality control of the group.

Comprehensive overlays of everything put into the GIS will be the largest part of conducting the ecotourism assessment. GIS brings in the strong advantage of being able to measure thousands of factors at once with overlays. In the past overlays were frequently conducted to assess environmental factors however there were many limitations because it was difficult to get a hundred maps the same scale and in a

transparent form. With GIS everything can be put to scale with the click of a few buttons. Theme after theme can be overlaid without even having to print the maps out. Analysis can take place on the computer and queries can be made to answer questions as they arise. Distances can be measured when necessary and simulations can be developed that work out daily patterns of tourism activity. When problems arise they can be identified in the system and avoided in the future. The value of GIS as a tool in ecotourism assessment has not been recognized in most of the more affluent ecotourism locations. However, many areas will find that it provides unmatchable advantages that outweigh the problems of high cost and technical know how that are required to get the database started.

Chapter IV

ECOTOURISM: A STRATEGY AND MODEL

Strategies for Community Development

While we have looked at literature, definitions, case studies, governments and organizations that aid in the development of ecotourism; it is now time to consider the best strategy of applying such aid. To begin the creation of this strategy it is most necessary to establish a working definition. The definition that is most appropriate and applicable to ecotourism development within the US and throughout the world is as follows. Ecotourism is nature-based tourism built upon environmental forms of recreation that can be maintained sustainably while preserving local heritage, culture, and the natural environment.

With the definition made clear, it is important to determine the goals and objectives of ecotourism development. As it may be impossible to fully achieve all goals, each should be prioritized. The following goals have been derived as the most important in establishing a sustainable ecotourism strategy.

1. Establish a secure conservation oriented environmental management system from a GIS conducted Environmental Impact Statement.
2. Establish nature-based attractions that are marketable and desirable which lead to environmental education and promote environmental respect.
3. Develop ecotourism as a form of economic gain for the local community with the predominant employees being from within the community.
4. Utilize existing infrastructure to maximize benefits of local assets and attractions.

5. Avoid exceeding limits of carrying capacity when conducting tours in environmentally sensitive areas.
6. Use educated and trained guides to lead tourists on activities, and minimize tourist group size.
7. Establish activities that promote appreciation for local culture and local heritage.
8. Capitalize on activities and assets that are only found locally or that are principally limited to the local environment. Create a point of focus or specialty ecotourism feature while maintaining a general variety of ecotourism activities.
9. Minimize the number of activities that take from the environment but do not return benefits into the ecosystem.
10. Provide accommodations that will fit the needs and wants of the groups of people being marketed.

The above goals can be arranged and prioritized to best fit a community's needs. However , the above prioritization illustrates the needs of most ecotourism developments. The following paragraphs clarify in more detail the above goals.

Goal one illustrates the importance of managing ecotourism based on the environmental impact assessment that was illustrated in Chapter III. It also is meant to recognize that GIS is the most effective way to both conduct the EIS and do follow up management. This goal is prioritized as number one because it is a crucial step in assuring sustainability of activities based on environmental sensitivity.

Goal two is the second foundation for success as: if the ecotourism development is to be successful it must have a marketable and popular activity base. While ecotourism could potentially be developed to promote the spotting and identification of the gray squirrel the interest and popularity of that topic alone is not likely to be enough to support a viable ecotourism system. The goal is meant to get the developer to seriously consider the interest tourists have in potential activities the local community could develop.

Goal three demonstrates the need to include local economic growth as part of the plan for ecotourism development. Ecotourism should employ from within. If a majority of the people employed in the ecotourism development have stake in its success the quality of the tourism will be enhanced. In addition, it should be designed to enhance the existing land uses with in the community as well as add to the local tax base.

Goal four is meant to reduce the need and cost of developing new infrastructure. By considering where assets and activity systems have potential to succeed and where infrastructure already lies, simultaneously, undisturbed land and overall beauty of environmental areas can be preserved. New infrastructure can lead to significant damage of the local ecosystems. Where possible such additions should be avoided.

Goal five is designed to assure sustainability and eliminate system breakdown due to overuse. Excessive tourists can quickly degrade both infrastructure and in some cases attractions. If significant measures are taken to limit the number of

visitors, an attraction will last long into the future. The survival of ecotourism developments will help to stabilize the local community and environment.

Goal Six illustrates the need to provide quality guides for visitors. With educated and trained guides tourists will learn to have greater value and respect for the surrounding environment and attractions. The limitation of group size will help control visitors and keep them from veering off trails, harming local flora or feeding wildlife.

Goal seven will strengthen ties between the community and the development. In addition, it is likely to capitalize on the history and past of the local community. Doing so will both widen the marketability of the development and add intriguing elements that demonstrate the way the local environment was previously used.

Goal eight is similar to goal seven but it is meant to create a niche in the regional, national, or worldwide ecotourism market. By excelling in a specific ecotourism activity a consistent influx of tourists can be generated. These tourists will then take advantage of the other activities that surround them. In creating a draw with such an activity it is important to consider the likely hood of its popularity and sustainability for years to come. With individuality an ecotourism development can be far more attractive.

Goal nine simply recognizes that most activities will in some way take away from the environment. Some may have a gradual effect degrading water quality, while others may be responsible for the migration of soils and seeds. In some cases, the negative effects can be reversed. In other situations, it is impossible to reverse

effects, in which case, a return to the environment can be made using a different strategy.

Goal ten ascertains the fact that to help both the community and the ecotourism development grow and survive it is important to provide accommodations for all levels of tourists which are marketed through the existing activities. Diverse accommodations may be necessary as some tourists will wish to spend all of their time within the surrounding environment and others will wish to have more luxurious overnight accommodations.

Each of the above goals can contribute to an everlasting and desirable ecotourism destination. By utilizing them as a strategy for the development of activities and accommodations, the needs and aspirations of the consumer can be met while maintaining environmental integrity.

The Model

The conceptual model of the ecotourism development should be a McHargian approach, using overlays to assess the ecotourism potential based on the attributes of that specific community. Capability and suitability analysis techniques should be used to help provide the model of sustainability for economic development, and environmental constraints. The main goal of these two forms of analysis are to maximize benefits and minimize costs (Bowen 1997).

Capability should look at environmental assets and their capacity to absorb ecotourism development. It should also establish areas most sensitive to environmental degradation. "The guiding principle in capability analysis is how can

we best protect the environmental attributes of an area when we are locating development" (Bowen 1997).

Suitability should be used to find locations based on the following question: "where are locations that minimize development costs, reduce operating costs, create the least drain on public resources, and do not create problems with land compatibility" (Bowen 1997). The suitability analysis should play a major role in determining potential ecotourism attractions. The environmental impact assessment, the mapping of infrastructure, and relationship of ecotourism activities location to the market it is attempting to attract are all factors included in the suitability analysis.

Carrying Capacity should partly be defined by overlaying the capability and suitability maps. It will illustrate the acceptable intensity of development. It might include the limitations of hiking trails and what the maximum number of people the trail can hold while maintaining sustainability (Bowen 1997). In most cases ecotourism development carrying capacity should be measured in number of visitors per square mile or per mile depending on how linear the activity base is.

It is important to note that by using GIS all components of the maps will be linked to data tables which will help in the further analysis of carrying capacity. The diagram below (Figure IV-1) illustrates how the results of the simplified model should be interpreted. In this simplified model, suitability considerations and capability considerations when added together give you a general measurement of carrying capacity. Sustainability is the balance of economic development and environmental constraints. In most communities either the economy or the environment take precedence within the plans of a community and it is usually

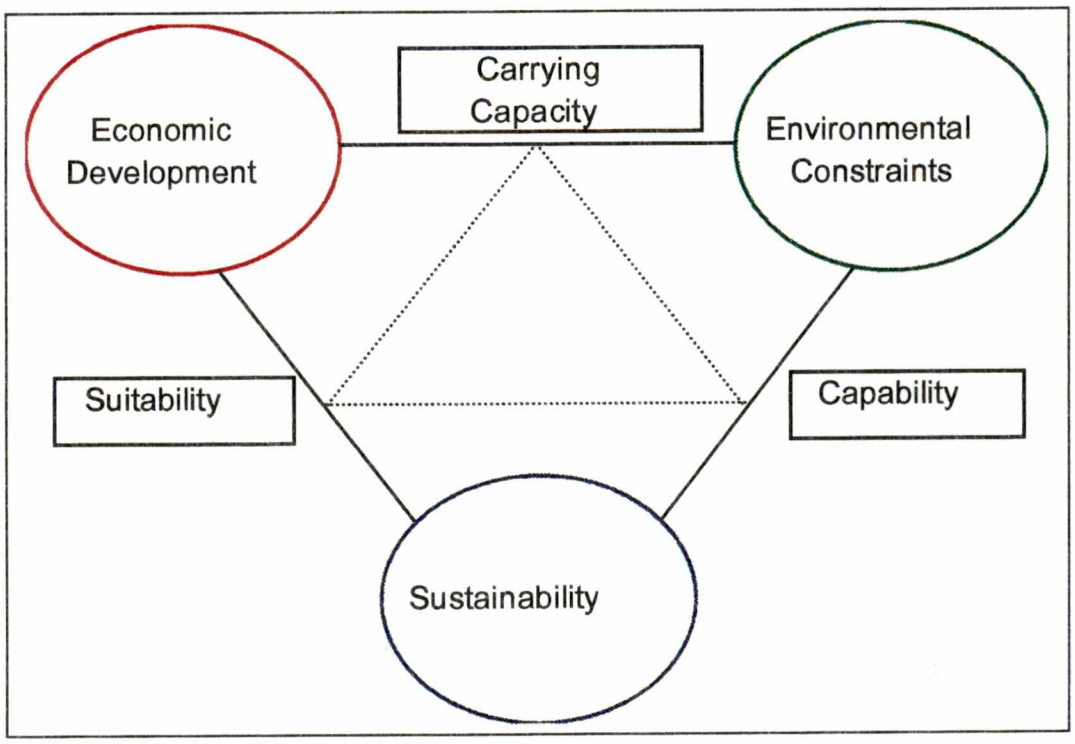


Figure IV-1. Simplified Sustainability Model

economic development that has the upper hand. However, after years of stressing economic development, communities will begin to decline and quality of life will decrease. On the other hand those communities that concern themselves primarily with environmental preservation tend to have to travel long distances for employment or they lack needed monetary funds to make things happen within the community. By balancing the two factors all around quality of life will benefit.

In the next more complex model (Figure IV-2) it is easier to see the relationships that take place in planning an ecotourism development. Most evident is the fact that all factors contribute to the goal of sustainability. Energy consumption, waste disposal, resource depletion, economic development, environmental

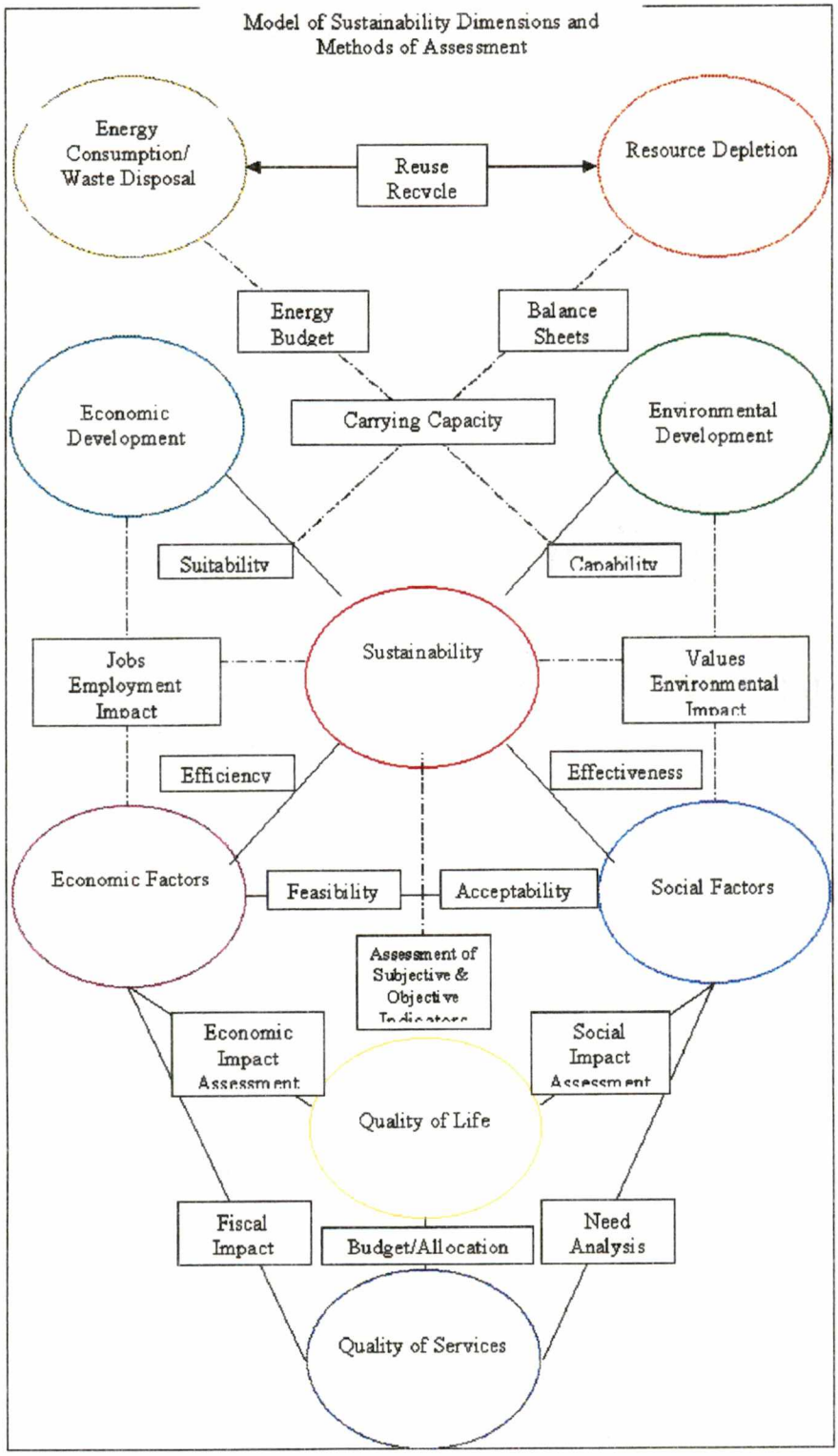


Figure IV-2. Detailed Sustainability Model

development, economic factors, social factors, quality of life and quality of services are the biggest parts of the equation. However, the impact of jobs and employment as well as the impact of values and the local environment can contribute to the success or decline of a sustainable development. Social and economic impacts as well as fiscal impact and need analysis can strongly influence the quality of service. Efficiency and effectiveness, suitability and capability are the final factors that influence sustainability.

Each of the models demonstrates relationships that are often ignored in developing ecotourism communities. However if these relationships are recognized ecotourism can be a long term community support device and add significantly to the quality of life of the local residents. Not only will residents live in a community that has maintained its environmental integrity and natural beauty but they will reap financial benefits as well. Jobs, tax revenue, reputation, and local opportunities will all be enhanced.

The key to using the above models is to create a strong comprehensive GIS database that can be easily updated on a monthly or even weekly basis. With GIS as a tool the community and all its related factors can be managed and monitored. Knowledge of local assets, attractions, constraints, and infrastructure is of utmost importance. Each is a part of the system that must be constantly maintained so that it is actively contributing to both tourists and residents alike.

While it may appear that such tight reigns on the community is excessive, unnecessary or even invading, the inventories are necessary and it is not as if there will be cameras watching every move of residents or tourists. Instead, it will be the

changes taking place within the community in the form of environmental, infrastructure, wildlife, and traffic patterns that will be monitored closely. GIS will allow the community to react to changes and potential dangers quickly and accurately.

With the help of the previously considered strategy and the illustrative models it is now possible to develop a sustainable ecotourism community. The following chapter provides insight on how these principles can be applied in a real working community. It also portrays in greater detail how development steps can and should be taken. While the following case study depicts a rural county in the Appalachian Mountains of east Tennessee, the goals and principles of the previous chapters can be applied to communities throughout the US and the world. The only prerequisite is that sufficient environmental assets exist in order to support sustainable ecotourism activities.

Chapter V

AN ILLUSTRATION OF GIS APPLICATION FOR COCKE COUNTY ECOTOURISM DEVELOPMENT

Cocke County Background

Cocke County, a relatively undeveloped rural county in east Tennessee borders North Carolina to the east and Great Smoky Mountains National Park to the south. The county has an area of approximately 430 square miles. A large part of the county is made up federally owned land. Cherokee National Forest for example attributes to 43,000 acres of the county while Great Smoky Mountains National Park 18,914 acres. One quarter of the county is still undeveloped and a part of the Southern Appalachian National Biosphere. The park itself is recognized world wide as an International Biosphere Reserve. Originally occupied by Cherokee Indians and later settled by European emigrants Cocke County has a rich and diverse natural heritage (West et al. 1997). Between the heritage and recognized environmental commodities, the county has strong ecotourism potential.

The location of Cocke County is ideal; its proximity to the most visited national park in the US with close to 10 million visitors per year gives the county excellent potential for a tourism based economy (National Park Service, 1997). In addition, Cocke County is within a one days driving distance from a majority of the US population. Surrounding communities such as Gatlinburg and Pigeon Forge have proved that tourism can be a very successful form of economic development for the Appalachian region.

Current unemployment in Cocke County is very high and 35% of those employed travel outside the county for work. Local industry is suffering and the local economy in general which was previously dependent on farming is declining. Figures V-1 and V-2 illustrate these declines. This condition suggests strong opportunities for new forms of economic growth (West and al. 1997).

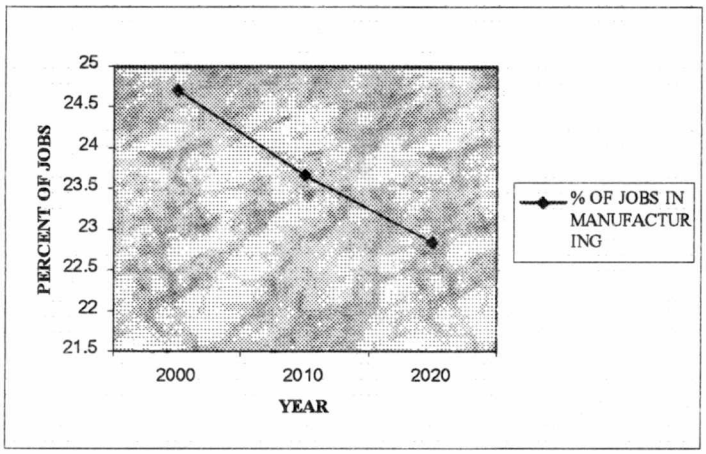


Figure V-1. Cocke County Projections for Manufacturing Jobs

Source: West, Nathan et al. 1997. Gateway Development Plan for the Cosby/Hartford Area of Cocke County Tennessee.

Nature-based tourism has been around in Cocke County since the 1800's when hunting and fishing camps were established in the Smoky Mountains (Henry 1997). Today,

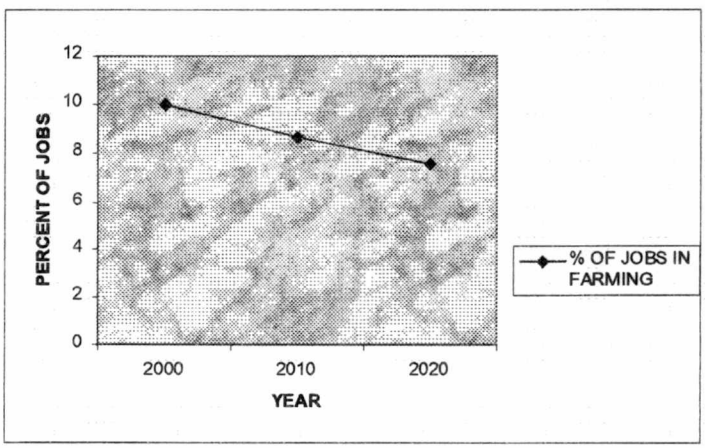


Figure V-2. Cocke County Projections for Farming Jobs

Source: West, Nathan et al. 1997. Gateway Development Plan for the Cosby/Hartford Area of Cocke County Tennessee.

there are already a few nature based activities that are consistent with ecotourism development, however, there is little demonstration that these activities are sustainable. Within the county: natural beauty, environmental resources, and local heritage are all an ideal base for ecotourism development. The rest of this chapter will demonstrate how ecotourism can become a major form of economic development for the Cocke County community.

While much of the county consists of an undeveloped natural environment, for the purpose of ecotourism development the area will be limited to a small planning area in which ecotourism potential assessment will take place. By limiting development to a smaller part of the county, GIS can be managed on a smaller scale and areas such as those suited for industrial or mass retail might be completely avoided. For this thesis the planning area for ecotourism is defined by Wilton Springs road to the North, Stone Mountain Ridge to the east, Sevier County to the west and North Carolina to the south. Figure V-3 demonstrates the layout of the planning area in relation to the county in general. This area is specifically fit for ecotourism with a wide range of activity possibilities and a sufficient existing infrastructure. The planning area itself has a large amount of land protected by the federal government including a majority of the county's National Park and National Forest land. Figure V-4 illustrates the parts of the planning area which are protected by the national government. It should be noted that much of the mapped area for Cherokee National Forest is actually owned privately but for GIS related purposes the boundaries have been digitized as they appear. Two small cities are also found within this planning area. The first is Cosby Tennessee, an unincorporated city with a close

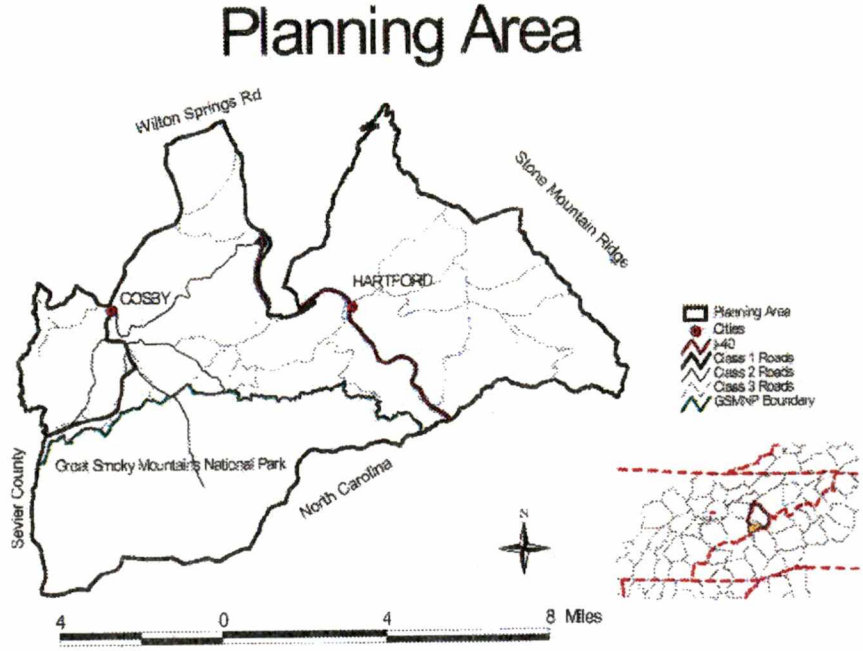


Figure V-3. Planning Area

Source: Created from SAA GIS Data Base

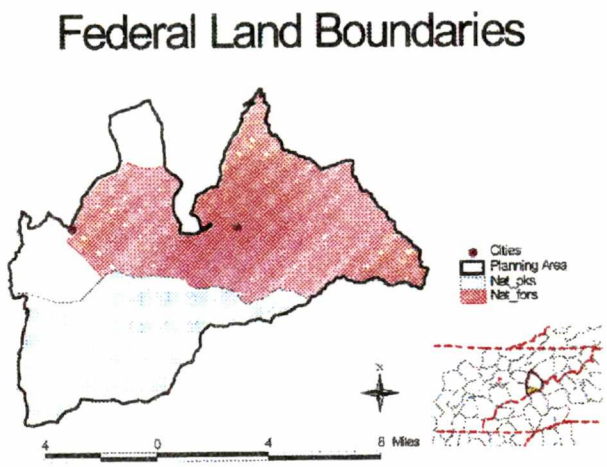


Figure V-4. Federal Land Boundaries

Source: Created from SAA GIS Data Base

proximity to the National Park. The second is a smaller community located along the pigeon river and bordering both the National Forest and Interstate 40. Combined the cities have a population of approximately 3017. The median age of the area's population is between 25 and 54 and the workforce is made up of approximately 584 citizens. 48% of this work force travels outside the county for employment (West et al. 1997). While this may seem

like a disadvantage to the area it is actually an opportunity. However, the largest benefit of the area is it's regional location and undisrupted environment. Figure V-5 illustrates the planning areas relationship to the region. The following three sections will explore in detail the steps in creating an ecotourism base for the planning area.

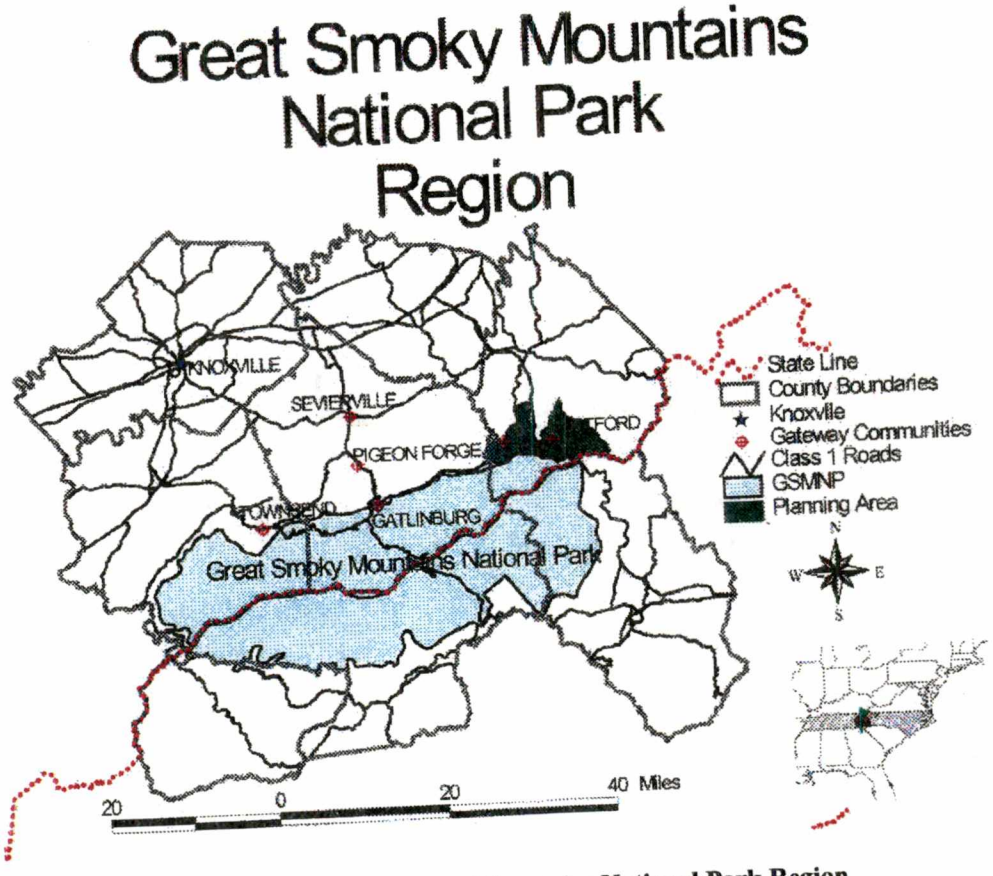


Figure V-5. Great Smoky Mountains National Park Region

Source: Created from SAA GIS Data Base

Cocke County Environmental Assets

Cocke County has a wide variety of assets, however, until they are identified as such it will be difficult to determine their true value. The following GIS inventory

of assets for Cocke County and the planning area illustrate how it is possible to uncover an asset and it's value.

The first asset of Cocke County to be inventoried is undeveloped land. This should preferably be limited to land that still supports viable ecosystems. To analyze the undeveloped land in the planning area, existing coverages have been used which were derived from satellite imagery by the Southern Appalachian Man And Biosphere Organization (SAMAB). Figure V-6 is a map of existing land use that illustrates undeveloped land in Cocke County and the related planning area. It is evident in this map that significant amounts of land exist that are both undeveloped and have healthy green ecosystems. The planning area (outlined in gold) proves to be approximately 90% undeveloped land. This asset is ideal for

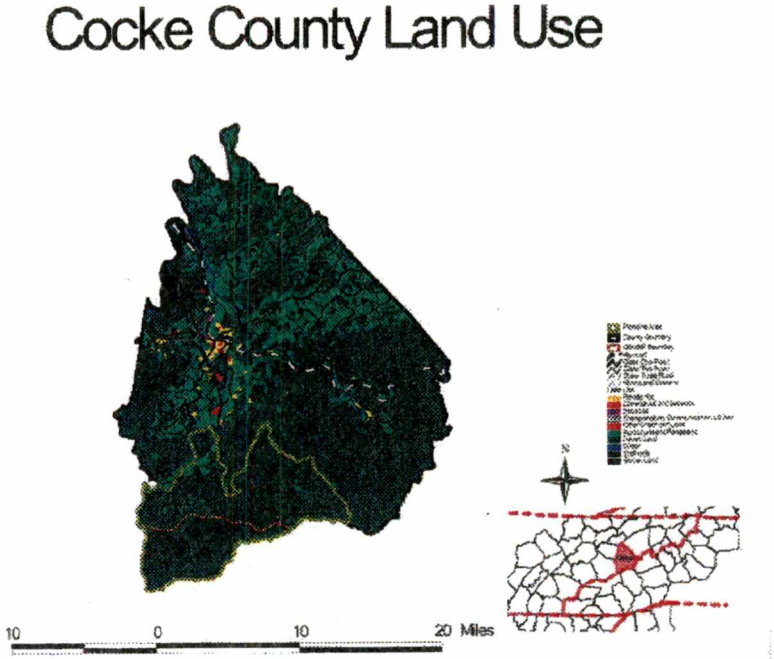


Figure V-6. Cocke County Land Use

Source: Created from SAA GIS Data Base

ecotourism development.

The next phase in determining capability for ecotourism is to define the topography and slope of the area. In this case study, the planning area is very slope oriented. A topography map was created from a raster image which was derived from aerial photographs by SAMAB. It was then opened with a spatial analysis tool within GIS and given contour lines. In addition, a slope map was created from a hard copy of a US Geological Survey map. Figure V-7 is a topography map of the County and Figure V-8 is a map of areas with less than 15% slope. Though it is slowly becoming

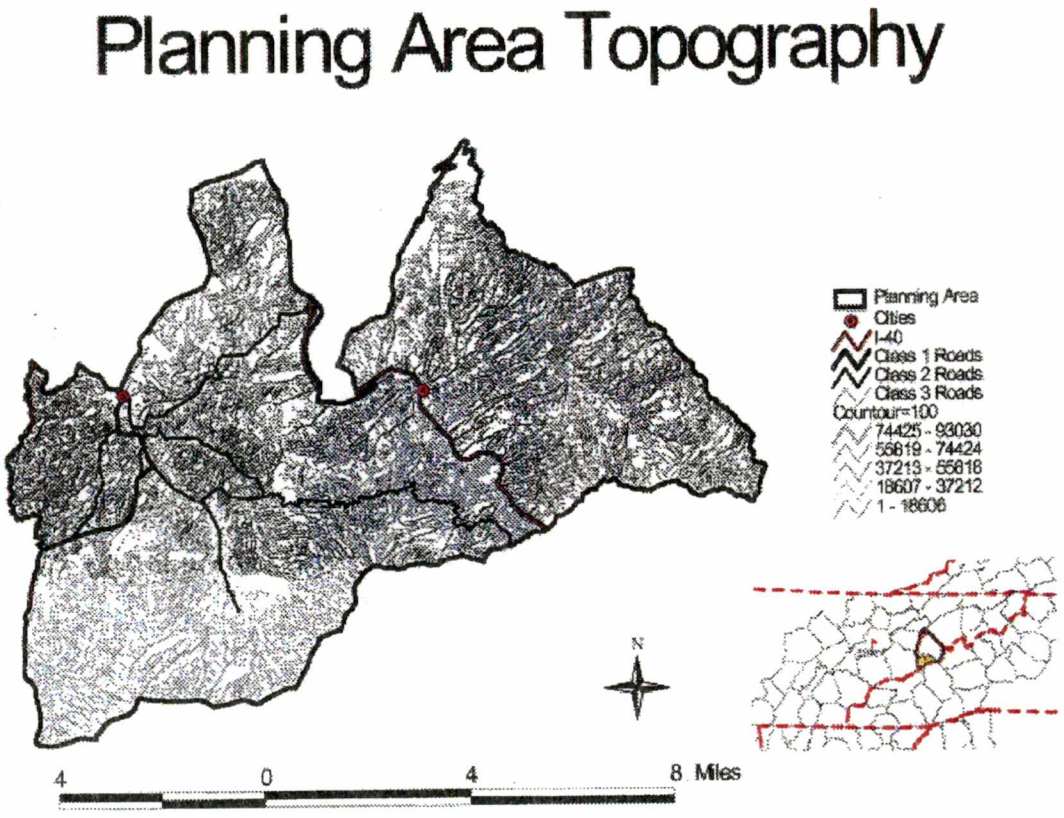


Figure V-7. Planning Area Topography

Source: Created from SAA GIS Data Base

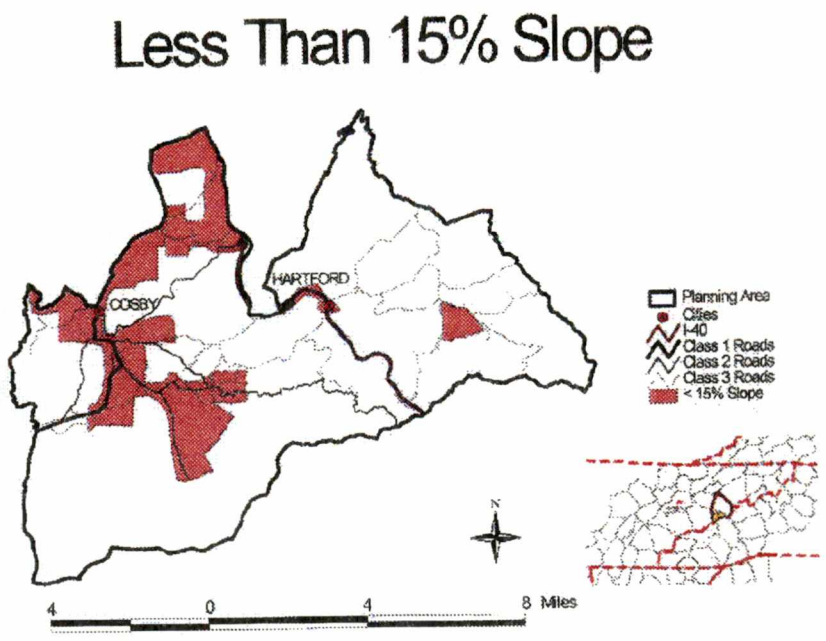


Figure V-8. Less Than 15% Slope

Source: Created from SAA GIS Data Base

less of a problem, US Geological Survey did not have a digitized version of the areas topography available for this study. The guidelines illustrated in Chapter Three should be used to further analyze slope and its capabilities. By using the above topography and slope maps watersheds can also be identified. As indicated earlier drainage of watersheds should be closely looked at before development locations are chosen.

Land Cover is another factor within the county that has been determined. It has also been derived from satellite imagery as with the land use map above. Figure V-9 is a map of existing land cover for the designated planning area. Creating a map of land cover is one of the most expensive and time consuming processes of creating a GIS database. An example of directions for undertaking this process can be found in Appendix-B.

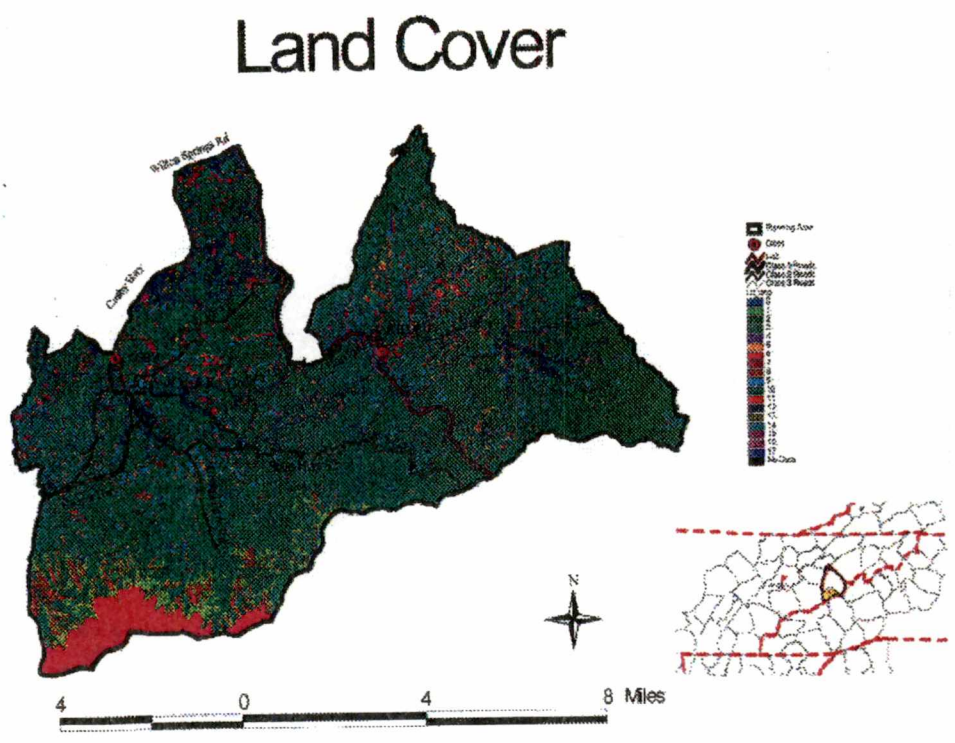


Figure V-9. Land Cover

Source: Created from SAA GIS Data Base

Through both windshield surveys and looking at the map it is evident that land cover consists mainly of deciduous forests. Figure V-10 illustrates this more clearly. In addition, it is evident that the county has a diverse range of land cover which the following section of the land cover attribute file (Table V-1) illustrates. The numbers and land cover associations can be compared to Figure V-9 to gain a better understanding of how specific land cover is derived.

Water bodies and wetlands within the county have also been identified. Figure V-11 identifies both wetlands and water bodies within Cocke County and the planning area. Due to the variations in topography most of the county's water bodies

Table V-1. Land Cover

Source: Created from SAA GIS Data Base

Land Cover Number	Associated Land Cover
1	Northern Hardwood Forests
2	Mixed Mesophytic Hardwood Forests
3	Oak Forests
4	Bottomland Hardwood Forests
5	White Pine / Hemlock Forests
6	Montane Spruce-Fir Forests
7	Southern Yellow Pine Forests
8	White Pine / Hemlock / Hardwood Forests
9	Mixed Pine / Hardwood Forests
10	Herbaceous
11	Barren
12	Agriculture - Pasture
13	Agriculture - Cropland
14	Wetlands
15	Developed
16	Water
17	Indeterminate - Clouds, Shadows

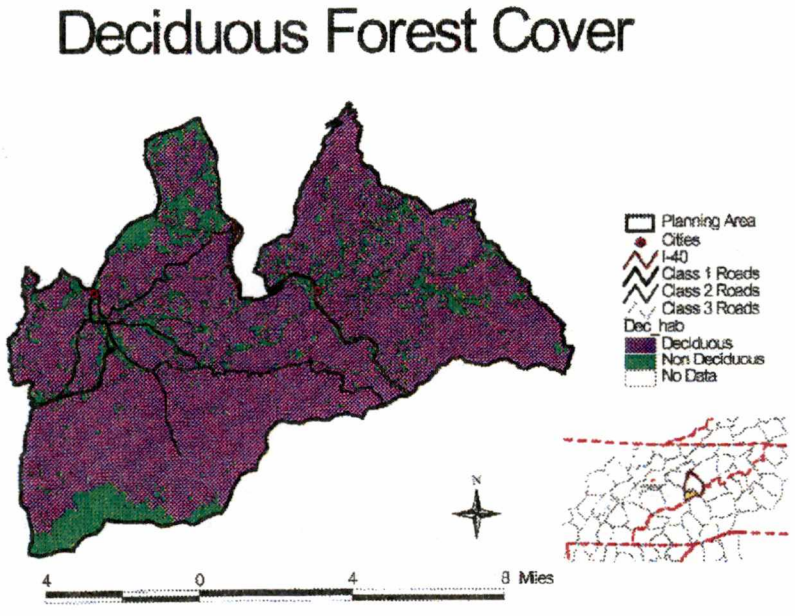


Figure V-10. Deciduous Forest Cover

Source: Created from SAA GIS Data Base

occur in the form of streams. However, one very significant river runs through the county and the planning area, as is evident in the map. Both rivers and streams in the planning area should be considered very significant assets.

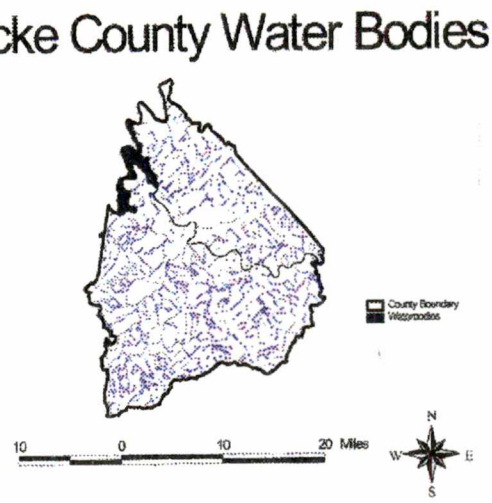


Figure V-11. Cocke County Water Bodies

Source: Created from SAA GIS Data Base

Wildlife habitats within Cocke County are a very large asset. In Table A-1 (which can be seen in Appendix-A) some of the more interesting species of the area are identified. This table has been exported from GIS as a database file. It should be noted that it can be associated with many different types of maps including: habitat range maps and land cover maps of the area. The following map illustrates how animal habitats can be related to ecological sub-regions (see Figure V-12). In addition, to the wide variation of species within the county there are also a significant number of threatened and endangered species within the county. Table A-2 in Appendix-A illustrates these sensitive species and their related habitat associations. One aspect of the county's habitat assets is the fact that up to 240 different bird species can be found within the county. Approximately 171 of these birds can be found as residents during various times of the year (Great Smoky Mountains Natural History Association). Black Bear can also be found within the county. The following

map (Figure V-13) illustrates their potential habitat. The large numbers of species residing in the county make habitats a very valuable asset.

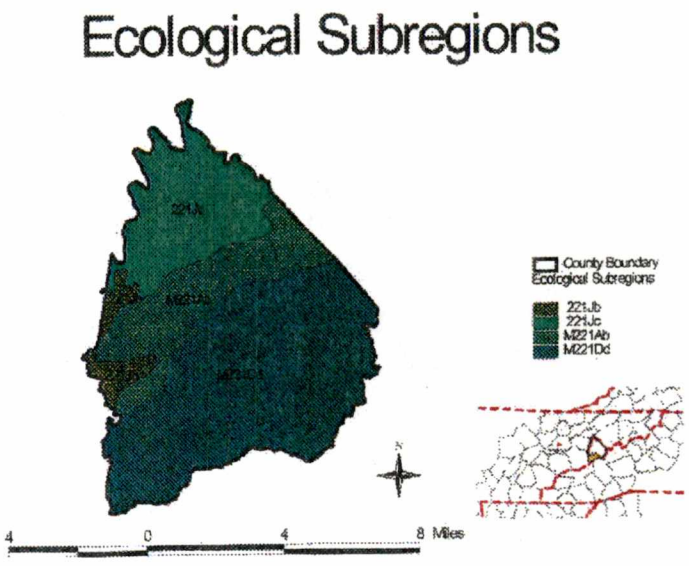


Figure V-12. Ecological Subregions

Source: Created from SAA GIS Data Base

Cocke County's soil associations have been identified as well, a map of these associations will help to determine what uses need to be avoided or promoted according to soil type. Figure V-14 is a map of the county's soil associations. Due to the large areas of steep slope in the county much of the soil is highly susceptible to erosion. Once soil associations are clarified, tendencies and related characteristics of these soils should

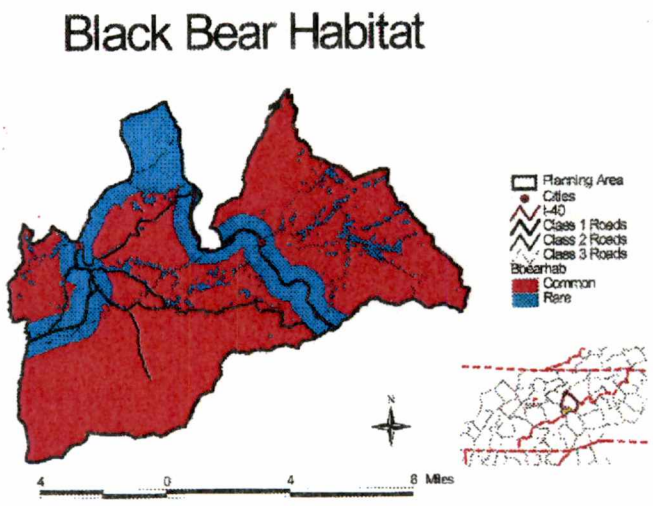


Figure V-13. Black Bear Habitat

Source: Created from SAA GIS Data Base

be explored and added to attribute files of the GIS database. Table A-3 in Appendix-A is an example of what might be included in the attribute file.

Based on the above inventories and exploration it is now possible to sum up the county's assets. The first and most recognizable asset is the mountainous terrain and the close proximity to preserved natural areas including Great Smoky Mountains National Park and Cherokee National Forest. The county's history, natural beauty, wildlife habitats, stream networks, extensive undeveloped land which support working ecosystems, and the available work force are some of the more noteworthy assets. The following sub sections will discuss in detail the most important assets that have been recognized with the inventory and overall analysis of county attributes.

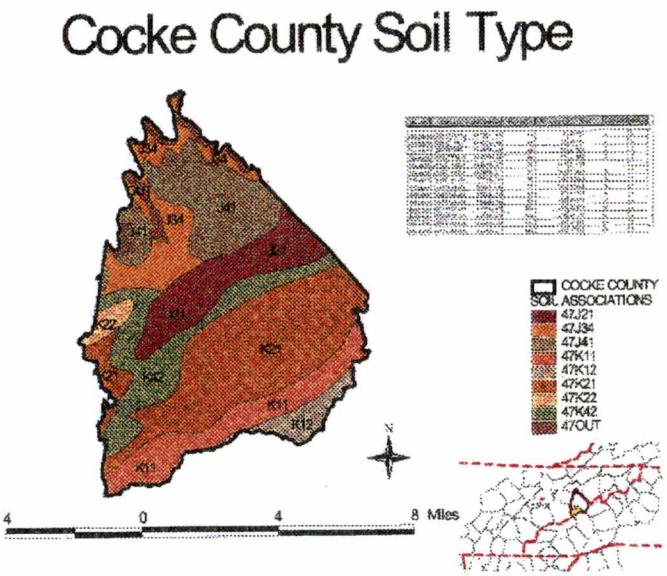


Figure V-14. Cocke County Soil Type

Source: Created from SAA GIS Data Base

Cocke County's location is a very significant asset primarily because it is located within one day's drive of approximately 3/4 the population of the United States. As a Gateway to the Smoky Mountain National Park; the most visited

National Park in the US, Cocke County has the potential to capitalize on its location. Figure V-5 seen earlier in this chapter helps illustrate the planning areas' geographic location as an asset.

Good access to Cocke County is one of its primary strengths. Interstate 40 provides excellent access to Cocke County and the planning area via State highway 321 as well as the Foothills Parkway. In addition, the intersection of Interstate 81 is only 5 miles from Cocke County and Interstate 75 is only thirty miles from the county. As a result the area is a heavily traveled thorough fair supporting visitors traveling in all directions.

The 1995 estimate of Cocke County's population is 31,400 resulting in a large available work force. The estimated countywide, currently unemployed, available labor force is 3,240 as of February 1996. The total labor force, including employed individuals is 17,840. In 1995, Cocke County had 337 high school graduates 51.9 percent of which were college bound (West et al. 1997).

The habitats of animals and plants throughout the county and planning area are one of the biggest assets that should be capitalized on. Figures V-15 and V-16 are examples of wildlife that can be found in the planning area. The wildflowers, birds and large mammals of the area are species that are often rare in surrounding regions and are of growing interest to today's society.



Figure V-15. Cocke County Wildlife 1

Source: http://www.web.net/fon/bear.htm

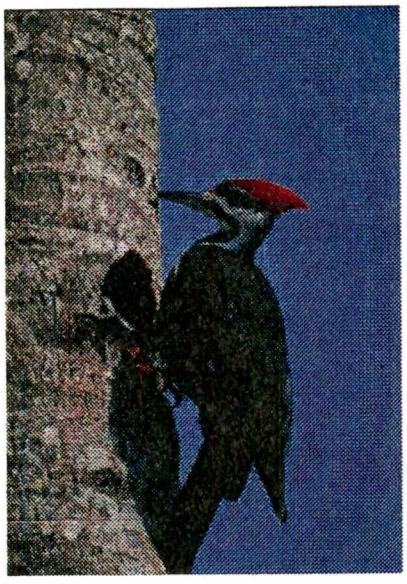


Figure V-16. Cocke County Wildlife 2

Source: http://www.wildamerica.net/gallery/69.jpg



Figure V-17. Typical View

At the foot of the Great Smoky Mountains National Park and the Cherokee National Forest, Cocke County is filled with natural beauty. The undeveloped land and frequency of wild streams and large expanses of deciduous forests all help to contribute to the natural beauty. Figure V-17 is typical view that might be found in the county and especially the planning area. With such grand appearances it is easy to recognize the areas natural beauty as one of its strongest assets (West et al. 1997)

Most people of Cocke County are tied to the region through their mountain heritage and culture. The mountain heritage of this area is unique to this region of the United States and is also a strength of the community. Local residents such as this dulcimer maker (Figure V-18) provide a window into the past of Cocke County and the Appalachian region. Additional arts

and crafts that were previously the way of life in the mountainous region are still practiced and widespread throughout the community(West et al. 1997).



Figure V-18. Dulcimer Maker

Now that assets and environmental impact assessments have been undertaken, the next step is to analyze these assets further. Results from this analysis will lead to the extrapolation of potential attractions. While not every asset may have been brought up in this section, those demonstrated above are enough to clearly show how assets should be determined. The maps and data bases created in this section are now a base from which a variety of overlays can be created. Building upon this base of assets, attractions (which are discussed in the following section) can be more easily recognized.

Cocke County Ecotourism Attractions

The attractions that may come out of this vast array of assets, are diverse and have very good potential of adding to successful development of a community based on ecotourism. As defined in chapter four an attraction involves the combination of a natural area and defined infrastructure which have the capability to help people explore and learn (McArthur 1997). Based on these criteria it is clear that many such opportunities exist in Cocke County.

To explore these potentials for Cocke County further local infrastructure for the planning area was added to the GIS database. This was done to help show if assets are in close proximity to the infrastructure necessary to make them attractions. The following map (Figure V-19) portrays the local infrastructure. Though important for all new facilities or overnight accommodations, infrastructure as shown in Figure V-19, is usually not necessary for many ecotourism attractions that are designed to be sustainable. However, infrastructure providing transportation is a different story. The next maps, V-20, and V-21, portray infrastructure that is more inline with the needs of ecotourism development. The first figure, illustrates local roads in the planning area. The position and conditions of these roads are very valuable in determining ecotourism attractions. In this figure, class one, two and three, roads are identified. However, only class one and two roads should be considered for access by public

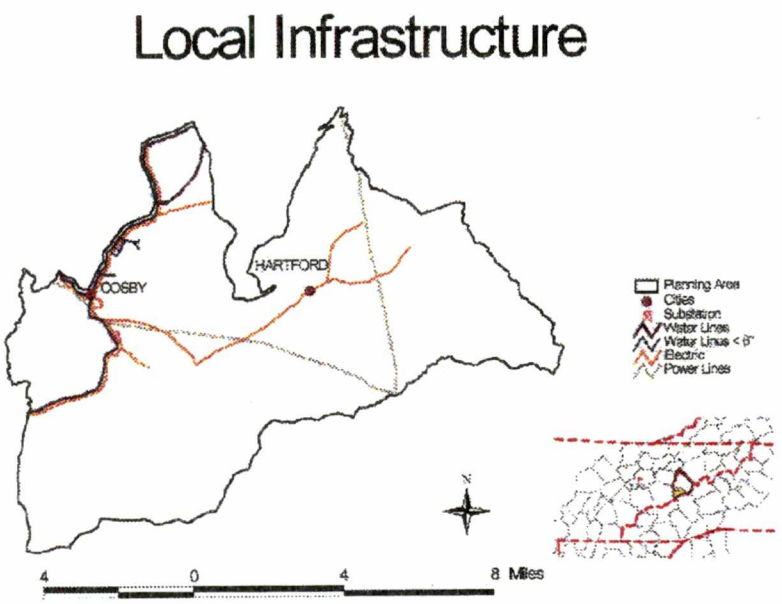


Figure V-19. Local Infrastructure

Source: Created from SAA GIS Data Base

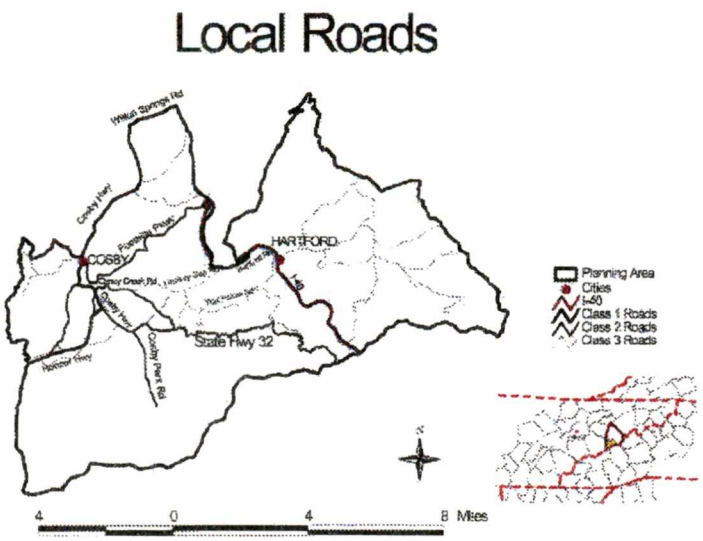


Figure V-20. Local Roads

Source: Created from SAA GIS Data Base

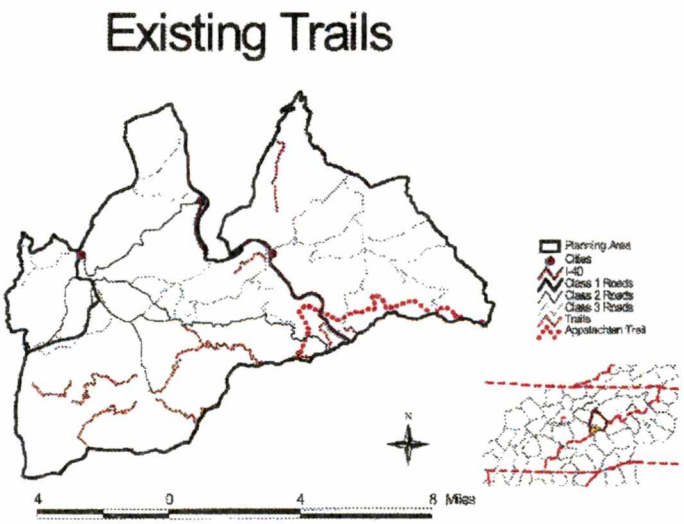


Figure V-21. Existing Trails

Source: Created from SAA GIS Data Base

automobiles. Class three roads may, in the case of Cocke County, be roads that were formerly logging roads used by the forest service. As a result these roads might be considered for the introduction of bike trails or greenway systems depending on their grade and overall quality. In some cases, they may be best used by tour guides transporting hunters, fisherman, or even rafters. The second figure illustrates local trail systems that might be

used for attraction development or assessment of access to prevent the community from having to spend money on the creation of new infrastructure.

One of the best uses for existing infrastructure such as roads can be attractions based on land cover assets. Cocke Counties varying topography and large quantities of thick deciduous forests make scenic drives an ideal attraction. The natural beauty of the leaf colors, streams, and mountain views are appealing and enchanting. Driving on existing roadways to view these assets is an activity that will tempt all ages. Foothills Parkway is one such attraction that already exists within the planning area. It works its way alone a ridge line which overlooks the city of Cosby and the National Park. Figure V-22 is an example of a view from this scenic drive. It is apparent how an attraction such as this can be created or even discovered when topography, land cover, and infrastructure maps are overlaid.

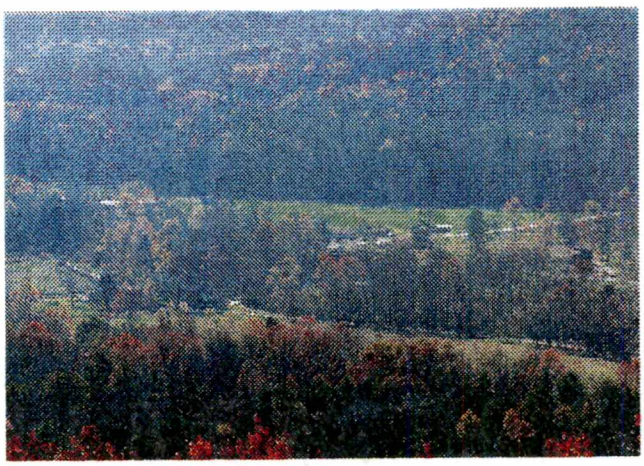


Figure V-22. Scenic Drive View

The map of water bodies, when combined with information from the wildlife habitat database, maps of roads and existing trails, creates significant help when planning and locating areas for fishing tours. Figure V-23 is a map of trout streams in relation to roads and trails. Even more narrowed down attractions might

be appropriate. The attraction analysis might be directed at ecotours for a specific type of fishermen. If for example, retired fly fishermen were being marketed overlays should be modified. In such a case, the tourist may want to fish in a remote location but at the same time may not want to expend the energy it takes to hike in. In these circumstances the map in Figure V-24 may be helpful in determining suitable locations.

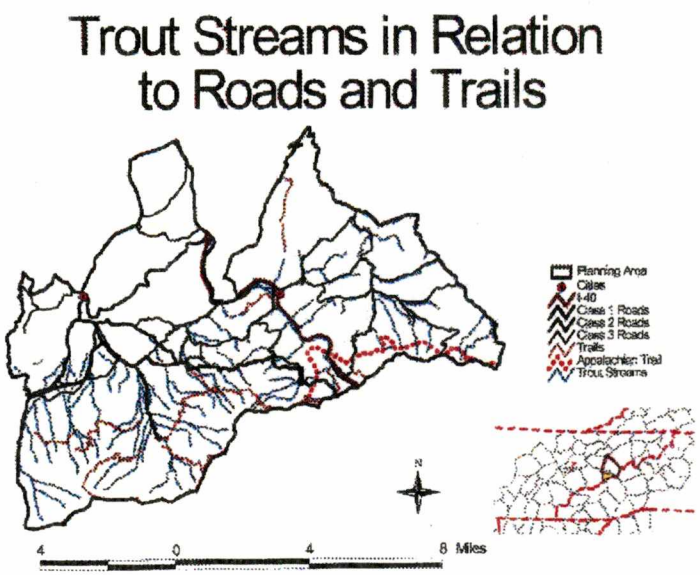


Figure V-23. Trout Streams in Relation to Roads and Trails

Source: Created from SAA GIS Data Base

In the cases of wildlife viewing or hunting within the planning area, it may be ideal to locate wildlife in rather inaccessible areas. In such cases one might compare the existing trail map to a map such as

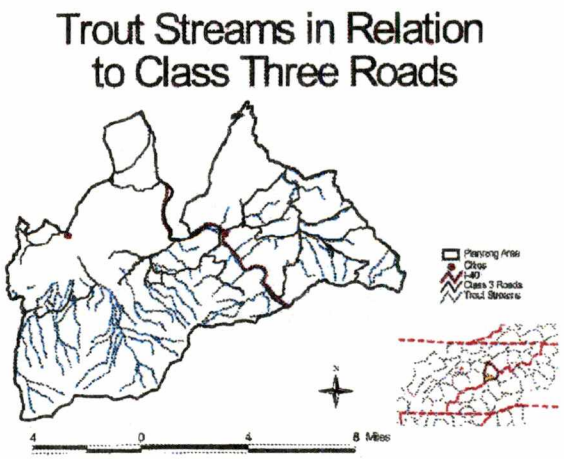


Figure V-24. Trout Streams in Relation to Class Three Roads

Source: Created from SAA GIS Data Base

Figure V-25 which illustrates roadless areas. Roadless areas can be a valuable attraction to bird watchers, wildlife researchers and often even to hunters. They might be especially helpful for establishing remote camps for tourists to learn survival techniques or for long-term integrated studies on ecosystems.

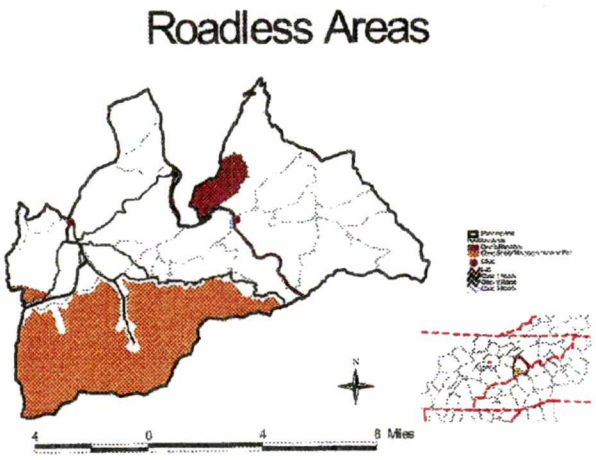


Figure V-25 Roadless Areas

Source: Created from SAA GIS Data Base

While undeveloped areas make ideal attractions in ecotourism developments, developed areas can help orient attractions as well. Figure V-26 is a map which illustrates the local economic base of the planning area in relation to trails and streams. This map is important for determining the attraction placement. For example if a retail store is located near a point on a stream, this may be

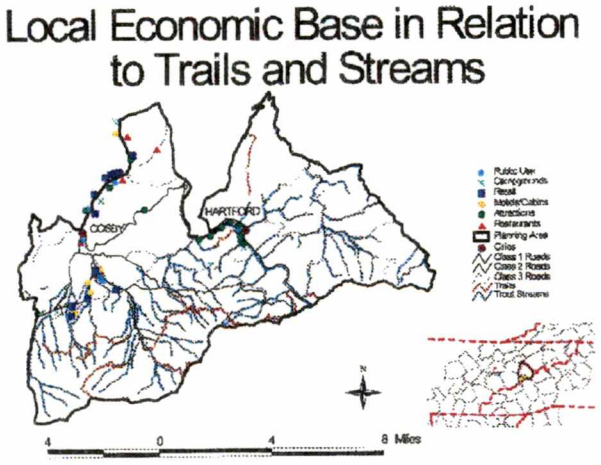


Figure V-26. Local Economic Base in Relation to Trails and Streams

Source: Created from SAA GIS Data Base

used to determine that: it would be a good place for a kayaking attraction to have its take out point. The purpose might be as simple as: a way to satisfy a tourist's hunger and thirst at the end of an activity.

As the assets have demonstrated, there are many potential attractions within the planning area, as a result, new trails will eventually have to be developed in some form or another. However, to make this practice more sustainable a map of topography in relation to soil association would be a good start. Figure V-27 is an example of such a map. By comparing the attributes of the soil association and the slope (calculated based on contour intervals) it can be determined if a new trail can be put in without creating excess erosion or runoff.

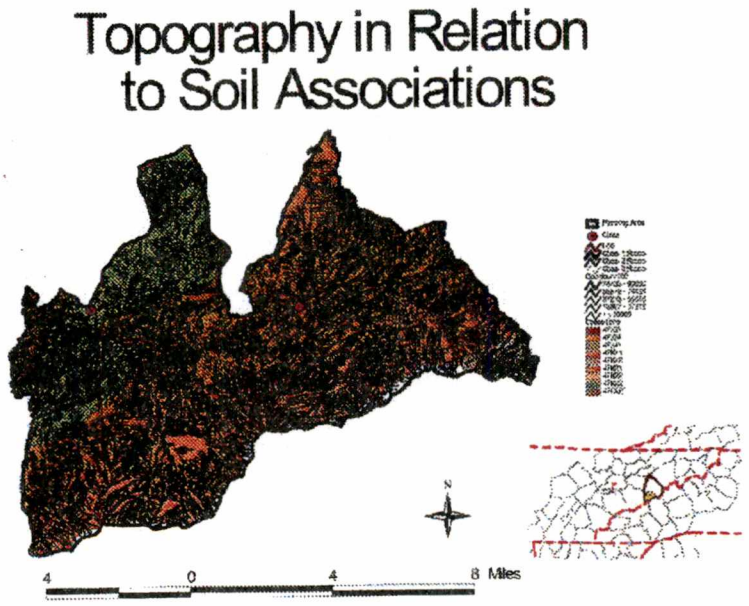


Figure V-27. Topography in Relation to Soil Associations

Source: Created from SAA GIS Data Base

One important part of attracting ecotourism is that a environmentally friendly atmosphere needs to be created. A growing way to produce such an atmosphere is through the creation of a greenway system. A greenway system can help connect various attractions in a pedestrian and bike

friendly format. Figure V-28 is an example of such a greenway designed to fit the Cocke County planning area and its attractions. It is important to note that this greenway was placed along an existing roadway in order to prevent new environmental obstructions. Figure V-29 is a map which illustrates the greenways relationship to the National Park and various ecotourism recreational areas. It should be noted that the greenway connects all the major recreational sites on the map. This

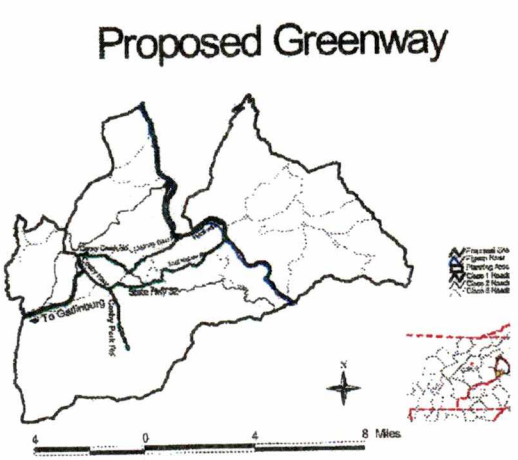


Figure V-28. Proposed Greenway

Source: Created from SAA GIS Data Base

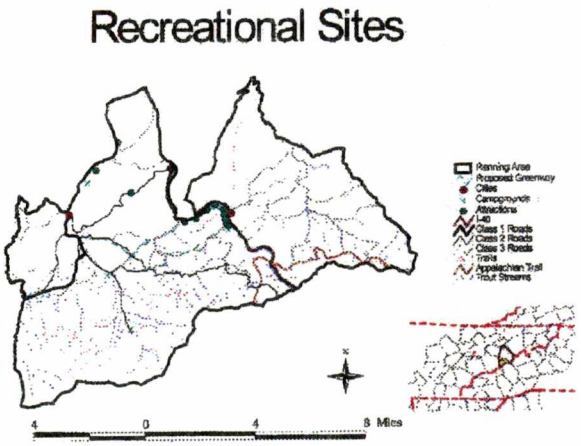


Figure V-28. Recreational Sites

Source: Created from SAA GIS Data Base

allows the tourist to have non-motorized access to attractions throughout the planning area.

The above examples are just a few of the main possibilities through which ecotourism attractions can be developed. The next section will list the best possible attractions that can succeed and thrive in this small planning area with an overall assessment of the ecotourism development.

Analysis of Cocke County's Ecotourism Potential

Ecotourism presents a wonderful opportunity for Cocke County. Hunting, fishing, rafting, biking, and hiking are just a few of the recreational activities possible within the county. With at least one-third of the county's land occupied by the national park and national forest, recreational opportunities are abundant. In addition, the Pigeon River provides ample opportunity for a variety of water recreation (see Figure V-30). For the hunting and fishing enthusiasts, Cocke County has several trout streams that are stocked regularly (see Figure V-31). There are also black bear, deer, turkey, grouse, and waterfowl populations throughout the county and planning area (see ruffed grouse in Figure V-32). Hiking trails are found in abundance in both the National Forest and the National Park (see Plate 5-27). The county is also host to part of the Appalachian Trail that runs along the southern border of the county and through Great Smoky Mountains National Park. Cocke County has already gained recognition for its excellent mountain biking experience. Cherokee National Forest has both single-track and broad based trails that are good enough to attract bikers from around the country. Within the Cocke County area, camping, picnicking, and horseback riding are a few more recreational opportunities that can be found (West and al 1997). It is

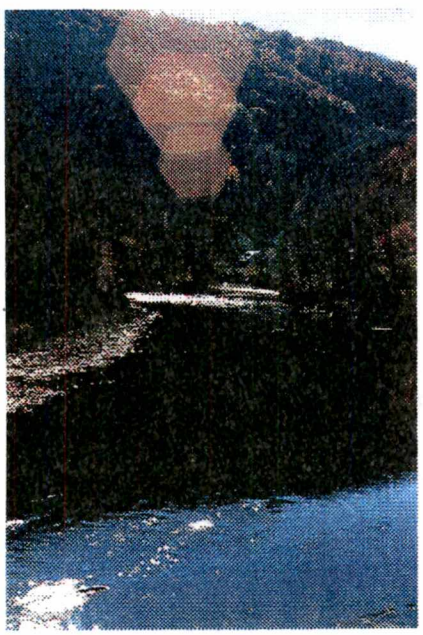


Figure V-30 Pigeon River

evident through both the asset and attraction inventory, that the county and the planning area both have more than sufficient assets to create an ecotourism development. In some forms this development has already begun however, in a few cases sustainability of the attraction may be in question.



Figure V-31. Trout Streams

In addition to developing further the attractions mentioned previously, a market must be defined for Cocke County. From the analysis, the market most consistent with the counties assets would be the development of ecotourism strategies based on the three categories of specialization.



Figure V-32. Ruffed Grouse

The first should be to market nationally based on the areas rare biological diversity. As this is by far the strongest asset of the area, it should be prioritized. Attractions such as educational

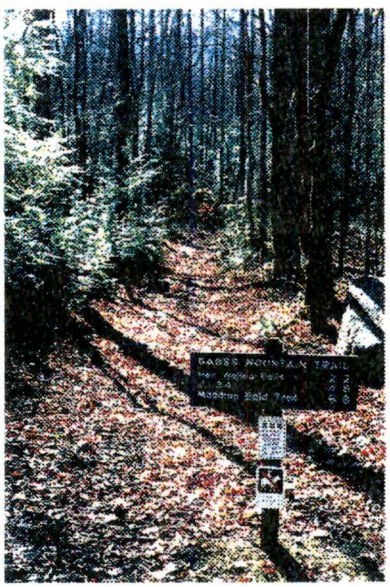


Figure V-33. Hiking Trail

camps for learning about the local mountain environment would be ideal. In addition, this area might include the marketing of universities to come and partake in environmental research. Another aspect of this biological diversity marketing technique should be to capitalize on the possibilities of hunting and fishing in the area.

The second specialization should be to market to the active ecotourist. Those who enjoy extreme or more challenging adventures such as white water rafting, technical mountain biking, and extreme hiking could add significant income to the local community. With the strong base of existing rafting companies and the local national forest's mountain bike trails this market has excellent potential. In addition, the inventories illustrated the areas strength in topography and mountain streams which are suitable for these activities.

The third objective should be to market to those interested in crafts and mountain heritage. This objective has excellent potential due to the communities strong roots in their past. A recreation of an old Appalachian village with people working on arts and crafts might be a good way to capitalize on the county's cultural assets.

By marketing to these three categories the planning area can be assured of a broad and balanced tourist population which will help in diversifying the ecotourism segment of the local community. In addition, the ages and backgrounds of the visitors will be varied which can help influence all members of the community to take part in the activities and give them direct interest in preserving their local environment.

Utilizing asset and attraction inventories discussed in Chapter Three and the strategies and capability and suitability analysis model in Chapter Four, this case study has outlined and provided an example for how ecotourism development can be applied.

It is important to note however that this case study does not completely address all the issues that need to be raised when developing ecotourism. The social issues of the county are very relevant to the long term success of ecotourism. Social issues were not addressed because they can vary so greatly between communities and to consider all issues would overflow the scope of this thesis. As a result issues in Cocke County such as their very serious crime and reputation problems were not addressed. However, they would need to be included as part of the counties overall ecotourism analysis. Other communities may also have a variety of social, political, or cultural issues that should be of vital concern in addition to the analysis illustrated above.

Chapter VI

CONCLUSION

Summary of Ecotourism Development Utilizing GIS

Ecotourism is an ideal strategy for development with nature; while geographic information systems are a method of controlling this development strategy. Ecotourism has the power to limit environmental degradation and when implemented properly can promote environmental education, preservation, and economic growth. Similarly, GIS promotes accuracy of assessment and control of analysis. Both can contribute significantly to today's environmental problems.

Many countries today, including our own, are rapidly losing their green spaces and natural environments. Traditional forms of development are unsustainable and inefficient and must be averted in exchange for developments that capitalize on their environmental assets. Ecotourism is an alternative that can guide communities in the right direction by including factors such as preservation of heritage, culture, and the natural environment. Further, the following goals have proven themselves effective in ecotourism development as well. The most important of which are to: secure conservation oriented environmental management using GIS, establish marketable environmental attractions, use ecotourism to create economic gain within the community, maximize benefits of assets, support environmental education for visitors and guides and finally capitalize and focus on specific local assets.

GIS as a tool has the ability to back these goals. It should be used to develop inventories of assets and used to analyze these assets to assess the potential for attractions and ecotourism as a whole. Only then should a development be approved.

Once completed the development can be effectively managed and updated with the help of the original GIS database. Though it is expensive and time consuming, GIS is worth the extra effort because of its ability to oversee the construction of the base of the development.

The example case study of the planning area in Cocke County demonstrates GIS's usefulness in assessing ecotourism potential. Only through the series of overlays that were created was it possible to see possible dangers or advantages of developments in specific areas. Through this study the strong points of the county were determined and once the sustainable ecotourism is sufficiently established, the discussed marketing can take place.

While Cocke County was just one example it is enough to point out the strengths of using GIS for ecotourism assessment. It is hoped that after reading this study one will agree that ecotourism should be more broadly recognized as an alternative to traditional developments and that the creation of a working GIS database is the correct way to implement this alternative. As the worlds undeveloped land shrinks, our concerns for sustainable, environmentally friendly development should grow.

Ecotourism and geographic information systems from a distance may seem unrelated. However, in the fields of planning, environmental consulting, community development, growth management and economic development, a common ground can be found. It is this common ground that is shaping the future of our country and our world. People in these fields may not feel the burden, but, they should. Through their responsible actions, sustainability on this planet can be a reality. If they fail to

make the proper considerations for the environment and future generations the global system may be jeopardized. For these reasons, it is important to adequately respect nature and the environment as a daily practice. As Lewis Mumford writes in Ian McHargs *Design with Nature*:

> the first public recognition that man's life, in sickness and in health, is bound up with the forces of nature, and that nature, so far from being opposed and conquered, must rather be treated as an ally and friend, whose ways must be understood, and whose counsel must be respected (McHarg 1969, p. vi).

The fact is that today's molders of the future must recognize the environment as an "ally" as Mumford mentioned. The environment should not be a barrier to development but a an asset to development. It is uncontested that environmental areas and natural habitats will need to develop for the growing human population. However, by practicing sustainable methods and strategies for this development longer lasting communities can be created.

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APPENDICES

APPENDIX-A

Table A-1. Cocke County Wildlife Habitats

Source: Hermann, K. A. (Ed.). 1996. The Southern Appalachian Assessment GIS Data Base. Southern Appalachian Man and the Biosphere Program. Norris, TN.

Common_Name	Taxa	Federal_Status	Global_Rank	Improved_Pasture	Cropland	Caves	Rare_Community_1	Rare_Community_2	Rare_Community_3	Rare_Community_4	Rare_Community_5	Rare_Community_6	Remote_Habitat	Area_Sensitive	Open_Canopy_Forest	Closed_Canopy_Forest	Forest_Interior	Riparian_Habitats	Spring_Head_Seeps	Water
Seepage Salamander	Amphibian	2														X		X	X	
Imitator Salamander	Amphibian															X		X	X	1
Blackbelly Salamander	Amphibian															X		X	X	1
Santeetlah Dusky Salamander	Amphibian															X		X	X	1
Black Mountain Salamander	Amphibian															X		X	X	1
Pigmy Salamander	Amphibian															X		X	X	
Junaluska Salamander	Amphibian	2	2													X		X	X	1
Blue Ridge Two-lined Salamander	Amphibian															X		X	X	3
Tennessee Cave Salamander	Amphibian	2				X	18	20												1
Shovelnose Salamander	Amphibian															X		X		1
Jordan's Salamander	Amphibian															X		X		
Yonahlossee Salamander	Amphibian															X		X		
Northern Goshawk	Bird	2																		
Northern Saw-whet Owl	Bird																			
Bachman's Sparrow	Bird	2	3												X					
Henslow's Sparrow	Bird	2					3	4												
Ruffed Grouse	Bird						2											X	X	
Black-billed Cuckoo	Bird													X						
Northern Flicker	Bird														X					
Northern Bobwhite	Bird				X		2													
Eastern Wood-Pewee	Bird																			
Black-throated Blue Warbler	Bird													X		X	X			
Cerulean Warbler	Bird	2												X						
Prairie Warbler	Bird																			
Blackburnian Warbler	Bird													X		X	X			
Chestnut-sided Warbler	Bird						16	17						X	X					
Black-throated Green Warbler	Bird													X		X	X			
Pileated Woodpecker	Bird													X			X			
Gray Catbird	Bird																			
Acadian Flycatcher	Bird																X	X		3
American Peregrine Falcon	Bird	E					19	21	22	18			X	X						
Bald Eagle	Bird	T					9													3
Worm-eating Warbler	Bird													X		X	X			
Wood Thrush	Bird													X		X	X			
Loggerhead Shrike	Bird	2		X	X															
Swainson's Warbler	Bird													X			X			
Red Crossbill	Bird						15													
Red-bellied woodpecker	Bird													X						

Rare_Community_3

Common_Name	Large_Trees	Live_Tree_Snag_Cavity_Neste	Large_Snags_(>20_inches)	Downed_Logs	Leaf_Litter	Elevation	Aspect	M121Ab	221Ja	221Jb	221Jc	M121Dd	Comments
Seepage Salamander				X	X	4						X	
Imitator Salamander				X	X	3						X	
Blackbelly Salamander												X	Near stream headwaters
Santeetlah Dusky Salamander				X	X	3						X	Swift moving mountain streams
Black Mountain Salamander				X	X				X				
Pigmy Salamander				X	X	2						X	Requires shade, higher elevation forests
Junaluska Salamander				X	X	6						X	Aquatic dependent
Blue Ridge Two-lined Salamander				X	X							X	
Tennessee Cave Salamander									X				
Shovelnose Salamander								X				X	Bottom of cold, clear streams
Jordan's Salamander				X	X			X				X	
Yonahlossee Salamander				X	X							X	Old stumps (especially chestnut)
Northern Goshawk								X	X		X	X	Based on wintering only
Northern Saw-whet Owl		X				1						X	Nests in high elevation spruce-fir; winters in sapling pine
Bachman's Sparrow									X	X	X		Based on wintering and breeding
Henslow's Sparrow								X					Based on wintering and breeding
Ruffed Grouse				X		3		X				X	Fallen logs amist dense saplings
Black-billed Cuckoo								X	X	X	X	X	
Northern Flicker			X			4		X	X	X	X	X	Live cavity/snags > 14" DBH
Northern Bobwhite								X	X	X	X	X	
Eastern Wood-Pewee						4		X	X	X	X	X	Variety of dry habitats
Black-throated Blue Warbler						2		X				X	Minimum Tract - 6,200 ac. Highly developed understory
Cerulean Warbler	X											X	Minimum tract size = 4,325 acres; uneven forest canopy,small
Prairie Warbler								X	X	X	X	X	Open country, poor soil, scattered shrubs for nesting
Blackburnian Warbler	X					2		X	X			X	
Chestnut-sided Warbler						2		X				X	
Black-throated Green Warbler								X			X	X	
Pilcated Woodpecker	X	X	X	X		4		X	X	X	X	X	Minimum Tract - 1000 acres, reguires some older habitats
Gray Catbird								X	X	X	X	X	
Acadian Flycatcher						5		X	X	X	X	X	
American Peregrine Falcon								X	X			X	Based on nesting only
Bald Eagle	X		X									X	
Worm-eating Warbler						5		X	X	X	X	X	Minimum Tract - 910 acres; steep slopes, dense underst
Wood Thrush						4		X	X	X	X	X	Minimum Tract size = 7 acres.
Loggerhead Shrike								X	X	X	X	X	
Swainson's Warbler								X				X	Associated with Rhododedron thickets, To South VA.
Red Crossbill						2		X				X	Southern Appalachian Red Crossbill

Common_Name	ELCODE	Taxa	Federal_Status	Global_Rank	Improved_Pasture	Cropland	Caves	Rare_Community_1	Rare_Community_2	Rare_Community_3	Rare_Community_4	Rare_Community_5	Rare_Community_6	Remote_Habitat	Area_Sensitive	Open_Canopy_Forest	Closed_Canopy_Forest	Forest_Interior	Riparian_Habitats	Spring_Head_Seeps	Water
Red-headed Woodpecker		Bird														X					
Eastern Wild Turkey		Bird			X	X								X	X						
Kentucky Warbler		Bird													X			X			
Northern Parula		Bird													X			X			
Downy woodpecker		Bird															X				
Hairy Woodpecker		Bird													X						
Scarlet Tanager		Bird													X		X	X			
Summer Tanager		Bird													X						
Prothonotory Warbler		Bird													X						2
American Woodcock		Bird			X	X		6	7	9									X	X	
Ovenbird		Bird													X			X			
Louisiana Waterthrush		Bird													X			X	X		1
Field Sparrow		Bird																			
Golden-winged Warbler		Bird																			
Blue-winged Warbler		Bird																			
Yellow-throated Vireo		Bird													X						
Canada Warbler		Bird													X						
Hooded Warbler		Bird													X			X			
Clingman Covert		Invertebrate	2																		
Spruce-Fir Moss Spider	ILARA33010	Invertebrate	E					20	26								X				
Sculptured supercoil		Invertebrate	2																		
Roan supercoil		Invertebrate	2																		
Noonday globe snail	IMGAS95081	Invertebrate	T					19									X			X	
Avernus Cave beetle	IICOL4E180	Invertebrate	2	1			X														
Deceptive Cave beetle	IICOL4E230	Invertebrate	2	1			X														
Lee County Cave beetl	IICOL4E280	Invertebrate	2	1			X														
Holsinger's Cave beetle	IICOL4E290	Invertebrate	1	1			X														
Long-headed cave beet	IICOL4E410	Invertebrate	2	1			X														
Nobletts Cave beetle		Invertebrate	2				X														
Petrunkevitch's cave be	IICOL4E510	Invertebrate	2	1			X														
Overlooked Cave beetle	IICOL4E530	Invertebrate	2	1			X														
Saint Paul Cave beetle	IICOL4E580	Invertebrate	2	1			X														
Silken cave beetle	IICOL4E620	Invertebrate	2	1			X														
Thomas' Cave beetle	IICOL4E650	Invertebrate	2	1			X														
Red Wolf	AMAJA01020	Mammal	E											X	X						
Rafinesque's big-eared	AMACC08020	Mammal	2	3			X	19	22	25				X							

Common_Name	Large_Trees	Live_Tree_Snag_Cavity_Neste	Large_Snags_(>20_inches)	Downed_Logs	Leaf_Litter	Elevation	Aspect	M221Ab	221Ja	221Jb	221Jc	M221Dd	Comments
Red-headed Woodpecker			X			6		X	X	X	X	X	Live cavity/snags> 14" DBH
Eastern Wild Turkey								X	X	X	X	X	Home Range - 1000 acres, Remote Habitat = > .5 mile from roads
Kentucky Warbler						5		X	X	X	X	X	
Northern Parula						4		X	X	X	X	X	Minimum Tract Size - 3,200 acres
Downy woodpecker			X					X	X	X	X	X	Live cavity/snags > 6" DBH
Hairy Woodpecker			X					X	X	X	X	X	Minimum Tract = 45 acres, Live cavity/snags > 10" DBH
Scarlet Tanager								X	X	X	X	X	Minimum Tract - 75 acres
Summer Tanager						6		X	X	X	X	X	Minimum Tract - 250 acres; Dry sites.
Prothonotory Warbler		X							X	X	X		
American Woodcock					X			X	X	X	X	X	Fertile, moist soil, clearings, bare soil, thick litter layer
Ovenbird					X			X	X	X	X	X	Minimum Tract - 35 acres
Louisiana Waterthrush						5		X	X	X	X	X	Minimum Tract - 2,160 acres; Rocky streams
Field Sparrow						5		X	X	X	X	X	Br/Winter, Open country, poor soils, hedge rows, shrubs
Golden-winged Warbler						4		X				X	Elevation - 1000-5000 ft., fields with deciduous saplings
Blue-winged Warbler						6		X	X	X	X	X	Open country,fairly level ground,deciduous shrubs/sapl.
Yellow-throated Vireo	X					6		X	X	X	X	X	Open understory, usually near water
Canada Warbler						2		X				X	Minimum Tract - 2,470 acres, rhododendron thickets
Hooded Warbler						4		X	X	X	X	X	Rich understory layer
Clingman Covert						3						X	
Spruce-Fir Moss Spider						1						X	Requires moss mats on rocky outcrops - needs shale
Sculptured supercoil					X							X	
Roan supercoil					X	1						X	Roan Mtn, NC & TN
Noonday globe snail					X		N					X	Needs moist soil; rich herbaceous undergrowth
Avernus Cave beetle								X					
Deceptive Cave beetle									X				
Lee County Cave beetle									X				
Holsinger's Cave beetle									X				
Long-headed cave beetle									X				
Nobletts Cave beetle												X	
Petrunkevitch's cave beetle								X					
Overlooked Cave beetle									X				
Saint Paul Cave beetle									X				
Silken cave beetle									X				
Thomas' Cave beetle									X				
Red Wolf												X	

Table A-2. Cocke County Soil Associations

Soil Type	Soil Name	Slope	Drainage	Surface Runoff	Permeability	Elevation	Associated Land Cover	Use
K21	Sylco - Ranger - Citico	35-95%	well drained	medium	moderate	1800-4500	oak forest and occasionally pine	
K41	Calvin - Hayter - Dunmore	0-65%	well drained	medium to rapid	moderately rapid	NA	mixed hardwood forest	cropland
K12	Unaka - Ashe	10-60%	well drained	medium	moderate	3600-5000	yellow poplar, black cherry, oaks , hemlock, buckeye, bi	pasture
J51	Talbott - Rock Outcrop - Etowah	0-70%	well drained	medium and rapid	moderately slow	NA	mostly hardwood forest	small grain tobacco and soy bean
J21	Dunmore - Dewey	2-50%	well drained	medium to rapid	moderate	NA	85% cleared, hardwood forest	small acreages of small grains and tobacco
J41	Dandrige - Needmore - Whitesburg	2-70%	excessively drained	rapid	moderately slow	NA	forests of oak, hickory, beech, maple, elm, and locust	pasture
J34	Holston - Monogahela	0-25%	well drained	medium	moderate	NA	mixed hardwoods and pines	tobacco, hay, small grains and pasture
K42	Jefferson - Allen - Statler	2-75%	well drained	rapid to medium	moderately rapid	NA	yellow poplar and upland oaks	pasture
J31	Decatur - Dewey - Waynesboro	1-10%	well drained	medium	moderate	430-1400	pine plantations	most is cleared and used for soybeans, hay, an
J33	Waynesboro - Allen - Sequatchie - Statler	2-30%	well drained	medium	moderate	NA	oaks, hickory, beech, elm, maple, and yellow poplar	small grains, hay, and pasture
							NA	NA

Table A-3. Cocke County Sensitive Species

Source: Hermann, K. A. (Ed.). 1996. The Southern Appalachian Assessment GIS Data Base. Southern Appalachian Man and the Biosphere Program. Norris, TN.

American Peregrine Falcon	Bird	E
Bald Eagle	Bird	T
Spruce-Fir Moss Spider	Invertebrate	E
Noonday globe snail	Invertebrate	T
Red Wolf	Mammal	E
Virginia Big-eared Bat	Mammal	E
Carolina Northern Flying Squirrel	Mammal	E
Gray Bat	Mammal	E
Indiana Bat	Mammal	E
Ruth's golden aster	Plant	E
Large- flowered skullcap	Plant	E

APPENDIX-B

CREATING A LAND COVER BASE MAP

The following is an exert from the Southern Appalachian Man And Biosphere Southern Appalachian Assessment GIS Database. It explains in detail the steps that were performed in creating a land cover base map from Satellite Imagery Data. This process would be an ideal way to start creating a new GIS database.

Source Material: Landsat TM satellite scenes

Organization: Multi Resolution Landscape Characteristics Consortium, US Forest Service, Tennessee Valley Authority
Date:
Distance Resolution: unknown
Contribution: spectral data, multitemporal coverage

Source Material: Stands, Spruce-Fir extent delineations
Organization: US Forest Service
Date:
Distance Resolution: unknown
Contribution: spruce-fir class, training material, aerial photography

Source Material: USGS LUDA (GIRAS) data, DMA 3 Arc second DEM
Organization: US Geological Survey
Date:
Distance Resolution: unknown
Contribution:

Source Material: River Reach 3 File (RF3)
Organization: US Environmental Protection Agency (USGS - Digital Line Graph (DLG))
Date:
Distance Resolution: unknown
Contribution: streams

Source Material: National Wetland Inventory
Organization: National Biological Service
Date:
Distance Resolution: unknown
Contribution: wetlands class

Processing History Information

Process Description:

The following text has been extracted from the "Southern Appalachian Assessment Land Cover Mapping Project Final Report" produced by Pacific Merdian Resources, Inc. (PMR). PMR was contracted to perform the land cover classifiaction.

I did minor editing to the extracted material.
Karl A. Hermann
3/21/96

All image classifications were performed using ERDAS (Atlanta, Georgia) software.

The initial design of this project was to acquire all the imagery at once and then process all of the data simultaneously through each of the image processing tasks. Delays in receiving data resulted in the imagery being processed as three sets of scenes. The following describes the methods used to classify a single scene from start to finish.

Classification Scheme

The first step in any mapping project is the specification of a classification system which categorizes the features of the earth to be mapped. Specifications of the system are driven by (1) the anticipated uses of the map information, and (2) the features of the earth that can be discerned with the data (e.g., aerial photography, satellite imagery) being used to create the map.

A classification system has two critical components: (1) a set of labels (Herbaceous, Spruce-Fir, Northern Hardwood, etc.); and (2) a set of rules--or a system--for assigning labels (e.g., a "Northern Hardwood forest will consist of 70% or more of the total forested area in sugar maple, beech or yellow birch.").

Without a clear set of rules, the assignment of labels to types can be arbitrary and lack consistency. The land use/land cover classification scheme for this project was designed to best meet the needs of all agencies involved in the SAA study. Primary concerns in determining the scheme were balancing project time and budget con straints while still meeting the needs of all agencies involved.

Table 2 presents the final classification labels for the data layers developed from the satellite image classification. Appendix A contains the definitions for determining the appropriate land cover classification label.

Table 2. Final Classification Scheme

Class Number	SAA Class Descriptions
1	Northern Hardwood Forests
2	Mixed Mesophytic Hardwood Forests
3	Oak Forests
4	Bottomland Hardwood Forests
5	White Pine / Hemlock Forests
6	Montane Spruce-Fir Forests
7	Southern Yellow Pine Forests
8	White Pine / Hemlock / Hardwood Forests
9	Mixed Pine / Hardwood Forests
10	Herbaceous
11	Barren
12	Agriculture - Pasture
13	Agriculture - Cropland
14	Wetlands
15	Developed
16	Water
17	Indeterminate - Clouds, Shadows

Data Preprocessing

A total of fourteen Landsat TM scenes (Table 3) were needed to cover the SAA study area. This imagery was obtained from three sources: Multiresolution Land Characteristics (MRLC) through the EROS Data Center, EOSAT , and the Tennessee Valley Authority (TVA).

With multitemporal data available for most scenes, the amount of data involved in this mapping project was enormous. Both hardware and time constraints for the project made data reduction a necessity. The first step in dealing with the imagery was therefore to subset the bands to be used in the classification.

Table 3.
Landsat TM Imagery use to Classify the Southern Appalachians

Scene	Date
1633	3/1/92, 5/20/92
1634	5/20/92, 9/28/93
1733	10/2/92, 7/17/93
1734	9/14/91, 10/2/92
1735	5/11/92, 11/3/92
1834	9/29/94, 11/29/93
1835	10/25/92, 6/6/93
1836	6/6/93, 4/19/93
1935	4/23/92, 7/31/93
1936	7/12/92, 11/17/92
1937	7/31/93.10/3/93
2035	6/28/90
2036	6/12/90
2037	11/11/93, 8/26/94

Several statistical techniques exist to select the best combination of spectral bands of the imagery. (Jensen, 1986; Swain, 1978), (Jensen, 1986), (Johnson and Wischern, 1982). In cover type classification and biophysical variable analysis, there is no one optimum choice of spectral bands. Band selection for this project was based on the sensor involved, the area of interest, hardware limitations, and time constraints. For each scene area, an eight-band, multi-temporal image was created that consisted of bands 3, 4, 7 and a ratio of band 3 to band 4 from both image dates. There were two exceptions to this eight band selection. Only one scene date was received from the TVA for scenes 20/35 and 20/36 and therefore only four bands were used, and band 7 was not delivered with these scenes so band 5 was used to replace band 7.

Since the majority of the TM scenes and most of the ancillary data were delivered in UTM zone 17 with a NAD83 projection processing was completed in this coordinate system. Any imagery not in UTM zone 17, NAD83 projection was converted using PROJECT in ARC/Info.

The nearest neighbor algorithm was used. In addition, the single date scenes received from the TVA had to be resampled to 30 meter pixels then projected into UTM zone 17.

All scenes were checked for anomalies such as striping, clouds, leaf status and proper projection/rectification. Several scenes were reordered because both dates were 'leaf off'. Hydrology and roads coverages were used to check rectification of the scenes. One date for each of the three scenes 17/35, 18/35 and 20/37 was mis-registered. Their registration was corrected by shifting the upper left coordinates by an amount specified by the EROS Data Center, from whom the data was received. Each scene was cut to the SAA study area with an additional one mile buffer and scene to scene overlap was minimized.

Preliminary Field Visit

The purpose of visiting the study area for field data collection is twofold: 1) to assess and document ground vegetation variation and 2) to transfer knowledge between Forest Service and Pacific Meridian personnel. Variation in vegetation is directly correlated with the spectral variation in satellite imagery. This variation is correlated with spectral variation in the satellite imagery during the image classification process. For this to be successful, a merging of the knowledge of forest vegetation with the knowledge of spectral reflectance is imperative. The best means of bringing these two factors together is through teamwork in the field.

Prior to any processing, an initial field visit was made to acquire a general knowledge of the vegetation in the Southern Appalachians.

This was a week long trip in visiting forests from northern Georgia to northern Virginia. Forest Service personnel accompanied Pacific Meridian in the field giving an overview tour of their forest and explaining the causes of vegetation variation

in their districts.

This was an excellent start to the project and notes from this trip were used in all steps that follow.

Image Classification

Upon completion of pre-processing and the preliminary field visit, each image was stratified into urban agriculture and other areas using the Land Use Data Analysis (LUDA) layer provided by the National Biological Service. Stratification of imagery allows the image processor to narrow the range of expected classification results based on ancillary knowledge. Areas in the LUDA data labelled as agriculture or urban were used to mask corresponding areas from the imagery.

An ISODATA unsupervised classification of approximately 25 clusters was then run on these areas and the classes were identified using aerial photos and the image processors knowledge of satellite imagery. The image processors first labelled the clusters as either forested, non-forested or mixed classes. Forested areas were set aside to be processed later. Non-forested areas were further separated into urban, pasture, crop or mixed. Areas that were labelled as agriculture in the LUDA data and that Pacific Meridian identified as crop or pasture were considered to be correctly classified. Likewise urban areas identified by Pacific Meridian which matched the LUDA data were also considered to be correct. These areas were set aside and not considered for future processing.

The mixed classes were then run through another ISODATA unsupervised classification for further class separation and identification. Again, classes were identified as urban, pasture, crop, forested, or mixed and compared to the LUDA data as discussed above. Any classes still identified as mixed then defaulted to the LUDA classification with agricultural areas being labelled pasture or crop based on photo interpretation by the image processors.

Forested areas were placed back with the original imagery for the remainder of the classification.

An ISODATA unsupervised classification was then run on the

remaining imagery. Depending on the variation in the imagery, fifty to seventy-five spectral classes were identified in the classification. Several classes were identified as being spectrally very similar but representing very general landcover types within the study area. For example, water, pasture, and herbaceous were each represented by multiple spectral classes. In cases where a spectral class could reliably be found to represent a single land cover type, i.e. water, barren, etc., the spectral classes were simply relabeled to that land cover type. Classes that could be identified as a general class type, such as deciduous, but not as a specific cover type, such as northern hardwood, were labeled as deciduous, coniferous, etc.

More confused spectral classes were given a unique color so they could be easily distinguished. This newly recolored spectral variation map was used to identify areas to be field visited. As many of the different spectral classes as possible were targeted for field visits to collect field data pertaining to vegetation cover type for the entire range of spectral reflectance present in the study area. The goal was to correlate the spectral variation in the imagery with the variation in the land cover.

Field Data Collection

Field work occurred during the months of May and July, 1995. Draft maps of the initial classification were taken to the field and compared to the vegetation on the ground. Notes were taken to indicate where the classification was accurately identifying the land cover and where it was inaccurate. General notes were also recorded that documented all spectral and vegetative variation encountered. These field notes were used to assist image processors in checking the results of unsupervised classifications and identifying training sites for completing image classification of the study area.

More than 100 person days were spent visiting the study area and meeting with Forest Service personnel from each of the forests in the study area. Pacific Meridian image processors completed the field data collection with the assistance of Forest Service personnel. The image processors responsible for completing image classification were responsible for the field data collection, ensuring consistency throughout the entire mapping project.

Re-Processing

After returning from the field, Pacific Meridian used the knowledge gained in the field to refine the unsupervised classifications. Areas noted in the field as correctly classified were set aside. Areas noted as being incorrect were masked from the imagery and re-classified. In addition, a few supervised training sites were added where the unsupervised classification could not distinguish between classes.

As a classification was completed, digital elevation data, hydrology layers, field notes, aerial photography, and ARC/INFO stand inventory layers were used to identify possible problem areas in the maps. For example, digital elevation models were compared with the classification to identify areas where northern hardwoods were appearing below 4000 foot elevations. While this combination is not impossible for the area, it is an unusual occurrence and warrented checking. Aerial photos and field notes were used to check these areas. Where the classification was determined to be correct, the area was set aside so as not to be changed. Areas classifying incorrectly were selected for re-processing and run through another iteration. This continued until no further gains in class identification could be achieved from the imagery. Any remaining modifications would be achieved with the use of ancillary data and manual editing.

From the start of the mapping project, several classes were known to be difficult to achieve strictly from the satellite imagery. These included wetlands and bottomland hardwoods. Bottomland hardwoods were classified using the imagery along with hydrology and elevation data. A one hundred meter buffer of streams at lower elevations was used to confine these hardwoods to the bottomlands. An unsupervised classification was run and bottomland hardwood classes identified using field notes and aerial photography.

Wetlands were based exclusively on the Fish and Wildlife Service National Wetland Inventory (NWI). Wetlands were defined as the palustrine wetland sub-classes of forested, emergent, scrub-shrub, and moss/lichen that were greater than two acres in size. The only exceptions were that "Water" and "Bottomland Hardwood" classes would always take precedence where the NWI and SAA classes overlapped.

In addition, the Forest Service's 1992 montane spruce-fir was used as the spruce-fir classification.

Draft Map Review and Editing

Draft maps were plotted at 1:100,000 scale and delivered to the National Forests within the study area for review and comment. Unfortunately, Forest Service inupt during the draft map review was inconsistant. Several of the draft map reviews were excellent, identifying both correct and incorrect classes as well as having comments on the general ecology of the area being reviewed. However, several draft map reviews were incomplete and were never returned (see Appendix B). Of the total 74 draft 1:100,000 maps prepared for review, only 22 were returned with comments.

As Pacific Meridian received the reviewed draft maps, image processors made final enhancements and corrections to the classification. Since few corrections had been identified by Forest Service personnel during the draft map review, image processors reviewed aerial photography where available while making edits. As no aerial photo coverage was provided for much of the private lands, only limited editing could be accomplished in these areas.

Edgematching

The remaining step in the development of the land use/land cover raster classification was the joining of all fourteen scene classifications into one file. When several scenes are classified independently and then joined together, inconsistencies in data can result along scene boundaries. These inconsistencies are the result of several factors:

1.) Differences in ajoining scene dates can capture the seasonal variation in vegetation as well as natural or man made disturbances and cloud cover variation.

2.) Incomplete ancillary data, such as gaps in the wetlands data where data collection is not yet complete;

3.) Variation in or lack of draft map comments. For example, the comments received for scenes 16-17/33 indicated that "White Pine/Hemlock" areas occurred throughout the area. Comments from adjoining scenes 16-17/34 indicated that "White Pine/Hemlock" occurred very infrequently in the area.

4.) Inconsistancy in image classificiation due to processing of adjoining scenes by different personnel.

Edgematching minimizes inconsistencies between adjoining scenes. The classified scenes were stitched together and then visually checked against the imagery and aerial photography. Inconsistencies caused by variation in scene dates and incomplete ancillary data were not changed because the data, based on the scene classified, is correct. Inconsistencies due to differences in draft map reviews were changed only if a definitive distinction between the correct class and the incorrect class could be identified on the aerial photography. Remaining inconsistencies were checked against the imagery, aerial photography and other ancillary data and the appropriate edits were made.

After edgematching, the final step was to transfer the data to an Arc GRID format and convert it to the SAA Albers projection.

Polygon Creation

The final land cover classification raster layer was used to develop the polygon GIS coverage. The polygonization process has three distinct stages: raster scan; conversion to ARC for elimination; and polygon labeling.

1. Raster Scan - The raster scanning process smoothes or generalizes pixel data to produce homogeneous units. The resulting pixels represent areas of homogeneous land cover pixels. The scanning process was accomplished using a series of scanning routines in ERDAS.

2. Conversion to ARC and Elimination - The products of the ERDAS scanning routine are converted to an ARC polygon coverage and all polygons less than 2 acres were removed. First, all polygons less than .3 acres were removed using a

simple DISSOLVE command. The remaining polygons less than 2 acres in size were removed using a series of intelligent eliminates. Intelligent eliminates compare the less than 2 acre polygon to the polygons surrounding it and prioritize the surrounding polygon with which it should be merged. For example, if a one acre white pine/hemlock polygon was surrounded by an oak polygon and a white pine/ hemlock/hardwood polygon the one acre polygon would be merged with the latter. Due to software constraints, the study area had to be processed in five parts.

3. Polygon Labeling - After vectorization of the classified pixel data, polygon attributes or labels were added to the polygon data. Polygon pixel summaries were calculated for each polygon and a label was assigned based on the composition of the classes within the polygon. For example, if a polygon was 65% oak, 25% white pine - hemlock, and 10% barren the polygon received the label of Oak Forest. The rules used to label the polygons can be found in Appendix C.

Crosswalk between Map Class and Accuracy Assessment Class

SAA Class Descriptions	Accuracy Assessment Class
Northern Hardwood Forests	Hardwood
Mixed Mesophytic Hardwood Forests	Hardwood
Oak Forests	Hardwood
Bottomland Hardwood Forests	Hardwood
White Pine / Hemlock Forests	Conifer
Montane Spruce-Fir Forests	Conifer
Southern Yellow Pine Forests	Conifer
White Pine / Hemlock / Hardwood Forests	Conifer/Hardwood

Mixed Pine / Hardwood Forests	Conifer/Hardwood
Herbaceous	Herbaceous
Barren	Barren
Agriculture - Pasture	Agriculture
Agriculture - Cropland	Agriculture
Wetlands	Wetlands
Developed	Developed
Water	Water
Indeterminate - Clouds, Shadows	Indeterminate

The USFS and Pacific Meridian will incorporate fuzzy set theory to assess the accuracy of this data. Color infrared, Forest Health Monitoring (FHM) stereo triplicate photography at a scale of approximately 1:12,000 was chosen as the primary sampling unit (PSU) for accuracy assessment. The center of each forest health photo set was digitized and buffered to create a circular PSU of approximately 1,236 acres. A total of 236 PSUs were buffered. The polygon coverage was then intersected by these PSUs to produce a final coverage representing the population of polygons available for accuracy assessment sampling. The list of polygons available for sampling were summarized in a database which was then sent to the Rocky Mountain Forest and Range Experiment Station for polygon sample selection. The goal was to select 50 polygons of at least 40 acres for each land use/land cover class for accuracy assessment analysis.

An accuracy assessment still being conducted. Results are expected by July or August 1996.

This classification is a comprehensive database for the area and provides a powerful tool for resource planners to utilize in increasing the effectiveness of resource management. This

database is currently being assessed for accuracy. The database will be made available by the Forest Service on multiple CD ROM in early 1996. For information on the CD-ROM, contact Karl Hermann at the National Biological Service, University of Tennessee, 17 Ridgeway Road, Norris, TN 37828.
Appendices

Appendix A
Southern Appalachian Assessment
Land Cover Classification Key

If clouds, shadows . . . . . .Indeterminate

If NWI = Palustrine or Lacustrine wetland and
area is not open water or bottomland hardwood species . . . .
. . . . . Wetlands

If vegetation > 25% . . . . . Vegetated

If > 25% tree crown cover . . . . . .Forested

If > 70% of the total tree crown cover is deciduous . . . .
. . . . . .Deciduous

Northern Hardwood Forests
Mixed Mesophytic Hardwood Forests
Oak Forests
Bottomland Hardwood Forests

Else if > 70% of the total tree crown cover is
evergreen . . . . . Evergreen

White Pine - Hemlock Forests
Montane Spruce - Fir Forests
Southern Yellow Pine Forests

Else . . . . . .Mixed

White Pine - Hemlock - Hardwood Forests
Mixed Pine - Hardwood Forests

Else if tree crown cover < 25%
If cropland or pasture . . . . . .Agriculture

Improved Pastures
Croplands

Else . . . . . .Herbaceous

Else if vegetation < 25% . . . . . .Non-Vegetated

If > 50% synthetic surface (LUDA) . . . . . .Developed
If lake, river, pond . . . . . Water
Else if > 75% is non-vegetated . . . . . .Barren

Appendix C Polygon Labeling Rules

If c17 >= 75% then label = c17
If (c12+c13) >= 66% then label = whichever is greater between c12 and c13
If any other class (c1 through c11 or c14 through c16) >= 66% then label = that class
If class with majority of pixels has >= 30% more of the polygon area than the next highest
class then label = majority class. For this rule, c12 and c13 should be added together for
consideration as a majority class and then if these to classes are >= 30% then the label will be
whichever is greater between c12 or c13.
If _(c1 through c10,c12,c13,c14) >= 25% then
If _(c1 through c9) > 25% then
If _(c1 through c4)/_(c1 through c9) >= 70% then
If c1 >= c2,c3 and c4 then label = c1
If c4 >= c1,c2 and c3 then label = c4
If c3 >= c1,c2 and c4 then label = c3
else label = c2
If _(c5, c6, c7)/_(c1 through c9) >= 70% then
If c6 >= c5 and c7 then label = c6
If c5 >= c6 and c7 then label = c5
else label = c7
If _(c8,c9)/_(c1 through c9) >= 70% then
If c8 >= c9 then label = c8
else label = c9
If _(c5,c6,c8) >= _(c7,c9) then label = c8
(**Please don't simplify this and the next line with

"else c7".
I want to catch labels that fall through)
If _(c5,c6,c8) < _(c7,c9) then label = c7
Else if _(c1 through c9) < = 25% then
If _(c12,c13) >= c10 and c12 >= c13 then label = c12
else if _(c12,c13) >= c10 and c12 < c13 then label = c13
else c10
Else if _(c1 through c10,c12,c13,c14) < 25% then
If c15 >= 50% then label = c15
else if c16 >= 50% then label = c16
else if c11 >= 50% then label = c11
else if c11 >= c15 and c11 >= c16 then label = c11
else if c15 >= c16 then label = c15
else if (c16 - c15) <= 15% then label = c15
else if (c16 - c15) > 15% then label = c16
Else label = default value of 20

Where
c1 = Class 1 = Northern Hardwood Forests 10 = Herbaceous
c2 = Class 2 = Mixed Mesophytic Hardwood Forests 11 = Barren
c3 3 = Oak Forests 12 = Pastures
c4... 4 = Bottomland Hardwood Forests
13 = Crop
5 = White Pine - Hemlock 14 = Wetlands
6 = Spruce-Fir 15 = Developed
7 = Southern Yellow Pine 16 = Water
8 = White Pine- Hemlock - Hdwd 17 = Indeterminate
9 = Mixed Pine - Hardwood

Entity/Attribute Information

Entity: LANDCOV.VAT
Definition: land cover class
Attributes: VALUE
COUNT

Entity:
Definition:
Attributes:

Entity:
Definition:
Attributes:

Status Information

Data Set Status: Available

Release Date: 3/21/96

Metadata Reference Information

Date: 3/20/96

Review Date:
(Source: Hermann, K. A. (Ed.). 1996. The Southern Appalachian Assessment GIS Data Base CD ROM Set. Southern Appalachian Man and the Biosphere Program. Norris, TN.

APPENDIX-C

GIS SUGGESTED SOFTWARE AND DATABASES FOR COMMUNITIES INTERESTED IN ECOTOURISM DEVELOPMENT

Today there is a wide variety of GIS software that can be used for the creation of maps and map overlays. In this appendix I will discuss what I believe are the best GIS systems for the management of ecotourism development.

For this thesis the primary software was Arcview 3.0. This is a product created by ESRI (Environmental Systems Research Institute). It is one of a family of ESRI tools that can be used to create and view GIS databases. The process can be started with Arc Info which is designed for the following tasks:

- Creates and maintains geographic information and coverages.
- Manages large, multi-user spatial databases.
- Converts between multiple data types with the exception of (shp files).
- Performs spatial analyses which defines in greater detail the images on the screen.
- Applications are simplified so that even beginners can view and use the creations.

However, ESRI software stands out because of its availability for both UNIX and Windows NT environments. In addition, ESRI provides excellent forms of support for users and is constantly improving its products to be more user friendly. More information on ESRI products can be obtained at http://www.esri.com.

The next software group that is most productive in developing GIS data bases is from the Intergraph company. Intergraph also provides a family of software similar to those of ESRI. It is also available in a Windows NT environment which helps the product be more user friendly. Intergraph has two very big advantages. First is its layering abilities which are ideal for overlay techniques such as those discussed in this thesis. The second is the fact that it is probably the most popular GIS software

world wide. Its popularity is very significant because this means Intergraph data bases can be shared between users on regional, national, or international basis. More information can be obtained about Intergraph products at http://www.intergraph.com.

APPENDIX-D

ADDITIONAL MAPS CREATED FOR THE COCKE COUNTY ECOTOURISM ASSESSMENT

Many of these maps are also useful as examples for communities attempting to develop ecotourism using GIS.

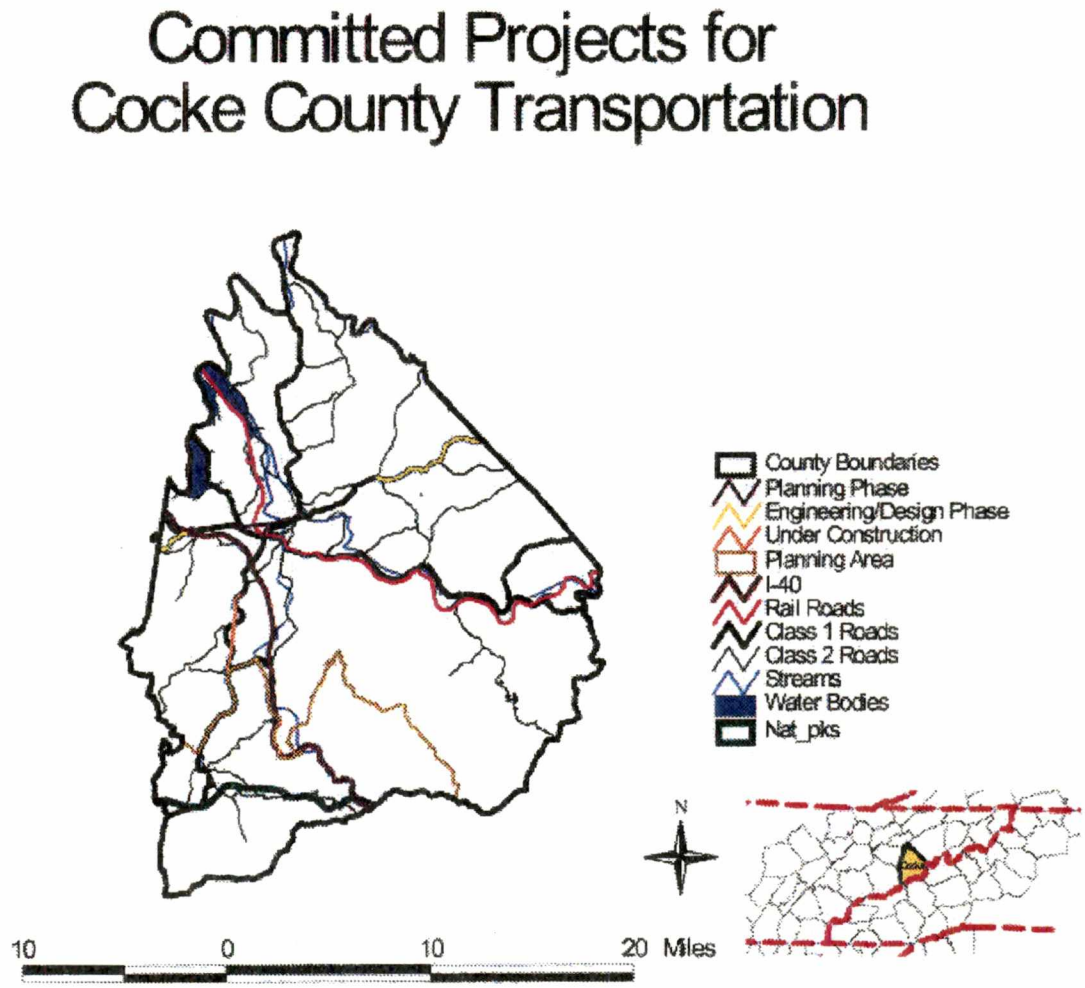


Figure D-1. Committed Projects for Cocke County Transportation

Source: Created from SAA GIS Data Base

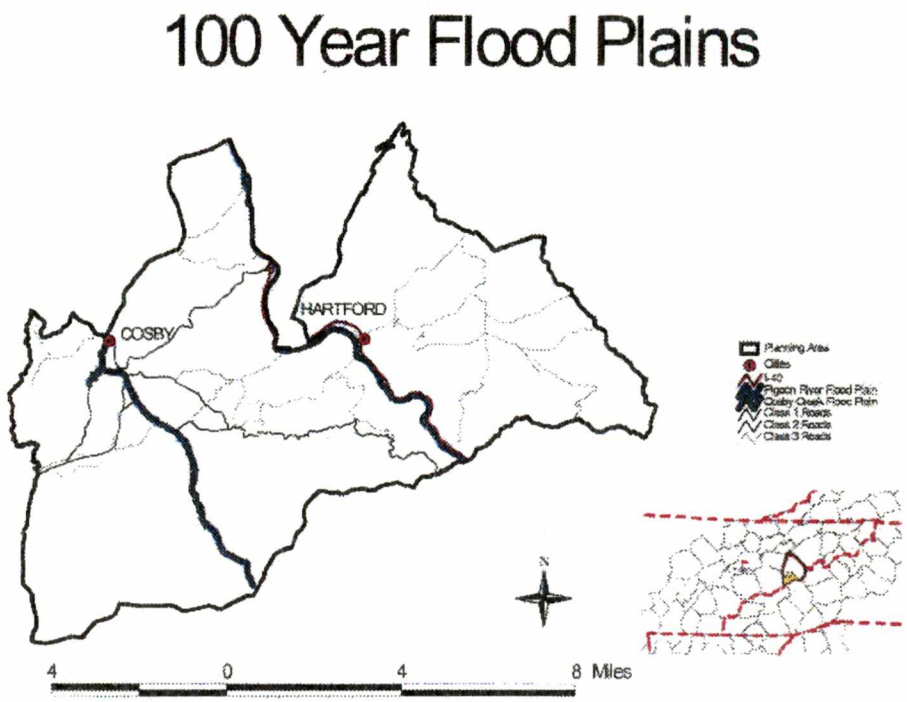


Figure D-2. 100 Year Flood Plain

Source: Created from SAA GIS Data Base

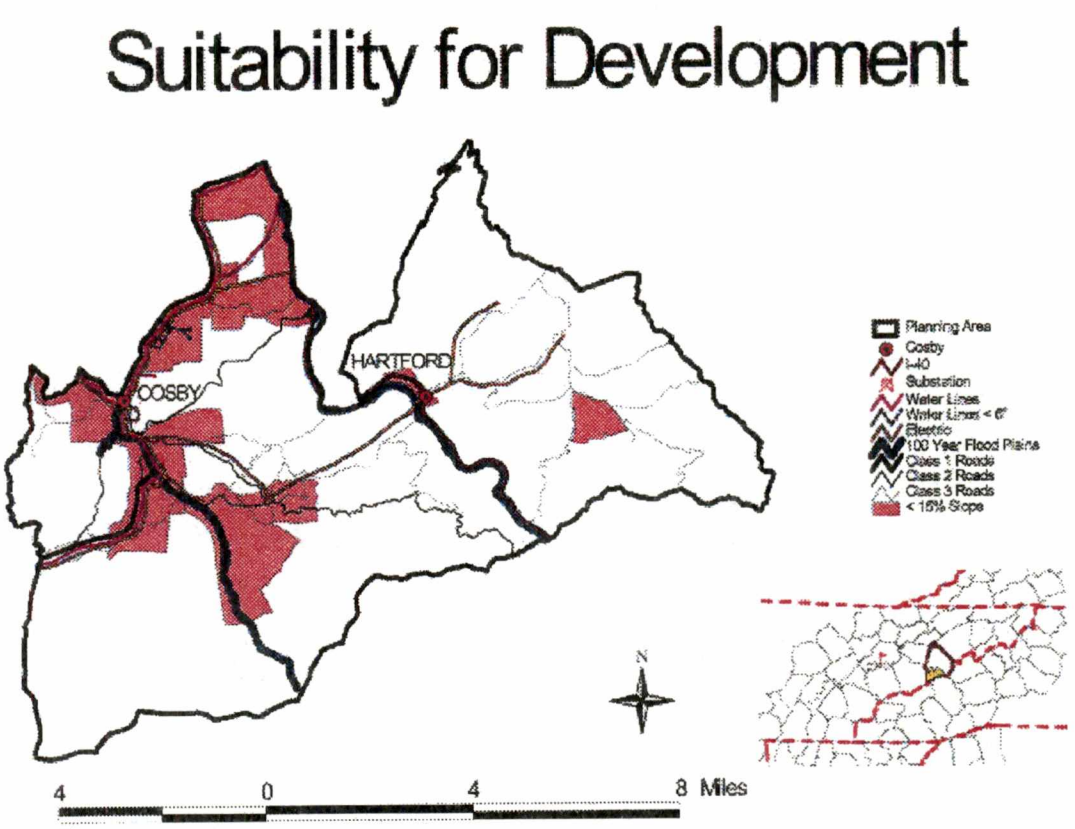


Figure D-3. Suitability for Development

Source: Created from SAA GIS Data Base

Regional Transportation Improvements

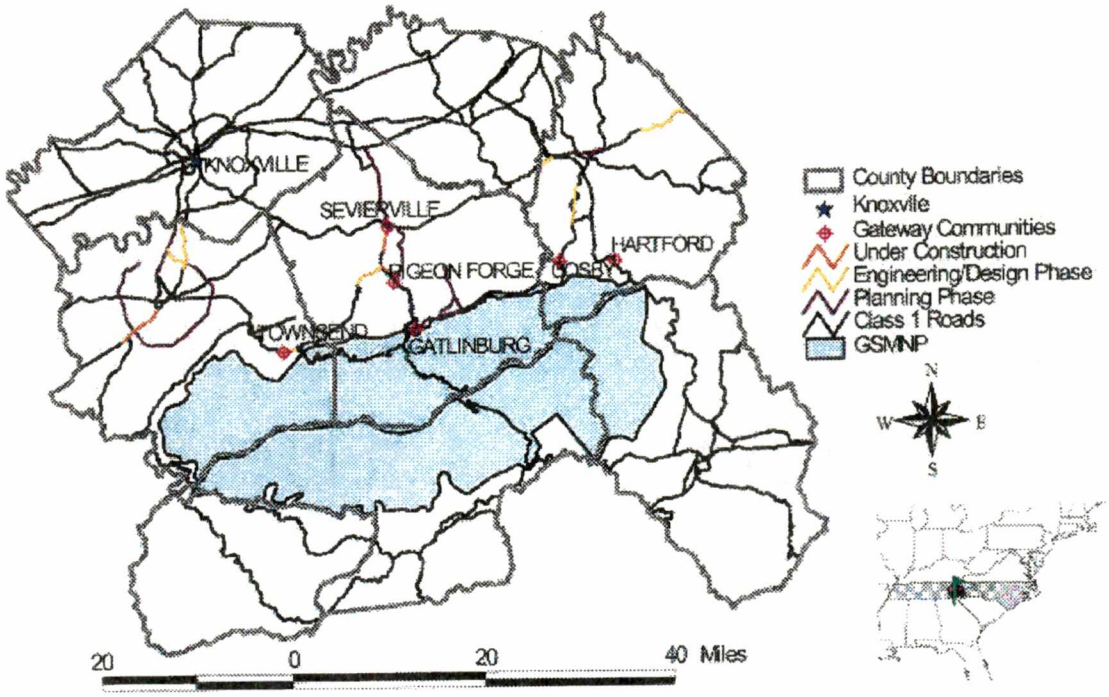


Figure D-4. Regional Transportation Improvements

Source: Created from SAA GIS Data Base

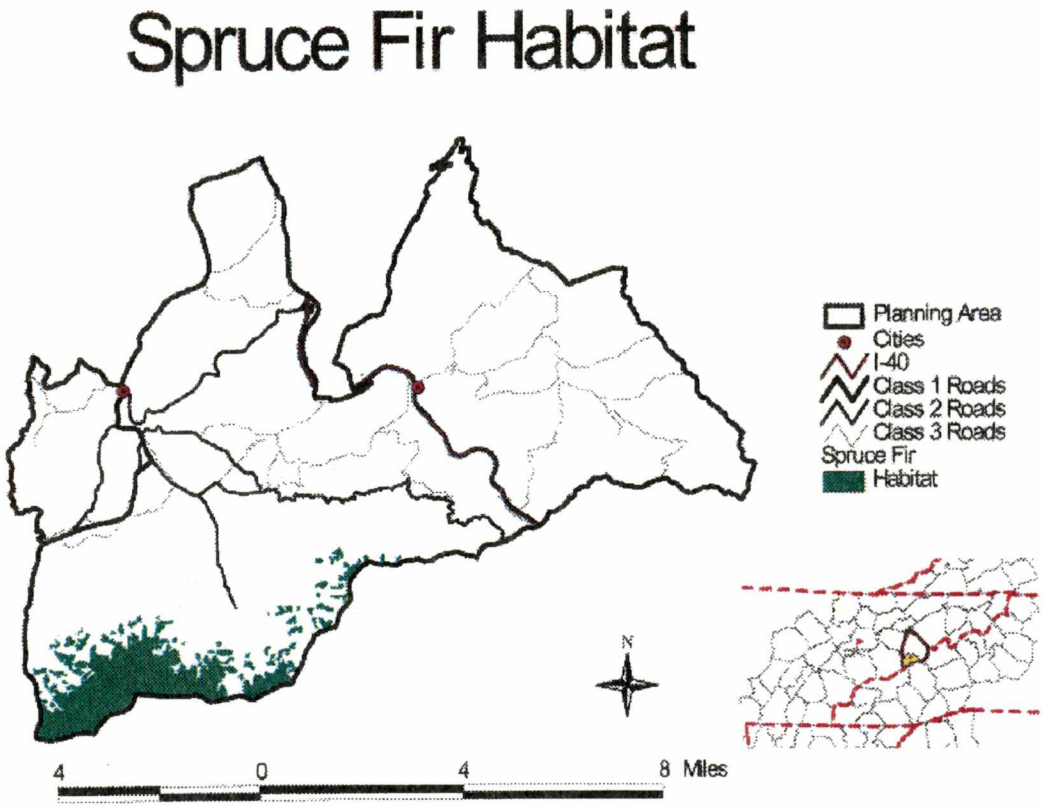


Figure D-5. Spruce Fir Habitat

Source: Created from SAA GIS Data Base

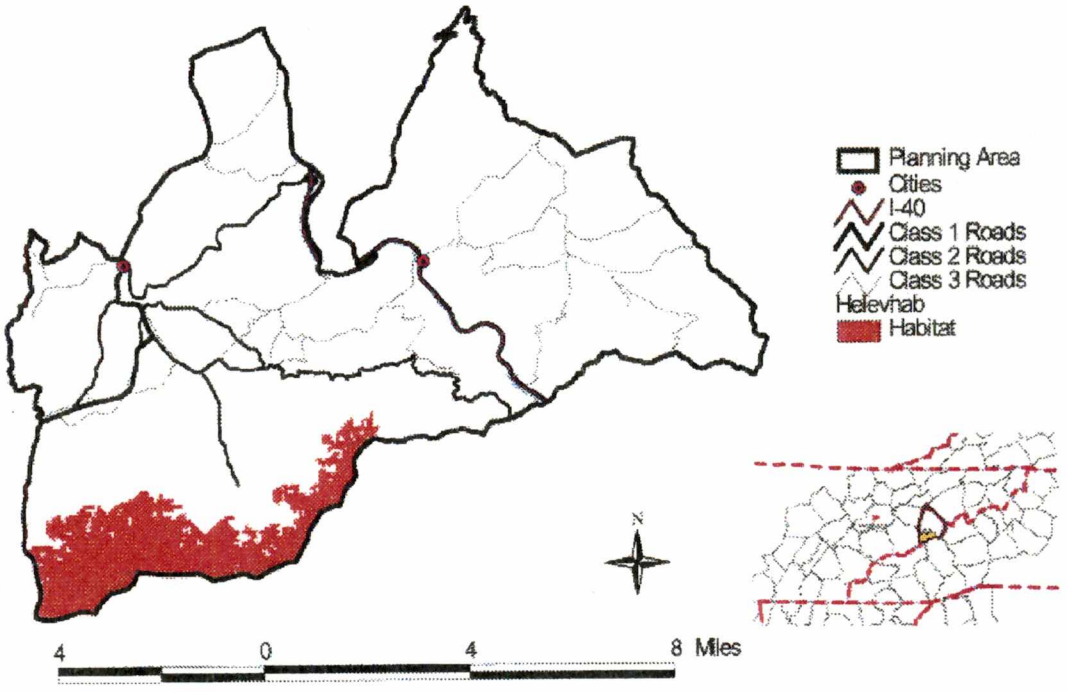


Figure D-6. High Elevation Habitat Areas

Source: Created from SAA GIS Data Base

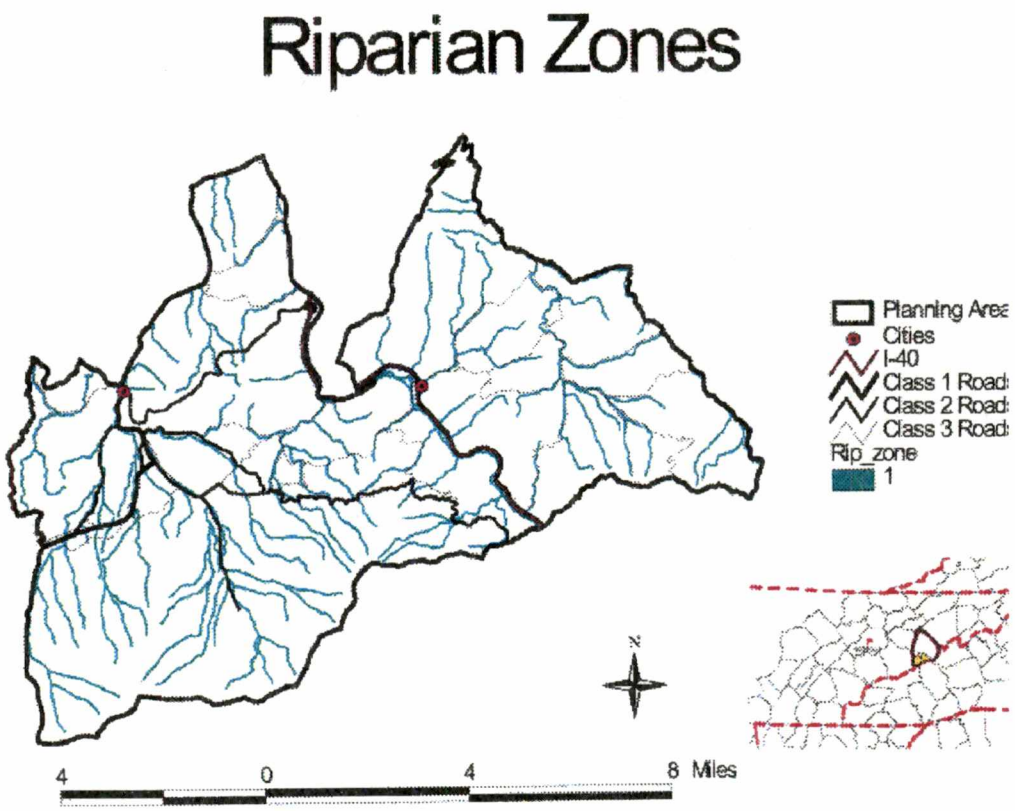


Figure D-7. Riparian Zones

Source: Created from SAA GIS Data Base

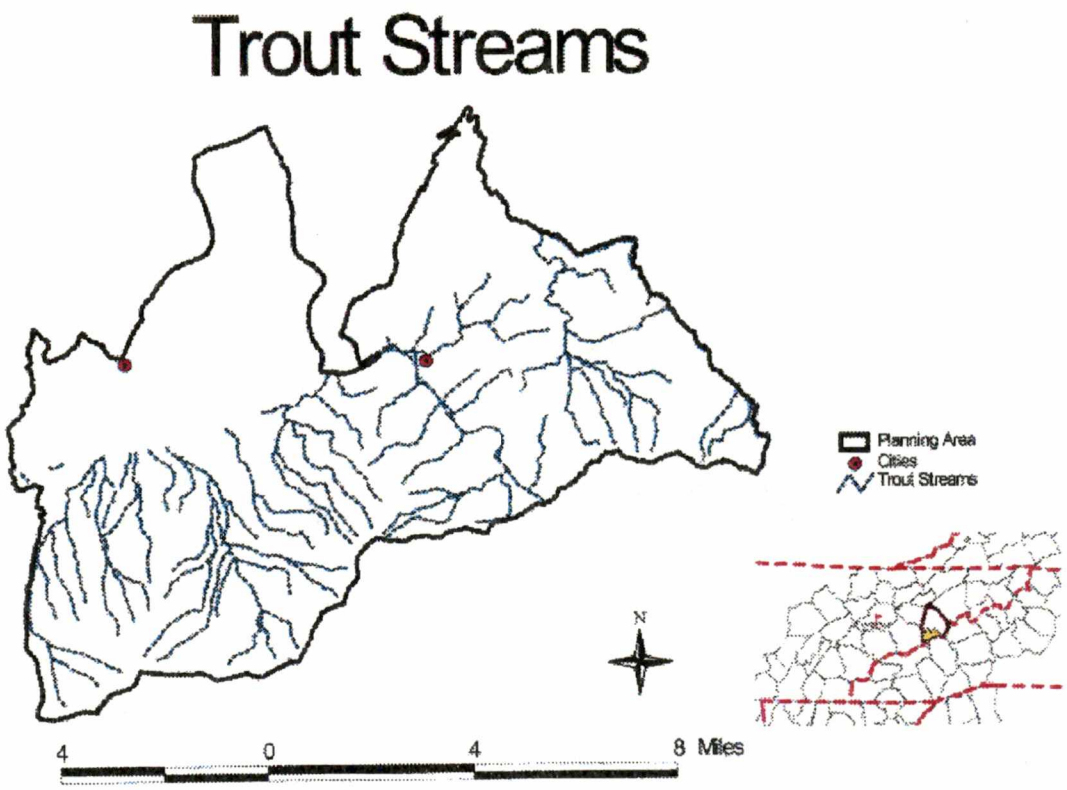


Figure D-8. Trout Streams (2)

Source: Created from SAA GIS Data Base

VITA

On February 6th, 1972, Nathan A. West was born in St. Louis, Missouri. After moving to Memphis, Tennessee, Nathan took part in home schooling and was the first in the state to be granted legal permission to be taught in this fashion. In the seventh grade, he attended boarding school in St. Louis until he graduated from high school in 1991. Later that year, Nathan enrolled in Willamette University of Salem, Oregon. In 1995, he graduated with a bachelors degree in Environmental Science. He entered graduate school in 1996 and received a graduate assistantship providing computer and GIS support for the University of Tennessee School of Planning. In addition, he conducted research at the U.S. Geological Survey-Biological Resources Division, Southern Appalachian Field Laboratory under Dr. John Peine. Here he partook in a transportation analysis of Great Smoky Mountains National Park. Through his graduate experience Nathan was a leading team member in the completion of two development plans including: The Conceptual Development Plan for S. Jacinto, Portugal and the Gateway Development Plan for the Cosby/Hartford Area of Cocke County, Tennessee. In May of 1998, Nathan graduated with a Masters of Science in Planning Degree.